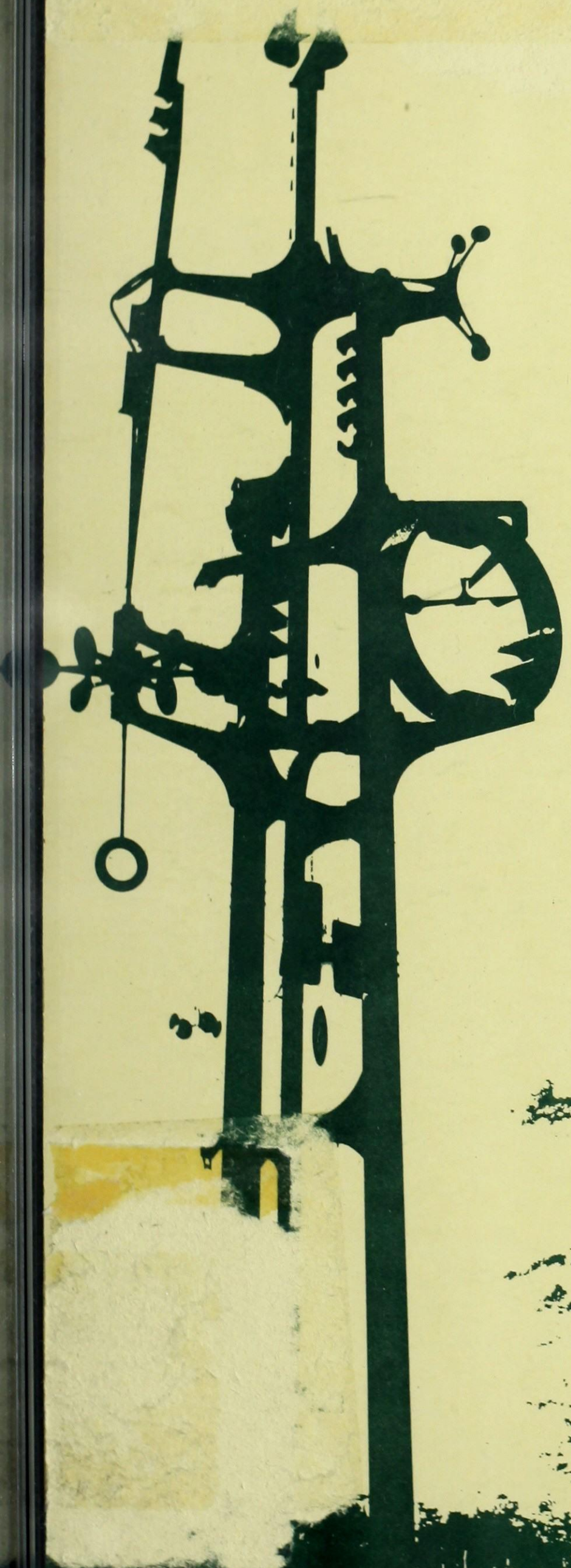
RECHERCHE ATMOSPHÉRIQUE



Air Quality and Inter-Environmental Research Branch

Annual Report

1983-84

Environment Canada / Environnement Canada

Atmospheric Environment Service / Service de l'environnement atmosphérique

2

Report: AQRB-84-M-001

Air Quality and Inter-Environmental Research Branch Annual Report 1983-84

Editor

Douglas A. Lane, Ph.D.

April 1984

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Le présent rapport fait partie d'une série publiée par la Direction générale de la recherche atmosphérique et destinée à l'usage interne. La langue de publication est laissée au choix de l'auteur. Cependant, si la demande existe, ces rapports paraîtront en français et en anglais. Les usagers sont invités à exprimer leur préference linguistique au Directeur général, Direction générale de la recherche atmosphérqiue, Service de l'environnement atmosphérique, 4905, rue Dufferin, Downsview (Ontario) M3H 5T4.

Air Quality and Inter-Environmental Research Branch
Atmospheric Environment Service
4905 Dufferin Street,
Downsview, Ontario, Canada M3H 5T4

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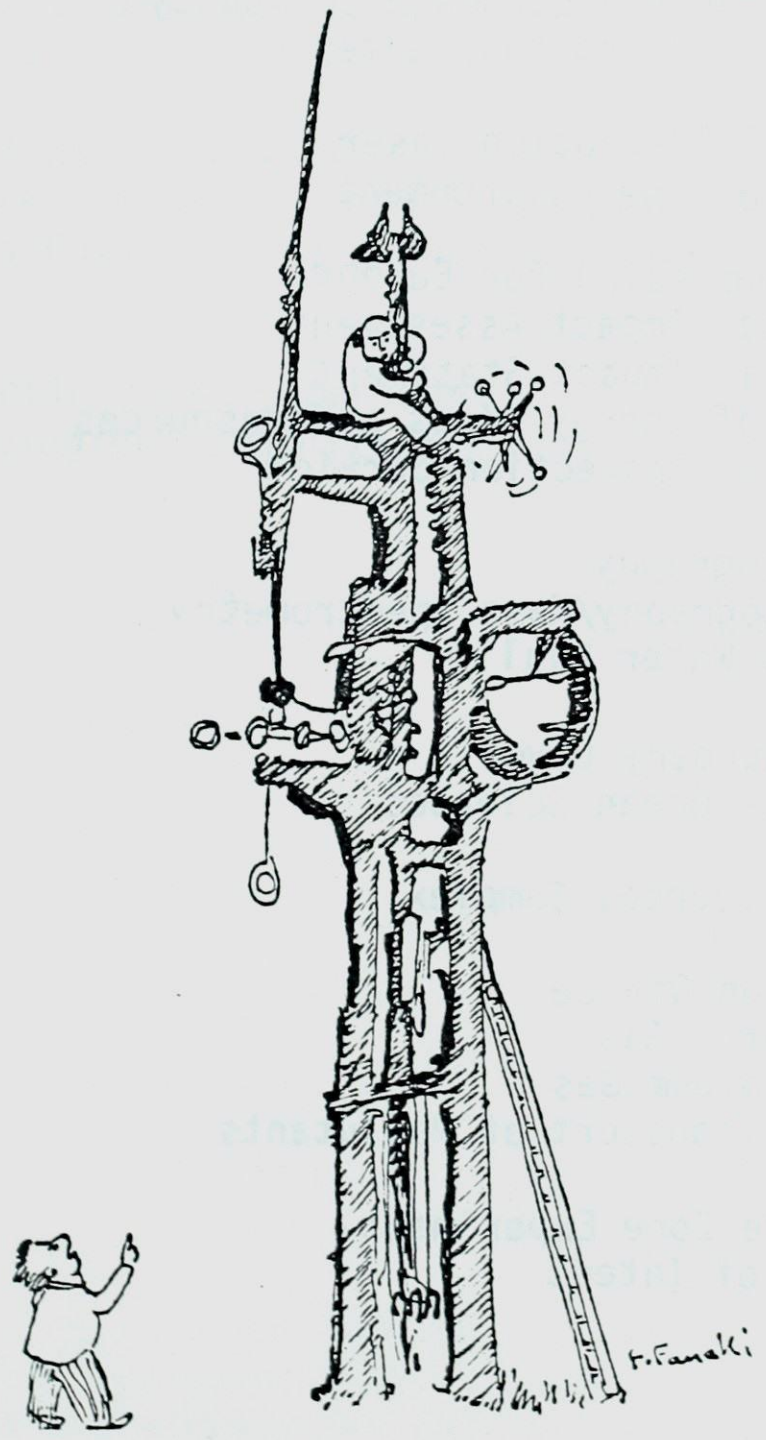


"I'm taking wind measurements! What does it look like?"
(Editor's note: I think he's working in vain)

2. TABLE OF ABBREVIATIONS

AECB	Atomic Energy Control Board
AECL	Atomic Energy Canada Limited
AES	Atmospheric Environment Service
AIMS	Atmospheric Interactive Modelling System
APCA	Air Pollution Control Association
APIOS	Acid Precipitation in Ontario Study (OME Project)
APN	Air and Precipitation Network
AQPAC	Air Quality Package for Environmental Emergencies
AQSCC	Air Quality Services Co-ordinating Committee
AS/6	Advanced Systems Model 6 Computer
ASL	Above Sea Level
ASTRAP	Advanced Statistical Trajectory Air Pollution Model
BIBS	Branch Interactive Budgeting System
CACGP	Commission on Atmospheric Chemistry and Global Pollution
CANSAP	Canadian Network for Sampling Precipitation
CAP	Capital
CAPMoN	Canadian Air and Precipitation Monitoring Network
CAPTEX	Cross Appalachian Tracer Experiment
CASD	Computing And Applied Statistics Directorate
CEC	Commission for the European Community
CMC	Canadian Meteorological Center
DIAL	Differential Adsorption Laser
DOE	Department of the Environment
ECE	Economic Commission for Europe
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMR	Department of Energy Mines and Resources
EPS	Environmental Protection Service
GC	Gas Chromatography
GC/MS	Gas Chromatography/Mass Spectrometry
GLWQ	Great Lakes Water Quality
IBL	Internal Boundary Layer
IOS	Institute of Ocean Sciences
IR	Infra Red
ISC	Industrial Source, Complex
LLO	LRTAP Liaison Office
LNG	Liquid Natural Gas
LPG	Liquid Petroleum Gas
LRTAP	Long Range Transport of Pollutants
MIZEX	Marginal Ice Zone Experiment
MOI	Memorandum of Intent

NADP	National Atmospheric Deposition Program (United States program)
NATO	North Atlantic Treaty Organization
NOAA	National Oceanographic and Atmospheric Administration
NRC	National Research Council of Canada
O&M	Operating and Maintenance
OME	Ontario Ministry of the Environment
PAH	Polycyclic Aromatic Hydrocarbons
PAN	Peroxy-acetyl Nitrate
PBL	Planetary Boundary Layer
PCBs	Polychlorinated Biphenyls
PEPE	Persistant Elevated Pollution Episode
RMCC	Research Management Co-ordinating Committee
RPC	Research and Productivity Council of New Brunswick
RSCC	Regional Screening and Co-ordinating Committee
SRC	Saskatchewan Research Council
SSD	Scientific Services Division
TCMP	Toxic Chemicals Management Program
TIBL	Thermal Internal Boundary Layer
TSP	Total Suspended Particulate Matter
UNB	University of New Brunswick
UNIMAP	User's Network for Applied Modelling of Air Pollution
US EPA	United States Environmental Protection Agency
UV	Ultra Violet
WATOX	Western Atlantic Ocean Experiment
WMO	World Meteorological Organization

3. EDITOR'S NOTES

The general intent of the AQRB report this year is to inform rather than to delineate: to convey accomplishments rather than to describe activities. It is for that reason that a report on each project carried out during the fiscal year, 1983-84, was solicited from each project leader with the request "to convey results in addition to a description of the project". It is hoped that the reader will feel that this has been accomplished and that he might be enticed by some of the reports to contact the appropriate scientist for further information.

An attempt has been made, this year, to harness the inherent power of the Branch word processor system and thus to reduce the work load of one individual in preparing the annual report. My thanks go out to each of the secretaries, Pat Pearson, Carrie Grant and Evonna Mathis for entering their respective Divisional reports onto the system and, in particular, to Doris Bardeau for her fine job in collecting, collating and synthesizing this report. My thanks also go to all of the scientists for their cooperation in preparing the individual project reports, to Kathleen Ford and Barb Grogan for supplying the information on contracts and unsolicited proposals, and to Fouad Fanaki for his delightful cartoon commentaries on the Atmospheric Environment Service.

In order to economize on paper and for clarity of presentation this report is available in two separate versions, an English version and a French version. It is hoped that the reader will find this report easy to follow, enjoyable to read and to contain much information of interest.

Douglas A. Lane.

4. FOREWORD

by James W.S. Young, Director

Last year I outlined how our Branch projects and programs related to Departmental objectives and Service priorities. I also described ten areas in which major thrusts are expected in the next 3 to 5 years. In alphabetical order, with an approximate percentage support from A-base funds in brackets, these are:

1. Air Quality Service (10%)
2. Climate Change (5%)
3. Core Research (10%)
4. Energy (5%)
5. Great Lakes Water Quality (3%)
6. Internal Services which Support Research (22%)
7. LRTAP (15%)
8. Northern Development (5%)
9. Oxidants (5%)
10. Toxic Chemicals (15%)

These thrusts have been broadly defined by AQRB as follows:

AIR QUALITY SERVICES: those activities through which the Branch responds directly to public demands for air quality information, advice and consultation.

CLIMATE CHANGE: the study of long-term changes in atmospheric composition which have the potential to influence climate either by affecting the transfer of radiant energy or modifying the properties and processes that lead to precipitation.

CORE RESEARCH: essential research that is <u>indirectly</u> related to priority issues or short-term applications and is carried out to fill the needs of the branch to maintain and to develop a scientific capability for other thrust areas.

ENERGY: encompasses atmospheric research conducted to encourage and support environmentally responsible conservation and development of Canada's energy resources.

GREAT LAKES WATER QUALITY: relates to the study of the atmosphere as a pathway for the introduction of deleterious substances into the Great Lakes.

INTERNAL SERVICES: those services required to support the day-to-day operations of the Branch. These services include the maintenance of internal financial and budgetary services, development and training of personnel, technical services, basic laboratory facilities, transportation and secretarial services and administrative and clerical services to each Division and the Branch.

LRTAP: encompasses the investigation of atmospheric processes, measurements and modelling associated with regional to global scale transport and deposition of air pollutants.

NORTHERN: refers to the study of air quality and related environmental problems north of 60 degrees latitude.

OXIDANTS: encompasses the investigation of atmospheric processes, measurements; and modelling associated with the formation of oxidants.

TOXIC CHEMICALS: encompasses the investigation of atmospheric processes, measurements and modelling associated with regional to global-scale transport and deposition of toxic chemicals.

Our ability to respond to any program is related to our understanding of the atmosphere and its interactions. There are three major elements that lead to this knowledge:

1. the data,
2. the research, and
3. the applications.

The first two, collecting data and carrying out research activities, are aimed at trying to answer six questions:

1. What is going on now? (Monitoring)
2. What had happened in the past? (Data Analysis)
3. How do atmospheric systems work? (Experimental Studies)
4. What could happen? (Modelling)
5. How much do we really understand? (Theory)
6. What does it all mean to man?
   (Impact Assessment, Public Awareness)

The answers we get to these six questions lead us to the third element by allowing us to address such practical things as:

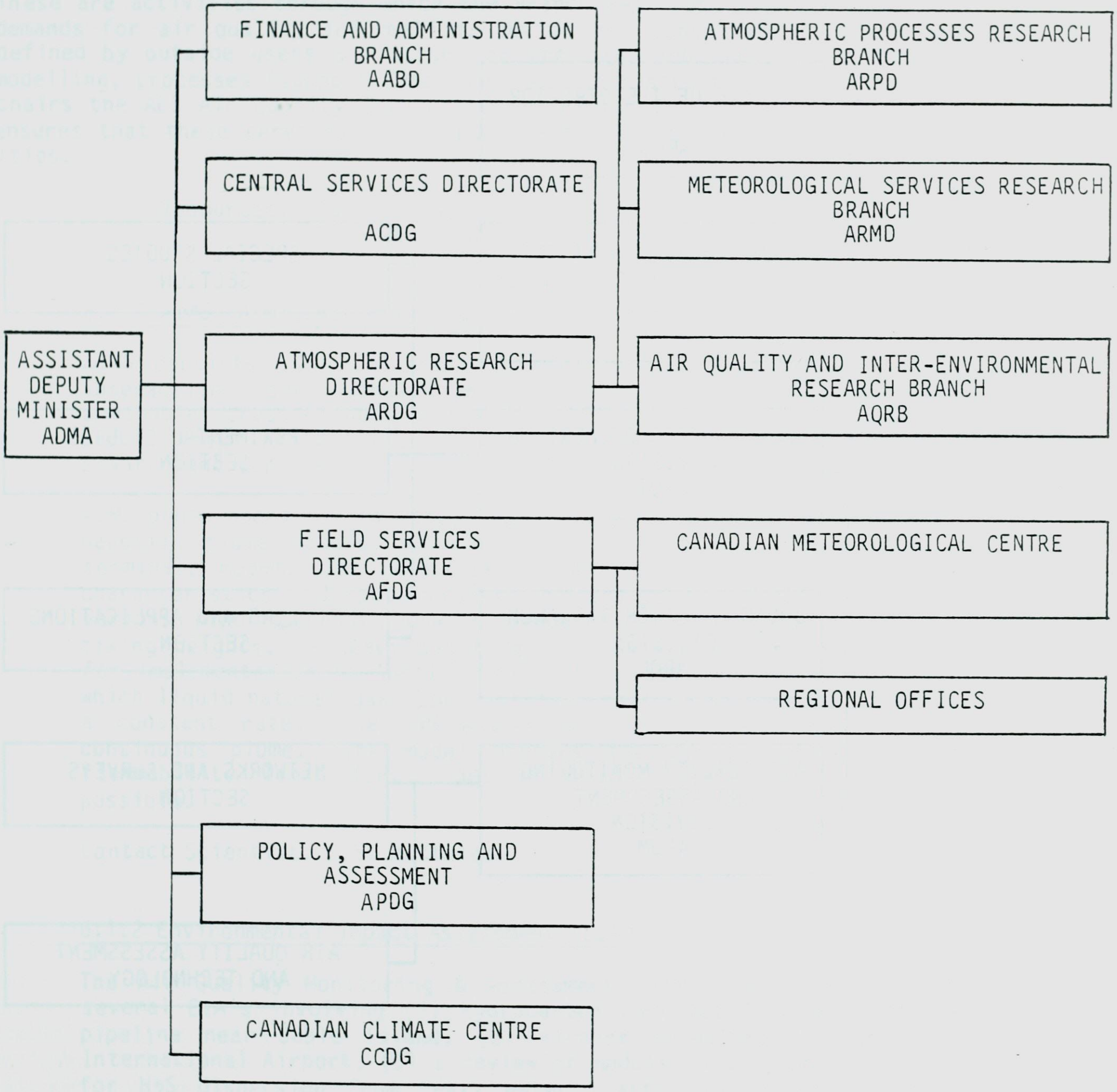
(a) Management of the Quality of the Environment (now and in the future);
(b) Socio-economic Impacts, and
(c) Environmental Emergencies.

You will see this perspective in the Branch* programs and projects and the progress reported on them in the following sections.

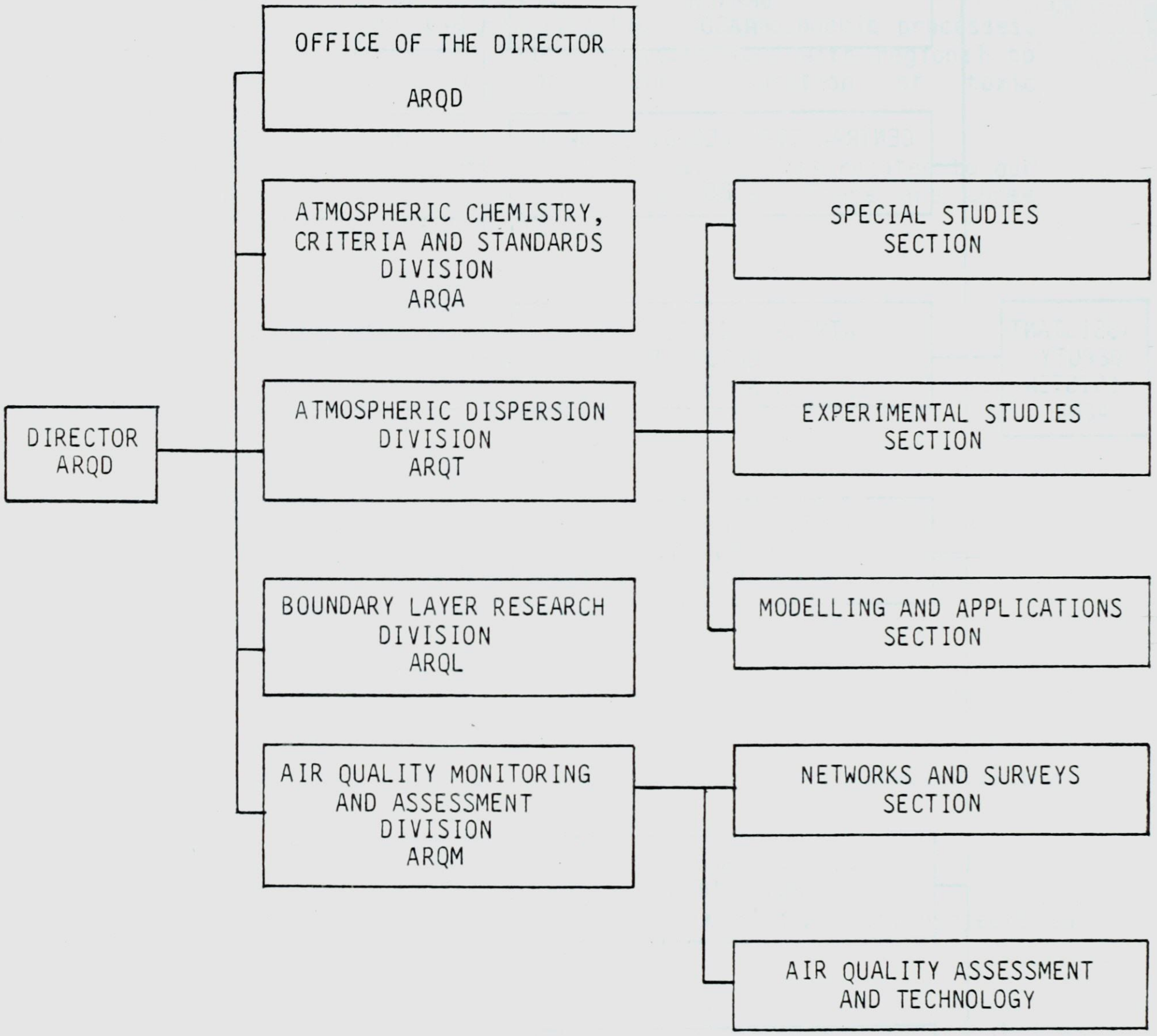
* The permanent staff of 64 is currently organized and distributed as shown in Section 12. Contact Scientists are referenced for each project reported in Section 6.

5. AES ORGANIZATIONAL STRUCTURE

(a) Atmospheric Environment Service



(b) AIR QUALITY AND INTER-ENVIRONMENTAL RESEARCH BRANCH



6. 1983-84 AQRB PROGRAM

6.1 Air Quality Services

These are activities through which the Branch responds directly to public demands for air quality information, advice and consultation. They are defined by outside users and issues of the day, and include monitoring, modelling, processes (support functions) and infrastructure. The Director chairs the AES Air Quality Services Coordinating Committee (AQSCC) which ensures that these services are responsive to DOE/AES policies and priorities.

Resources:	O&M	$123,000
	CAP	$ 53,000

6.1.1 AIMS (Atmospheric Interactive Modelling System)

AIMS consists of a collection of air pollution models which are interactive, user-friendly, and inexpensive to operate. They are available across Canada through the computer facilities of Dataline Inc. They are developed and upgraded by the Atmospheric Environment Service.

AIMS began operation in June, 1983, and consists of 3, point-source Gaussian plume models. The user can access the models with a terminal, modem, and telephone. The user specifies the source characteristics. Output consists of tables of concentration for various wind speeds, downwind distances, stability classes, and mixing heights. A heavy gas model is currently under development for implementation in April, 1984. It is designed for problems in which liquid natural gas (LNG) spills into a large body of water at a constant rate. The LNG evaporates and drifts downwind as a continuous plume. The model defines the contour of the lower flammability limit (LFL), beyond which ignition is no longer possible.

Contact Scientist: C.S. Matthias

6.1.2 Environmental Impact Assessment (EIA)

The Air Quality Monitoring & Assessment Section was involved in several EIA's involving (1) hydrocarbon releases from an undersea pipeline near Sable Island, (2) airport modelling at Vancouver International Airport, (3) a review of models used by Ontario Hydro for H_2S dispersion from heavy water plants, (4) a review of a NATO handbook on standards and rules for the protection of civilian population against chemical toxic agents and (5) the calculation of hourly-averaged ammonia concentrations during one year resulting from emissions from a fertilizer plant.

Contact Scientists: C.S. Matthias and S.M. Daggupaty

6.1.3 Air Quality Climatology

The AES Mixing Height Model produces statistics of joint frequencies of mixing heights (maximum and minimum), wind speeds, and wind directions at any upper air station in North America. For input, it requires upper air data, daily precipitation data, and hourly surface temperature data. Upper air data for all of North America, which had been purchased earlier from the National Climatic Centre in Asherville, N.C., was examined in detail. All files contained so many missing data that they could not be used for analysis.

The program was modified to use the Canadian formatted upper air data and was run for Nitchequon for the years 1965-69, so as to allow a comparison with an earlier study by R.V. Portelli. Extensive changes had to be made to several algorithms in the mixing height model before the Portelli results and the present results came into agreement.

The mixing height model is now validated against the Portelli study and against some hard-prepared calculations of mixing height and layer-averaged wind speed and direction. Mixed layer properties can now be calculated for any time period at Canadian upper air stations. For American upper air stations, data will have to be ordered.

Contact Scientists: C.S. Matthias and D.L. Bagg

6.1.4 Environmental Emergencies

The AQPAC (Air Quality Package for Environmental Emergencies) was developed to provide air quality guidance in the event of accidental release of toxic chemicals into the atmosphere. AQPAC, Version-1 was implemented at all AES regional centres. Seminars and technical help sessions on the use of the package were conducted at the regional weather centres.

Version-2 was developed by including the dry and wet deposition processes. Now the short-range dispersion models make estimates in real time for accidental releases, depleted air concentration, ground contamination and coordinates of threshold concentration or exposure. Physical, chemical and toxicity information on radioactive chemicals and vinyl chloride was added to the list of chemicals in the information package. Version-2 will be implemented at regional weather centres during the Spring of 1984. Further developmental work on AQPAC is continuing.

A document entitled "Recommendations for Meteorological Modelling and Monitoring" was completed for the Ontario Nuclear Contingency Planning Working Group. A special contribution was made on techniques for quantifying the source term during accidents.

Contact Scientist: S.M. Daggupaty

6.1.5 Support To Outside Agencies and Technology Transfer

Further revision work was done on the Canadian Standards Association document on "Guidelines for Calculation of Radiation Dose to the Public from an Accidental Release of Radioactive Material into the Atmosphere". The final version of the document was completed.

Day to day maintenance and technical advice on AQPAC was given to several enquirers and it was demonstrated to a visiting scientist from Hong Kong and Dr. G.W. Burgers from New York State. The puff model from AQPAC was made available to Ontario Hydro and the Ontario Nuclear Contingency Working Group successfully adopted this model as part of their package for emergencies.

Contributions were made to the design study and to the evaluation of an EMR contract project "on the impact of residential wood burning on urban air quality in Canada". At the request of EMR, the work was reviewed at all stages during the progress of the above contract. The study identifies 216 Canadian urban centres and ranks them according to pollution potential and for present and for future wood-burning characteristics.

Contact Scientist: S.M. Daggupaty

6.1.6 Simplot Impact Study

This was a comparison of model predicted ammonia concentration level with observations. The source was a fertilizer plant near Brandon, Manitoba. A joint report 'A simulation of Simplot using the Industrial Source, Complex (ISC) Dispersion Model, Brandon, 1982' was written and has been forwarded to the Manitoba government. On the basis of cumulative concentration frequency distributions, the model compared well with the observations.

Contact Scientists: A.K. Lo and C.S. Matthias

6.2 Climate Change

These are research studies of long-term changes in atmospheric composition which have the potential to influence climate. They involve characteristics, sources, dynamics, sinks and space/time distributions of various atmospheric components. 1983-84 activities fall into two categories, monitoring and analysis, and are associated mainly with the WMO BAPMoN network, and CO_2 monitoring program.

Resources:		
	O&M	$49,500
	CAP	$25,000

6.2.1 Arctic Haze

Atmospheric turbidity was evaluated at Resolute using global solar, diffuse sky radiation and upper air measurements for the period March 1969 to April 1980. The turbidity showed a slight increasing trend with a 11-year mean value of about 0.038.

The seasonal variation in turbidity is very consistent from year-to-year with a maximum occurring in late winter or early spring and a minimum in late summer. This is in sharp contrast to reported turbidity variations in other areas but is in agreement with aerosol measurements in the Canadian Arctic and at Barrow, Alaska.

Contact Scientist: R.J. Polavarapu

6.2.2 Carbon Dioxide Monitoring Program

The monitoring of carbon dioxide for climate change is one of the important components of the Canadian Climate Program. Three stations have been identified for potential upgrading from grab flask sampling to continuous monitoring: Alert, Sable Island and Cape St. James. Alert will be the first station to be upgraded in 1984/85. In order to support the operation of these stations, a calibration facility will be established at Downsview to provide the calibration gases needed for each station, quality control and analysis of the recorded data, maintenance of inter-station calibration and to establish intercomparisons with other countries with similar monitoring programs, such as, the United States and Australia. The Geophysical Monitoring for Climate Change (NOAA) laboratory in Boulder, Colorado and an operational station at Barrow, Alaska were visited as part of the initial planning process for developing the 5 year plan for this project. Some equipment has been purchased for both the laboratory and the Alert Station.

Contact Scientist: N.B.A. Trivett

6.2.3 CO_2 DISTRIBUTION RESEARCH

A study of the flask sample data from Alert, NWT and Sable Island for the years 1978-1982 was carried out to investigate the trend, interannual and short term meteorology related variability and a report was prepared.

Support was provided to Agriculture Canada for the development of an open-path, fast response CO_2 sensor for use with a sonic anemometer as an eddy correlation CO_2 flux system for use over different ecosytems.

Contact Scientist: A.D. Christie

6.3. Core Research

This is essential research indirectly related to priority issues or short-term applications. Activities maintain and develop a scientific capability for other thrust areas in monitoring, modelling and process research.

Resources: O&M $124,000
CAP $143,000

6.3.1 Remote-Controlled Sensing Development

The ARQT remotely piloted platform is a commercially available model aircraft with a length of 1.5 m, wingspan of 2.1m, and weight of 4 kg. The payload is 3 kg and it is controlled from the ground with a 6-channel radio transmitter.

The platform can carry temperature, relative humidity, pressure and turbulence sensors or an air sampling canister. The maximum altitude (above ground) is 1 km and the duration of a typical flight (depending on payload) is 15-20 minutes.

Contact Scientist: F.H. Fanaki.

6.3.2 Modelling of Airflow in Complex Terrain

Work on this project has centred on the continued development and application of the MS3DJH series of models. These are based on an approximate theory of boundary-layer flow over low hills due originally to Jackson and Hunt and extended to three dimensions by Mason and Sykes. Our own work has concentrated on refinements to the theory and development of models applicable to real terrain features with horizontal scales from about 0.1 to 10km. Careful comparisons have been made with alternative model predictions (2D) as well as with field data from the Kettles Hill and Askervein field studies. The models perform well and have been applied successfully in a number of collaborative projects (with University of Western Ontario, the Directorate of Meteorology and Oceanography for the Canadian Armed Forces and the U.S. Navy). Recent developments of the model have allowed for the effects of spatial variations in surface roughness and for internal gravity waves if the incident flow is stably stratified.

Contact Scientists: J.L. Walmsley and P.A. Taylor

6.3.3 1982 Nanticoke II Shoreline Dispersion Experiment

Follow-up work was carried on in 1983 to complete analysis of results from the Nanticoke II study. The project provided detailed spatial data close to the shoreline of the meteorological growth of the thermal internal boundary layer and the interaction of industrial plumes with this TIBL. While the conditions were not as favourable for this 1982 study as they were in 1978 at the same

site, the study was able to assess the additional impact of two new industries in the area. In terms of sulphur dioxide fumigations, their additional input has been nearly negligible and Ontario Hydro's Nanticoke Generating Station is still the major source for any TIBL fumigations.

Fifteen internal publications have been prepared by the Ontario Ministry of Environent, Ontario Hydro, the Japanese National Institute of Environment Studies, the Netherlands Public Health Institute, the University of South Florida and Unisearch Ltd. Two journal publications have been prepared and are in the review stage.

Contact Scientist: R.M. Hoff

6.3.4 Meteorology, Long Range Transport of Air Pollutants and Health: An Integrated Study

Isolated areas can be subjected to air pollutants from distant sources, commonly referred to as LRTAP (long range transport of air pollutants). The acute health effects associated with the degradation of air quality from these remote sources are not well defined in the literature.

In order to investigate the impact of LRTAP on asthmatic children, a joint field study with Health and Welfare Canada was carried out in June 1983 at a summer camp on Lake Couchiching, Ontario. Of 120 residential campers, 52 children (age 8-15) volunteered to participate in the study. Twenty-three of the subjects were asthmatic. Measurements of lung function were performed twice daily and the children answered a brief health symptom questionnaire. The camp was equipped with meteorological sensors and various pollutant measuring units were used to determine the air quality of the area during the study period. Measurements included SO_2, O_3 and size fractionated particulates. Comparison of the observed concentration of particulates within a canopy and outside a canopy suggested that the trees act as filters for certain size particles and play a role in the deposition process.

Back trajectory modelling was used to determine the history of the air masses reaching the research area. The trajectory analysis showed that the camp area was often subjected to air masses that had travelled over pollution sources in U.S.A. and in Canada. The associated increase in LRTAP pollutants coupled to meteorological measurements produced modest changes in health indices.

Contact Scientist: F.H. Fanaki

6.3.5 6th Remote Sensing Campaign of the Commission of the European Communities

At the invitation of Mr. P. Guillot of the Commission of the European Communities, AES sent a team of three persons to participate in the 6th Remote Sensing Campaign at the Etang de Berre, France in June 1983. These series of experimental field studies, which began in 1975 at Drax, England, are designed to

test, intercompare and develop new technologies for the remote sensing of air pollutants. The project involved the use of six differential absorption laser radars (DIALS), four for remote measurement of SO_2 and two for O_3. Results from the ENEL team (National Electricity Research Labs) of Italy were particularly impressive since they were reporting measurements of background levels (8 ppb) of SO_2 aloft. AES was involved with the air quality surveys during daylight hours with Barringer Correlation Spectrometers and LIDAR and, during the nighttime, AES's LIDAR provided mixing heights for use by the meteorological teams. A final report has been completed, and a session on LIDAR results from the project will be held at the XII Laser Radar Conference in Marseilles, France, in August 1984.

Contact: R.M. Hoff

6.3.6 Atmosphere-Ocean Interaction

Studies have continued of storms over the North-east Pacific Ocean. Warm and cold frontal systems are usually associated with weather radar and balloon-borne instrument packages, launched from a ship, the structure of such a system has been extensively investigated. The cloud area aloft is mainly fed by moist, warm air moving up near the cold front. As the system moves easterly, warm, moist air from the south moves northward in advance of the cold front and then rises. As it rises it mixes with faster moving air aloft and moves eastward. After frontal passage, the air is cooler aloft and warmed by the ocean surface, creating convective showers. Further understanding of these types of storm systems will lead to an enhanced ability to model and predict weather systems arriving at the Pacific coast.

Atmosphere-ocean exchanges of heat play a major role in determining the earth's climate. An historical data set for the North Pacific Ocean, covering over 25 years, has been examined to determine the spatial and temporal variations in the monthly averaged heat flux. There is, as expected, a large annual cycle but this cycle is quite different from year to year. The interannual variability also differed from various areas of the ocean basin. This variability is related to the variations in the oceanic heat transport. Studies have begun to investigate this relationship.

Contact Scientist: G.A. McBean

6.3.7 Air Quality Model Development

A tape containing 21 assessment models developed by and for the U.S. Environmental Protection Agency was purchased. The models were set up on the AES computer. Most of the models were tested by QAES to assure that they were running properly on the AS/6. Subsequently, two models were used in environmental impact assessments: one to simulate a proposed aluminum refinery, and another to simulate an existing fertilizer plant.

Contact Scientist: C.S. Matthias

6.3.8 Remote Sensing of SO_2 and O_3

A decision was made in 1983 to modernize the Atmospheric Dispersion laser radar facility to one with a capability to detect sulphur dioxide and ozone. After reviewing state-of-the-art systems in Europe and North America, a design for a Differential Absorption Lidar (DIAL) system was completed. Tendering of sub-components was carried out in 1983 with most sub-systems to be delivered in early 1984.

The AES DIAL will consist of a 10-mj tunable ultraviolet laser source near 300 nm. The laser, being built by J-K Lasers of Rugby, England, and Lumonics, Ltd. of Kanata, Ontario, will consist of a J-K 2000 series Hyper-Yag laser, which pumps a lumonics dye laser. The dye laser output at 600 nm will be frequency doubled into the UV. New optical detection facilities will be necessary on the DIAL system and these sub-systems will be constructed in-house from commercial optical components. The new DIAL system is expected to be assembled by late 1984 and usable in the field by mid-1985. The system is designed to have 4 ppb-km sensitivity for SO_2 and 8 ppb-km for ozone. These values should provide the ability to profile vertical concentrations of SO_2 and O_3 in regionally polluted air masses.

Contact Scientist: R.M. Hoff

6.4 Energy

Research activities in this thrust area are conducted to encourage and to support environmentally responsible conservation and development of Canada's energy resources. Activities are mainly modelling and processes research designed to develop benign energy sources and assessment tools for energy project evaluation, and to examine environmental implications of widespread use of alternative energy. The 1983-84 program includes development of (1) a complex terrain model for wind energy and (2) dispersion models for emergency application.

Resources: O&M $179,000
CAP $ 46,000

6.4.1 Wind Energy and Climate Applications

The MS3DJH model was applied to various terrain features in order to provide model results regarding wind flow over complex terrain. One application was to a Barchan sand dune for which observations were available; another was to San Nicolas Island, California. These studies resulted in one conference presentation and one report.

Contact Scientist: J.L. Walmsley

6.4.2 Askervein Experiment

This project forms part of the International Energy Agency programme of research and development on Wind Energy Conversion Systems. Canada is the lead agency for this experiment which involves about twenty scientists and other personnel from five countries studying boundary-layer flow over Askervein, a 125m hill in the Outer Hebrides of Scotland. During 1983 our work included the analysis of data from the 1982 experiment and the conduct of the main, September/October 1983 field experiment. Both activities progressed satisfactorily and we are confident that the project will produce a valuable, well documented and comprehensive data set on both the mean flow and turbulence above an isolated low hill.

Contact Scientists: P.A. Taylor and R.E. Mickle

6.4.3 St. Lawrence Valley Wind Energy Resource Assessment

The main objective of this continuing project has been to evaluate candidate sites for Project Eole (the design and construction of a large vertical axis wind turbine). It has been carried out in collaboration with Hydro Québec and the National Research Council. Sixty metre towers at three of the four candidate sites were decommissioned during the year but we will continue to collect and process data from the Iles-de-la-Madeleine site until March 1984. All of the sites have good wind energy potential and it has been decided to construct the wind turbine at Fonderie near Cap Chat. Detailed analyses of two years data from each site have been carried out to provide the necessary input for design of the wind turbine.

Contact Scientist: P.A. Taylor

6.4.4 LNG Project

The objective of this project is to improve the capability to assess the hazards associated with spills of liquid natural gas and other denser-than-air gases. This is being achieved by contracts to improve the basic knowledge of processes interacting during a spill and to develop modelling and assessment capabilities.

Two series of trials of 2000m^3 spills of gases of density 1.3 to 4.2 times that of air were conducted by the UK National Maritime Institute in a multi-agency sponsored study. The first series, 14 releases, was to an unobstructed surrounding. In the second series, 8 releases, obstacles such as walls and fences were placed to intercept the dispersing gas.

Preliminary analysis has demonstrated the importance of wind speed, and relative unimportance of atmospheric stability in determining the dispersal.

A contract to implement an assessment model for LNG spills on the AIMS (Atmospheric Interactive Modelling System) was let. A

preliminary version of the Colenbrander model was implemented and a user guide produced. A contract was also let to the Gas Research Institute in the US for participation in a cosponsored study of more sophisticated 3-dimensional numerical heavy gas dispersion models.

Contact Scientist: J.D. Reid

6.4.5 Diffusion of Heavy Gases

Diffusion of heavy gases is a function not only of the nature of the source and type of gas, but also of the atmospheric wind, turbulence and thermal stability. This interrelationship was examined on the microscale by a field study and by comparison of the results with the predictions of two theoretical models of diffusion.

Field studies were conducted at the Meteorological Field Station at Woodbridge, Ontario, using a special heavy gas source and a mixture of carbon dioxide and air. The formation, expansion and dilution of the heavy gas cloud was studied by measuring its concentration and determining its modification by the ground, wind speed and thermal stability. The temporal and spatial dispersion parameters were obtained. Comparison of the data with the model predictions suggests discrepancies in both cases but more work is required.

Contact Scientist: F.H. Fanaki

6.5 Great Lakes Water Quality (GLWQ)

This program involves studies of the atmosphere as a pathway for the introduction of deleterious substances into the Great Lakes. The most important of these are nutrients, heavy metals and persistent organic chemicals. Activities are directed towards program goals (1) to identify relevant sources, (2) to determine relative loadings, and (3) to define pollution deposition rates to the Great Lakes. In 83-84, these include estimating organic deposition and particulate enrichment by breaking waves, development of analytical methods and modelling techniques to determine vapour/particulate phase partitioning, and estimating atmospheric loading of toxaphene, nutrients and trace elements to the Great Lakes.

Resources: O&M $72,000
CAP $23,000

6.5.1 Organic Deposition to the Great Lakes

Several projects involving the production of bubbles were undertaken this year. The first, involving the transfer of gaseous organics to the Great Lakes, saw the installation of an automatic titrator on a tower in Lake Ontario measuring oxygen as a surrogate for the actual organics. Because of the limited data available

from the experiment, another identical experiment is planned during the spring gas evasion stage and autumn gas invasion stage. Because the most important atmospheric effect in many bubbling processes, including gas transfer, is the actual extent of breaking waves, or whitecaps, a significant effort was made to analyse multi-spectral scanner imagery of a field of whitecaps. Initial results indicate that a red-light enhancement procedure is capable of detecting the distinct processes of background diffuse reflection, wave slope specular reflections (glint) and the bubble scattering inherent in the white light of a breaking wave. However, the extra sensitivity and aliasing due to the limited resolution of the scanner leads to an estimate of the percentage of areal coverage siginficantly in excess of classical photographic methods. An attempt to gather more imagery near Prince Edward Island, was forestalled by unseasonable weather.

Another important aspect of bubbling is the scavenging of particles in the uppermost water depths. In particular, the hydrophobic nature of long chain, polar molecules associated with some important toxic organic compounds, makes them highly susceptible to scavenging. Subsequent hydrodynamic processes then offer the potential for direct enrichment of the food chain by surface grazing, large particle formation by coalescence and enhanced sedimentation rates. Equivalently, bubble scavenging by scrubbing of the main water body of such toxic particles may be at the expense of direct, inadvertent enrichment of the ecosystem and sediment deposition. An associated concept has been applied to the massive bubbling process occurring in the Niagara Falls, just downriver from the sites of known chemical injection. The concept of enrichment of the surface foam has been examined by collecting samples near the American Falls and analyzing them (in a gas chromotograph-mass spectrometer). In addition to compounds associated with solvents and oils, initial results indicate the enrichment of at least one polycyclic aromatic hydrocarbon. Another concept arising from these studies concerns the possibility of the bubble scrubbing of polluted rivers. Aspects concerned with economic feasibility, impact on the food chain of scrubbing background particles, and inadvertent aerosolization were identified for further study.

Yet another aspect of bubbling, the production of sound underwater by breaking waves has led to the development of a physical model. The work was presented to a research group in NATO and was published in the Journal of the Acoustical Society of America. An analysis of some wind-generated sound in the Pacific was published in Boundary-Layer Meteorology.

Contact Scientist: B.R. Kerman

6.5.2 Atmospheric Characteristics and Pathways Modelling

Atmospheric transport is believed to be responsible for the ubiquitous occurrence of a variety of toxic organic and inorganic substances on a global scale. For certain toxic chemicals such as

lead, PCBs and many organochlorine pesticides, atmospheric deposition appears to contribute a significant, if not the major, fraction of the total input of these chemicals to the Great Lakes ecosystem. For both of these atmospheric processes, the relative distribution or partitioning of a given airborne pollutant between vapour, particulate and liquid phases is a key parameter. The objective of this project initiated in 1983 is to develop and evaluate a mathematical model for predicting gas/solid/liquid phase partitioning of priority toxic chemicals in the atmosphere. Organochlorine compounds, particularly PCBs and pesticides, are receiving particular attention in the study.

Contact Scientist: W.H. Schroeder

6.5.3 Toxaphene Input Modelling

During 1983/84, a study was conducted to determine the importance and feasibility of estimating atmospheric input of toxaphene to the Great Lakes and their basins. The study focussed on identification of use-patterns (emission sources), atmospheric pathways and ambient air quality and precipitation measurements of toxaphene. It involved the analysis of trajectories from major source regions to receptors in the Great Lakes area and included preliminary estimates of the air concentration and deposition of toxaphene.

Information on use-patterns of toxaphene prior to 1976 and about 1980 were compiled and preliminary emissions inventories were produced. Ambient air quality and precipitation chemistry measurements for toxaphene were obtained from U.S. agencies. Subsequently, a comprehensive literature study on toxaphene was completed. Four-day back trajectories were computed from Beaver Island, a monitoring site in Michigan. The arrival dates of the trajectories coincided with dates of measurements. Seasonal mean trajectories (and standard deviations) from major source regions in USA were computed. These trajectories were analyzed for source receptor linkages. Preliminary estimates of air concentrations and deposition amounts of toxaphene for 1980 to the Great Lakes and their basins were computed. Transfer matrices linking source and receptor regions were also produced. The results indicate that the computed air concentrations of toxaphene are of the same order of magnitude as the measurements of "toxaphene like" substance.

The above study suggests that the atmosphere is the major contributor of toxaphene to the Great Lakes. It shows that the use-patterns of toxaphene are crudely documented, the atmospheric pathway is poorly understood and that data bases of measurements are limited and of dubious quality. Hence, development of new sophisticated models for estimating the atmospheric input of toxaphene to the Great Lakes and their basins are not warranted. The AES-LRT and ASTRAP models will be used in future modelling studies.

Contact Scientist: E.C. Voldner

6.5.4 Nutrients and Trace Element Load

The objective of the project was to estimate atmospheric loading of nutrients and trace elements to the Great Lakes and their basins. During 1983/84, wet deposition fields of nitrate and lead, predicted by the ASTRAP model for 1980 and 1981, were compared with amounts derived from the APN, CANSAP, APIOS and NADP networks in the Great Lakes basin. In addition, wet sulfur deposition was compared with observations in eastern Canada (see section 6.7.8).

Predicted and observed sulfur amounts show excellent agreement and preliminary results indicate that predicted and observed nitrogen deposition are comparable. Although predicted wet deposition of lead is considerably less than observed, the total modelled deposition in Ontario (comparison of lead estimates is restricted to Ontario due to lack of observations) approached the measured values. Thus, the model seems to have great potential for estimating loading of selected nutrients and trace elements to the Great Lakes basin and will be used in future studies.

Contact Scientist: E.C. Voldner

6.6 Internal Services

These are services required to support day to day Branch operations including financial services, personnel training, technical services, basic lab facilities, transport, and secretarial, clerical and administrative services. 1983-84 activities include development of BIBS (Branch Interactive Budgeting System), photo lab and visual aid service, word processor facilities, management information system, capital replacement program and a human resource inventory.

Resources:	O&M	$249,000
	CAP	$247,000

6.7 Long Range Transport of Air Pollutants (LRTAP)

The LRTAP program investigates atmospheric processes, measurements and modelling associated with regional to global scale transport and deposition of air pollutants. The goals of the atmospheric program are to measure wet and dry deposition within specified accuracies, and to model where emission reductions must be made to achieve a desired target loading. The program is part of a major federal scientific program involving several services and departments that deal with all aspects of the phenomena. The 1983-84 atmospheric sector activities included mainly lab and field studies of physical and chemical processes, concentration and deposition measurement and monitoring, simulation and control strategy modelling and pollution cycles and budgets. Major projects were the Cloud Chemistry study at North Bay, the CAPMoN operation and upgrade, the Eulerian model development and dry deposition studies.

Resources:	O&M	$1,236,000
	CAP	$ 716,000

6.7.1 Acid-Rain Related Chemical Research

A tunable lead diode laser system was developed by UNISEARCH Assoc. Inc. and delivered to AES in September. The detection limits for nitric oxide, nitrogen dioxide and nitric acid are all below 0.5 ppb. This instrument will be used for special field projects and for evaluating filter collection techniques for nitric acid and particulate nitrates. The laser technique has already been successfully compared to the filter pack and tungstic acid techniques for measuring nitric acid.

By means of Science subventions, York University has developed (1) a simple J_{NO2} instrument for monitoring the photolysis rate of NO_2 and (2) a simple yet sensitive NO_2 monitor. The measurements of both instruments will be valuable to the modelling of photochemical activity. Also, the NO_2 monitor is being engineered for aircraft use during cloud chemistry studies.

Instead of using standard pH meters, a flow injection colorimetric technique is being developed for measuring pH in cloud or precipitation samples. The accuracy and sensitivity of this method is superior to the pH meter and automation is a distinct advantage. For analysis of total acidity in aerosol samples a coulometric titration apparatus has been assembled. Gram's plots will yield total strong acid content. The DIONEX ion-chromatograph has been automated to take about 120-140 samples per carousel and to analyze for anions and cations simultaneously. For absolute calibration of ozone, a 2m long absorption cell with associated Hg lamp, optical components and detector have been built and tested. An in-house report is available.

The data taken during the 1982 summer Nanticoke field study has been analyzed and several publications are in progress. Some of the interesting findings include (1) the diurnal variation of pollutants (2) comparison of laser, filter pack and tungstic acid techniques for measuring nitric acid, particulate nitrate and ammonium (3) air parcel trajectories and frontal passages with the accompanying change in pollutant concentrations (4) dissociation of ammonium nitrate to nitric acid and ammonia (5) the relationships among atmospheric nitrates - PAN, HNO_3 and particulate nitrate--including some modelling work. Some preprints on this work are already available.

For some years, various tests on filter pack techniques (e.g. reproducibilty, break-through, interferences, temperature or humidity effects, etc) have been carried out at AES. A contract was given to Concord Scientific Ltd. to summarize the data and give conclusions. A draft report is already available. Air parcel trajectories for 1982 have been abstracted from CMC tapes and transferred to the ARQA files. Analysis on correlating air parcel trajectories with APN pollutant concentrations is continuing in fiscal year 84/85. No report is yet available on these results.

In atmospheric chemistry the data from the 1982 summer North Bay Cloud Chemistry project was abstracted, tabulated and preliminary analyses were completed. It was observed that NO_3^- as well as

$SO_4^{=}$ appears to be important to cloudwater acidity, in fact, frequently the NO_3^{-} was dominant. The cloudwater $SO_4^{=}$ can be accounted for by nucleation of water droplets on $SO_4^{=}$ aerosol particles. However, for NO_3^{-} this seems to be only partially true (further work is necessary here). High concentrations of Ca and Hg ions were also found in cloud samples--the importance of this chemistry need further investigation. The data suggests that aqueous oxidation of SO_2 to $SO_4^{=}$ takes place over a long time scale (i.e. much longer than life-time of cumulus cloud). Reprints on some preliminary cloud chemistry work (pre 1982) is available. A presentation of the 1982 field study results was given at the CACGP Symposium on Tropospheric Chemistry held in Oxford, (September 1983) and the 185th American Chemical Society meeting in Seattle (March 1983).

Contact Scientists: K.G. Anlauf and H.A. Wiebe

6.7.2 Advanced Chemistry Modelling

The purpose of this project is to develop and test chemical modules for LRT and oxidant models. Major emphasis during 1983/84 has been on further development and testing of an expanded chemical module for the Lagrangian AES-LRT model. This module involves the species SO_2, sulphate, NO_x, nitrate, PAN and HC (hydrocarbons). Several potentially important processes such as cloud chemistry, SO_2 solubility, diurnal and seasonal variation, have been parameterized and studied as to their influence on model results. Furthermore, tests were performed to determine whether or not the modelling of nitrogen chemistry with this model was realistically possible. This was found to be the case, in particular, when PAN chemistry was included. The development of a box model for oxidant chemistry was initiated. It is expected that this model will soon be operational and could be used for the analysis of chemical aspects of urban scale pollution problems.

Contact Scientist: J.W. Bottenheim.

6.7.3 PAN in the Environment

This project was started to determine the occurrence and pathways of PAN in the Canadian environment, in order to evaluate its contribution to LRT of oxides of nitrogen. The monitoring system developed during 1982/83 (System I) has been operated for extended periods at the APN site at Longwoods (spring, summer, fall), and at the more remote site at Chalk River (mid November-December). The system operated exceptionally well with very little down time. Analysis of the data is awaiting the HNO_3/nitrate data from the APN samplers, so that the importance of PAN in relation to LRT of oxides of nitrogen can be ascertained. A new system was designed and constructed for use during aircraft studies (system II). It samples with 15 minute time intervals and performs immediate GC analysis. System II was operated during the 1984 cloud chemistry study at North Bay. The lead time before the start of this study had been very short and hence many anticipated problems could not

be solved in time. The system was operational for a few days of the study but needs more developmental work. During this field study, several bag samples were collected. This procedure was considered less attractive, but no other PAN monitoring procedure appeared feasible. The bag samples were analyzed with System I, which was located at the ground chemistry station at Powassan for the period of this study.

Contact Scientist: J.W. Bottenheim

6.7.4 Control Strategy Model

The source-receptor matrices from long range transport models and information about the cost of controlling sulphur emissions are combined to formulate optimized emission control strategies for acid deposition. These optimized strategies estimate the geographical distribution of sulphur emission reductions such that acid deposition will be reduced to a specified target value by removing either the minimum possible amount of sulphur from emissions, or by minimizing the cost. Further testing of the methodology and its sensitivity to uncertainty in the input data is being carried out.

Contract Scientists: J.W.S. Young and R.W. Shaw

6.7.5 Nanticoke Project

The '82 Nanticoke tower data originally recorded on cassette tape was converted into engineering units. Preliminary analysis showed that most of the data was of good quality. Useable data were presented in both tabular and graphical forms in the text of an internal report, AQRB-84-001-L. The tower data should provide a base line meteorological information for Nanticoke II project and should be of contribution to further scientific studies related to the Nanticoke project.

Contact Scientist: A.K. Lo

6.7.6 LRTAP Climatological Dispersion Model

The draft of an internal report for the climatological dispersion model using Fay and Rosenzweig's analytical method has been completed. The remaining work will be to rewrite the findings in condensed form suitable for journal publication.

Contact Scientist: A.K. Lo and C.S. Matthias

6.7.7 Dry Deposition Project

Insufficient understanding and measurement of the dry component of acidic deposition has been identified a priority research area both in the Canada-United States Memorandum of Intent on Transboundary

Air Pollution (1982) and the US EPA Critical Assessment Document on the Acidic Deposition Phenomenon and Its Effects (US EPA-600/8-83-016A). This project is addressing this knowledge gap by developing and using micrometeorological eddy correlation techniques for measuring the relevant pollutant fluxes and looking towards parameterization schemes of deposition that would have application in LRTAP models. During the early part of the year reports on the data collected at Nanticoke, Ontario and Champaign, Illinois in 1982 were completed. Ozone and sulphur fluxes and deposition velocities were tabulated and stability-dependent adjustments due to limited sensor response were discussed. Upper limits for submicron particle deposition velocities were derived and found to be less than 0.5 $mm.s^{-1}$. The field program for the year consisted of periodic measurements during the summer months of pollutant fluxes to an agricultural field near Elora, Ontario, and continuous measurements of mean atmospheric variables throughout the summer and winter. By combining these two sets of measurements, an estimate of seasonal dry pollutant loading will be derived.

Another experiment during the winter near North Bay, Ontario examined the relationship between particle number and size-class concentrations and the sulphate aerosol content of the air. Instrument development during the year consisted of modifications to the ozone analyser for improved response, soft-ware development for the eddy accumulator flux system, and the completion and testing of a portable micro-computer system for eddy-correlation measurements. Planning was also initiated for a comphrehensive Forest Dry Deposition Study to begin next year and after several potential sites were examined, a suitable forest site was identified.

Contact Scientists: G. den Hartog and H.H. Neumann

6.7.8 Lagrangian Model

The Lagrangian modelling project involves several aspects of the numerical simulation of the cycles of atmospheric pollutants. A trajectory model is used to compute multi-level trajectories throughout the North American domain using meteorological and supporting data bases which are continually being updated. The Lagrangian concentration/deposition model uses the trajectories and other archived data to compute sulphur concentrations and depositions at specified sites during specific time periods for various purposes and is continually being upgraded and examined. An advanced chemistry model incorporating sulphur and nitrogen chemical processes is also being tested and used in a research mode (see section 6.7.2). Improved dry and wet deposition parameterizations are being investigated and tested in the models.

Trajectories and new plotting procedures have been completed to support the Branch, Ontario Hydro, AES Regions and the WATOX (Bermuda) projects and a forecast version was implemented for the CAPTEX project. The concentration/deposition model is being used to test a proposed wet deposition parameterization scheme. A

forecast version of the model used in the PEPE project was evaluated. Model-predicted wet deposition amounts were compared with deposition amounts obtained from observations in Eastern Canada and results were presented at the APCA Specialty Conference.

A real-time trajectory analysis program was developed and implemented at CMC to support the daily pH monitoring project. North American, seasonal dry deposition velocity fields have been gridded and examined and are soon to be tested in the model. Preliminary fields were supplied to Ontario Governmant (OME) and branch (ARQT) scientists for estimating deposition from observations.

Planning for the International Sulphur Deposition Model Evaluation Study - Phase I progressed to the point where the input fields should be ready for distribution by April 1984. The evaluation data have been screened and the statistical methodologies are being examined by project statisticians at CASD (Ottawa). Reprogramming and data base modifications for the CRAY computer were started and several successful CRAY runs have been made. An analysis of transfer matrices included intercomparison of MOI transfer matrices and 1980 transfer matrices from the AES-LRT and ASTRAP models.

Contact Scientists: M.P. Olson and E.C. Voldner

6.7.9 Snowmelt Acidic Shock Project

One of the environmental concerns of long range transport and deposition is the accumulation of pollution in the snowpack over the winter season and the sudden concentrated release of these pollutants into the streams and lakes during melt events. A project to study this snowmelt acidic shock problem was undertaken by the Hydrometeorology Division with funding from the AES LRTAP Program. This project consisted of two parts. In the first part, a snowmelt acidic shock model suitable for application to specific basins and to provide time series of the snowmelt, snowpack and melt water chemistry was developed. In the second part, a field study was implemented to collect suitable data on melt rate, snowpack and melt water chemistry to verify the model results.

The U.S. National Weather Service River Forecast System's conceptual snowmelt algorithm (HYDRO-17) was chosen as the basis for the snowmelt acidic shock model. Routines to handle the acid concentration in the snowmelt and melt water were incorporated into the model and tested using data from several small basins in southern Ontario. A 3m by 3m snowmelt plot has been constructed and was operated over the 1983/84 winter season at the Ontario Ministry of the Environment (OME) field station at Dorset, Ontario. Chemical samples of both melt water and snowpack were taken before, during and after peak snowmelt flows. Preliminary analysis of these samples have found pH values range for 3.8 to 5.6.

Contact Scientists: P.Y.T. Louie and B.E. Goodison.

6.7.10 Western Atlantic Ocean Experiment

Fluxes of sulphur and nitrogen compounds advected eastwards from the North American continent have been calculated for eight latitude and three altitude classes, on the basis of climatological wind data and available pollutant concentration measurements. A broad maximum in transport occurs between 33° and 48°N. Of the sulphur and nitrogen emitted to the atmosphere of eastern North America, approximately 34 and 22-76%, respectively, are advected eastward.

Contact Scientist: D.M. Whelpdale

6.7.11 LRTAP Scientific Liaison and Coordination

This project entails providing liaison and coordination between the federal atmospheric LRTAP program and those in various provincial, U.S. and European agencies. This has been achieved through participation in such committees as the RMCC Atmospheric Science Sub-Group and the Steering Body of the ECE European Monitoring and Evaluation Program.

Contact Scientist: D.M. Whelpdale

6.7.12 CAPMoN: Status of Air and Precipitation Quality Networks

The installation phase of the CAPMoN network is nearing completion. The stations in Manitoba, N.W. Ontario, Quebec, and the Atlantic provinces began operation in August. Some of the remaining stations in Ontario began operation in September. Three Ontario stations are awaiting the placement of contracts before installation. Two planned stations will not be operated due to the projected high cost of operation. These stations and augmentation of the present network will occur in 1984. The former eight APN stations have been converted into CAPMoN stations.

The 1982 CANSAP data has been published with the 1982 APN to follow shortly.

Contact Scientist: M.E. Still

6.7.13 CAPMoN Analysis

The main emphasis has been on developing ways to access the CAPMoN data. As a first step, a new publication format was developed that showed the relative magnitude of each new monthly data entry compared with the values obtained for the corresponding months in preceding years. This format was used first in the CANSAP Annual Report for 1981, published in June, 1983. This report also contained maps showing the spatial distribution of the annual mean concentrations and annual depositions. The next step will be to look at the effect of missing month(s) on the computed values of

the annual mean concentrations and annual depositions. Later, the spatial representativeness of the data will be studied.

Contact Scientist: A. Sirois

6.7.14 Eulerian Modelling of Acid Deposition

This project, carried out largely under contract to MEP Toronto and ERT Concord, Mass., has made major advances in the past year.

The model will involve the use of extremely large data bases (many incomplete and requiring imaginative interpolation or data generation procedures) that will be subject to quality control and preprocessing on the Downsview AS-6 prior to submission of full model runs on the CMC CRAY. The major I/O needs on the AS-6 and the CMC machines have been anticipated with suitable hardware additions. Commendable support has been provided by CMC staff.

The meteorological data base will use fields derived from the CMC version-g operational data assimilation and prognosis routines augmented to provide higher vertical resolution in the boundary layer by a column PBL model developed by MEP Co. Archiving is currently proceeding. The model is being implemented by ERT with sophisticated chemical transformation and deposition representation that will be dependent on good diagnostic cloud distribution for success. The model is designed for flexibility to allow subsequent upgrading as process understanding improves.

Joint programs with the US (as well as the Ontario and FRG co-sponsors of the model development) have been initiated to minimize duplication of effort on data base development, model evaluation and scientific exchange.

Contact Scientist: A.D. Christie

6.7.15 Cross Appalachian Tracer Experiment (CAPTEX)

The AES participated as the lead Canadian Agency (together with the National Aeronautical Establishment, the Ontario Ministry of the Environment and Environment Quebec) with the United States in a joint atmospheric tracer experiment. During the period 12 September to 30 October 1983, six releases of 200 kg each of an inert, perflourocarbon tracer were made from ground level - four from Dayton, Ohio and two from Sudbury, Ontario. The tracer was monitored by a network of automatic samplers at 80 sites - 60 in the northeastern U.S. and 20 in southern Ontario and southwestern Quebec. In Canada, additional samplers were installed at two levels on the CN Tower and one operated continuously in southern Nova Scotia throughout the whole experimental period. Seven aircraft - including the Canadian Twin Otter research aircraft - were used to obtain the vertical distribution of the tracer at distances up to 800 km from release. Additional meteorological data were obtained during each two-day release period by operating the standard upper air sounding network on a 6-hour frequency and

by 10 extra sites set up in the experimental area.

The complete quality-controlled meteorological and tracer concentration data sets will be available by early summer 1984 for trajectory model assessment and intercomparison studies. Preliminary indications are that in all experiments the tracer passed completely through the ground network and at least some of the aircraft intercepted the tracer aloft. Estimates of the horizontal dispersion σ_y, at ranges of 600-800 km from release, in some cases indicate small values of 12-20 km. However, on one occasion, the tracer measured by the aircraft at 1300 m ASL, at a distance of 700 km from release, had split into two maxima separated laterally by 100 km.

The Canadian component of the field program was co-ordinated through an operations office at AES, Downsview in daily contact with the main operations office at NOAA HQ Rockville, MD. The complex experimental logistics were successful and provided invaluable experience for the design of future large-scale tracer experiments.

Contact Scientist: P.W. Summers

6.7.16 Precipitation Chemistry on the Pacific Coast

Collection and analysis of rain and snow samples at IOS, on ships and at Mount Washington continued. Analysis of the snow core samples, collected jointly with Pacific Region, AES, Vancouver, has allowed the mapping of the precipitation chemistry in southwestern coastal region. Since the pH of "clean" precipitation in equilibrium with atmospheric CO_2 is 5.6, only the snow in areas near Georgia Strait/Vancouver is significantly depressed due to contributions from sulphuric and nitric acids. On Vancouver Island and the interior region the sulphate values were generally below the detectability levels of the analytical procedures used. These results indicate that the long-term measurement taken at Vancouver are probably representative for the Georgia Strait/Vancouver area but not for more distant locations.

Contact Scientist: G.A. McBean

6.8 Northern

These are studies of air quality and related environmental problems north of 60°N. Activities in 1983-84 include (1) determining the state and trends of background air quality with respect to hydrocarbons and arctic haze (2) air quality impact assessments in the north, and (3) field programs such as MIZEX.

Resources:		
	O&M	$20,000
	CAP	$27,000

6.8.1 Arctic Dispersion

Activity this year focussed on establishing the reliability of an acoustic sounding system for this type of study. The Bertin acoustic sounder was deployed at Sudbury in June as part of a study of fumigation of a low level source. Much useful data was gathered and supplied to the Ontario Ministry of the Environment. As a result of an Ontario Government Ministerial Order concerning the operating methods of the company, an acoustic sounder, is being investigated as an alternative boundary-layer wind sensor. Experimental results, involving the use of acoustic sounders to monitor shoreline inversion heights at Nanticoke were presented at a conference. Studies continue at the Woodbridge test site on the climatological occurrence of inversions.

Contact Scientist: B.R. Kerman

6.8.2 Marginal Ice Zone Experiment

The Marginal Ice Zone Experiment, (MIZEX), to be conducted during the summer of 1984 is a major international effort to provide data to allow modelling and prediction of variations in the ice edge position and concentration in the area near 80°N Lat. 0° Long. Areas of special interest include Arctic Navigation, Climate and Biology. The impact on Climate research is to incorporate MIZ parameterization into large scale models so that the response of ice covered oceans to major global disturbances can be understood. The Boundary-Layer Research Division's involvement relates to the meteorology portion of the MIZEX. In particular, the surface-air energy exchanges are to be measured in the MIZ. In ice covered oceans the growth, drift and decay of sea ice significantly modify the atmosphere-ocean interaction including thermal fluxes, surface albedo and momentum fluxes. More detail concerning processes, models and scientific questions can be found in the MIZEX science plan. In addition to the surface flux measurements, the AES tethersonde system will complement and provide calibration data for aircraft and ship weather observing systems including SODAR and radiosondes.

Contact Scientists: G. den Hartog and R.E. Mickle

6.9 Oxidants

These studies investigate atmospheric processes, measurements and modelling associated with the formation of oxidants (i.e. O_3 and peroxy compounds produced from hydrocarbons and nitrogen oxides in the atmosphere in the presence of UV solar radiation). Program activities conducted this year include examination of ambient concentrations, frequencies of exceedances, influx from the U.S., and significance of photochemical oxidant air pollutants in Canada.

Resources:		
	O&M	$35,000
	CAP	$13,000

6.9.1 Oxidant Climatology

The study of the transport of ozone during lake breeze situations near Lake Erie continued this year. Past work had led to the development of a sensitive ozonesonde which could be flown in conjunction with a commercially available tethersonde to provide detailed profiles to near 1 km during moderate wind conditions. Synoptic conditions were such as not to produce any high episode events during the July period, however, two lake breeze situations of slightly elevated ozone levels were studied. Profiles near Port Stanley to 800m clearly showed higher ozone levels in the onshore flow compared to the return flow aloft.

Contact Scientist: R.E. Mickle

6.9.2 Factors in Ozone Injury

The objective of this project was to relate foliar ozone injury in white bean to environmental factors using a relationship developed by Mukammal and Neumann (1980) and data collected in 1981 and 1982 by the University of Guelph. Analyses showed that the factors identified in 1980, namely weighted ozone dosage, plant maturity, evaporation rate from a 'Class A' pan and accumulated growing season rainfall were associated with the severity of injury that the relationships were not stable between years. This was deemed to be largely due to the inadequacy of simple combinations of evaporation and rainfall to act as surrogates for the controlling parameter of stomatal conductance. A more general aspect of air pollution effects was also undertaken, namely a commitment to keep abreast of developments in this area following re-appointment as CAgM Rapporteur on Air Pollution and Plant Injury for WMO.

Contact Scientist: H.H. Neumann

6.9.3 Hydrocarbon Monitor

The purpose of this project is to develop in-house capability to collect and analyze ambient air samples for volatile organic components in the C_2-C_{10} molecular range. During 1983/84, emphasis has been on developing procedures for the analysis of C_4-C_{10} hydrocarbons by using a SE-54 capillary column. Progress to date has been such that the major components, in particular, the important aromatic hydrocarbons (benezene, toluene, xylenes and ethylbenzene) can now confidently be identified and quantified. Important in this respect was the solving of the major interference by water on the analysis via the use of a Nafion drying tube. During part of this work in summer 1983, daily samples of ambient air were collected on the roof of the AES building. A report on the findings, as well as the procedural development work is forthcoming.

Time was also devoted to the design and construction of a fully automatic, "ultraclean" sample collection system for use during aircraft studies. The system was successfully operated during the

1984 cloud chemistry studies in North Bay. The large amount of data collected is currently being analyzed.

Contact Scientist: J.W. Bottenheim.

6.10 Toxic Chemicals

The atmospheric toxic chemicals program investigates processes, measurements and modelling associated with regional to global scale transport and deposition of toxic chemicals. The goals of the program are to determine the types, quantities and sources of toxic chemicals deposited to ecosystems from the atmosphere, and to establish the expertise and infrastructure to adequately deal with this important issue. Activity areas include identification of atmospheric toxic chemicals, measurement of wet and dry deposition, lab and field studies of chemical/physical transport and transformation processes, and modelling of transport, transformation and deposition. Major 1983-84 activities include pilot station operation near Maple, Ontario, sampling and analytical methods development, organic dispersion and deposition studies at field sites and in the lab. A number of projects were initiated in mid-year as part of the departmental Toxics Chemicals Management Program (TCMP).

Resources: O&M $135,000
CAP $213,000

6.10.1 Biological Monitors

Biomonitoring is a technique by which biological samples are used as indicators of pollution impingement and as a measure of air pollution impact. Lichens and mosses are particularly valuable plants for this purpose since they possess the characteristics which allow the quantification of injury or accumulation of metals which can be related to concentration of pollutants in the area.

The purpose of this project was to perform a literature search to collect all available data for Canada on the deposition of heavy metals and sulphur to lichens and mosses. These investigations included environmental quality studies around point sources and background monitoring of long-range transport of air pollutants. A preliminary analysis of the available data has been performed and, where possible, maps of pollution deposition across Canada are being produced. The data density across Canada was quite variable.

Contact Scientist: M.L. Phillips

6.10.2 Turbulence in New Brunswick Forest Canopy

Aerial spraying of insecticide is widely used in the protection of forests against spruce budworm in Eastern Canada. As in all spray operations, off-target drift is of concern so that a better

understanding of the complex interaction of the spray cloud during different meteorological conditions is necessary to maximize spray efficacy. In June 1983, further field work was undertaken in collaboration with NRC, UNB and RPC focussing on the direct effects of meteorology on spray deposit and drift. Monitoring of the response of the forest to solar heating indicated a predictable time for transition from stable to neutral stability. Characterization of turbulence to aircraft height during the various spray scenarios was used by UNB in model simulations of spray deposit. Mass balance measurements by NRC, RPC and UNB suggested better target deposit and less drift during turbulent neutral rather than less turbulent stable conditions.

Contact Scientist: R.E. Mickle

6.10.3 Investigation of Atmospheric Reactions of Mercury

In 1981, a literature review and synthesis of published information on homogeneous and heterogeneous reactions of mercury and some of its compounds in the atmosphere was completed. The resultant report identified several important information gaps or irreconcilable differences in published data and concluded with specific recommendations for future work. Two of the recommendations from the final report were subsequently selected as priority topics for further study.

Accordingly, during 1983 a contract was awarded to Dr. E. Cherniak at Brock University in St. Catharines, Ontario to investigate the chemical reaction between mercuric oxide and sulphur dioxide under controlled laboratory conditions. The objective is to determine the rate for this reaction at initial concentrations of the two pollutants which are representative of urban, rural and background (remote) locations. A novel and very sensitive analytical technique is being applied in these kinetic investigations to follow changes in the concentration of sulphur dioxide as a function of time.

Contact Scientist: W.H. Schroeder

6.10.4 Air-Water Partitioning of Mercury

In Canada as well as many other industrialized nations large quantities of mercury have been discharged into rivers, streams and lakes from a wide variety of human activities. In recent years, at least two Canadian research groups have attempted to account for known discharges (using a chemical mass balance approach) and to model the fate of mercury released into aquatic ecosystems. Their efforts have pointed to substantial losses of mercury from the aquatic environment and suggested volatilization into the atmosphere as a likely pathway for its removal from the water column. It is of interest to note that the majority of organic and inorganic mercury species are not very soluble in water, but have relatively high air-water partitioning coefficients. Utilizing a new instrument recently developed for AES which is capable of

measuring the mercury species of environmental interest, a collaborative project was initiated in 1983 with Dr. D. Miller at the National Research Council of Canada (Ottawa). The ultimate objective is to determine the identity and quantity of the major chemical form(s) of mercury evolved into the atmosphere from bodies of water contaminated with this heavy metal pollutant as a result of industrial activities. The initial investigations are being carried out in a laboratory-scale apparatus containing water and natural sediments into which a known amount of this contaminant (in the form of mercuric chloride) is introduced. Experimental conditions, including the pH of the water overlying the sediments, are being systematically varied to determine those parameters affecting gas-liquid partitioning. Results of laboratory studies are subsequently to be verified under field conditions at one or more suitable Canadian locations.

Contact Scientist: W.H. Schroeder

6.10.5 Chemical Speciation -- Literature Survey

The atmospheric behaviour and cycling through the environment of various heavy metals is strongly dependent upon the specific chemical forms involved and their respective physico-chemical properties. Hence, to understand (and ultimately predict) the atmospheric pathways of toxic trace elements, particularly heavy metals, knowledge is required concerning the major chemical species present in the atmosphere for the toxic trace elements of interest. Currently, with the possible exception of metals such as mercury and lead, there appears to be relatively little information available on specific chemical forms of heavy metals in ambient air, and what information does exist is widely dispersed throughout the scientific literature.

In an effort to draw together published information pertaining to the existence and identification of specific chemical forms of toxic trace elements encountered in ambient air, a literature search was conducted during the current reporting period. Emphasis in this project is on toxic air pollutants of industrial significance. Elements selected as priorities for this study are cadmium, lead, nickel, vanadium, arsenic and selenium. The major anthropogenic and natural sources of these substances are being documented and physical, chemical or biological processes resulting in transformation in the environment will be identified in the project report.

Contact Scientist: W.H. Schroeder

6.10.6 Literature Surveys

With financial support from TOXFUND, two contracts were awarded during the second half of fiscal year 1983-84 to provide supplementary information for two literature surveys conducted during F.Y. 1981-82. In the one case an update of the literature as well as an executive summary are being produced for the report

titled "Toxic Trace Elements Associated with Airborne Particulate Matter -- A Literature Review." In the other instance an executive summary is being prepared for an earlier literature survey and review of ambient air sampling and analysis methodology for selected toxic organic chemicals.

Contact Scientist: W.H. Schroeder

6.10.7 Organics Desorption from Particulate Matter

One of the persistent problems associated with the analysis of the organic fraction of particulate matter is that of removing the organics from the surface of the particulate matter quantitatively and without causing degradation of the organics during the process. Over the years many techniques have been tried and all have met with varying degrees of success but, unfortunately, none are quantitative and all produce chemical artifacts during the extraction process.

A novel technique, which has never been applied to the removal of organics from particulate matter is that of desorption by microwave radiation. Because it is volume heating rather than surface heating (as is infra-red heating), the particulate matter collected on a Hi-Vol glass fibre filter can be heated very much faster and, in addition, the longer wavelengths (compared with IR) are less likely to cause chemical bond breaking.

Preliminary calculations demonstrated that, for the few hundred milligrams of particulate matter collected on a standard Hi-Vol filter, heating at 20 to 100 watts power at a frequency of 2.45 GHZ for 15 to 30 seconds should be sufficient to desorb the organics. A microwave generator was obtained and a desorption cavity was designed and fabricated. Very preliminary results with the system show the promise of a new method for desorbing organics from particulate matter. This project will be continued during the next fiscal year.

Contact Scientist: D.A. Lane

6.10.8 Pilot Station Operation

In order to define in a more precise manner, the actual qualitative (3σ above noise) and quantitative (10σ above noise) measurement limits of the GC/MS procedures used for the analysis of Polycyclic Aromatic Hydrocarbons (PAH), a series of blank experiments were initiated at the Ontario Ministry of Natural Resources site at Maple, Ontario. Numerous blanks (box, travel, field, etc.) were obtained and, in addition, both a total suspended particulate (TSP) sample and a size fractionated sample were collected for each set of blanks processed. Ten sample sets have been collected and extracted utilizing overtime technical assistance. Analysis of the samples by GC/MS has been delayed due to unforeseen hardware failures in GC/MS instrument.

Contact Scientists: D.A. Lane and W.H. Schroeder

6.10.9 Organics Dispersion Research

During 1983, research focussed on gas and particulate-phase measurements of moderate molecular-weight organics in air along the Niagara River. Samples were taken during three periods in fall, winter and summer at Niagara-on-the-Lake, Niagara Falls and Fort Erie. From the data analyzed to date, gas phase components of certain priority toxics, such as PCB's and PAH's, have been seen to be an important, if not dominating, fraction of the air concentrations. Unlike some particulate phase components which show evidence of local influence, many of the gas phase components indicate regional (or larger) scale for their distributions. These results, which have implications for organic chemical network design, will be published in 1984.

Contact Scientist: R.M. Hoff

6.10.10 Toxics Model Development

Development is underway on two simple models describing the transport and dispersion of a continuous and an instantaneous heavy gas spill.

Contact Scientist: C.S. Matthias

"Alms for research....Alms for research...."

7. REGIONAL AIR QUALITY ACTIVITY REPORTS

7.1 PACIFIC REGION

The Pacific and Yukon Acid Rain Committee (Chairman PAES) held a joint federal-provincial workshop early in 1983 on acidic depositions. Fourteen speakers made presentations. A summary of the proceeding was published as an internal SSD Pacific Region report. AES sponsored at a seminar in January 1984 on alkalinities of lakes in Western Washington given by Dr. Clint Duncan, University of Central Washington.

As part of the Western LRTAP Program a transboundary precipitation chemistry monitoring network was established with thirteen stations extending from Western Vancouver Island to the Lower Fraser Valley. Twenty individual storm events were sampled during 1983. Preliminary results from six months data were presented at the Parliamentary Sub-committee on Acid Rain Public Hearing held in Vancouver on October 28, 1983.

SSD collaborated with Western and Central Region meteorologists on a sulfur deposition modelling study for Western Canada. This was based on trajectory and deposition modelling data provided by M. Olson of ARQD. A draft report was completed. In addition, SSD analysed the same trajectory data (for receptors at Vancouver, Terrace, Revelstoke and Fort Nelson) and a draft report was completed.

CANSAP data for B.C. and Yukon stations were obtained from AES HQ. A computer program was written to access, list and analyse these data.

The Afton Surveillance Commitee (PAES Environment Canada member) completed its report to the B.C. Minister of the Environment on "The Operation of the Afton Smelter at Kamloops, British Columbia and the Environmental Effects from the Stack Emissions."

Two EPA dispersion models (VALLEY and CDMQC) were adapted for use on the Regional mini-computer. The up-date version of AQPAC was installed. Two very simple heavy gas dispersion models for use in environmental emergencies were written for a micro-computer.

EPS and SSD collaborated on a report on the impact of a coal dryer on the air quality of southeastern B.C. and Glacier National Park, Montana.

Proposals for study of oxidants in the Greater Vancouver area were sent to AES HQ.

SSD Meteorologists attended a workshop on environmental emergencies and the AQPAC. Don Faulkner presented a seminar to EPS on models for use in responding to environmental emergencies.

SSD attempted to define the mixing height climatology of southwestern B.C. using the Holzworth model. This failed for summer situations apparently because of the advection of cooler air from the water areas.

AES PACIFIC REGION REPORTS

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7.2 WESTERN REGION

Western Region continues its active involvement in planning, organization and coordination of the Western Canada LRTAP program through membership (Secretary) on the Western Canada LRTAP Technical Committee.

A DOE seminar on LRTAP activities was sponsored by SSD Western Region in March. Technical presentations were made by AES Headquarters and regional staff. Current and future studies were presented by DOE Services as well as provincial agencies.

A report entitled "Sulphur Deposition Modelling in Western Canada" by the three western AES Regional SSDs is undergoing final review with publication as an internal Western Region Report scheduled in April 1984. The results of this work have been presented to the Environment Division, Chemical Institute of Canada, annual meeting in Calgary in June 1983 and the Western Canada LRTAP Technical Committee in Winnipeg (November 1983).

A preliminary report on "Sulphur Deposition in Alberta" has been prepared at the request of Alberta Environment. An internal SSD Western Region report will be available by April 1984. The results were presented to the Western Canada LRTAP Technical Committee in November 1983. Frequent consultations have been held with this agency regarding precipitation chemistry networks and incorporation of data into a format consistent with the CANSAP data.

Forward trajectories from Lodgepole have been computed by ARQT for the duration of the sour gas blowout (October-December 1982). A study has been completed and published as an SSD Report 83-2 for the period December 5-7, 1982. This report was prepared at the request of Alberta Environment. A more comprehensive analysis is currently underway to summarize the trajectory results throughout the period of the blowout. A preliminary analysis has been presented at the University of Alberta, Meteorology Division and the Alberta Climate Association. An internal SSD report is under preparation.

The Western Region environmental emergency van has now been completely instrumented and is ready for use when the need arises. The AQPAC system of programs still needs to be implemented.

Future plans continue to be devoted to precitipation chemistry and trajectory analyses for Western Canada.

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7.3 CENTRAL REGION

Completion of report "Sulphur Deposition Modelling in Western Canada" as part of Western Canada LRTAP.

Development of an alternate method for calculating wet sulphur deposition from CANSAP data.

Significant involvement with City of Regina Hazardous Materials Response Team, and Provincial Spill Report Centre. R.F. Hopkinson is now a member of the advisory committee to the City of Regina H.M. Response Time.

Through membership on the Regional Committees of RSCC, reviewed EIA for Cluff Lake Uranium Mine Phase II; proposal for SERU environment base-line studies; Regina Rail Relocation EIS; and COM Lancaster Sound EIS.

Attended Federal Provincial Committee on Air Pollution Meeting in Ottawa in May 1983.

Participated in LRTAP monitoring workshop October 17 and 18, 1983 in Downsview and first day of LRTAP Analysis Workshop in Rexdale.

Reviewed draft of Air Quality Handbook. Issued two amendments to the Regional Environmental Emergency Response Plan.

Held a Regional Environmental Emergency Response Seminar (October 19 and 20, 1983).

Submitted project proposal for the "bullet proofing" of programs in the AQPAC package. Extensive work has already been done on one of them.

Provided special forecast and advisory services to the environmental health emergency spraying against Western Equine Encephalitis (WEE) carrying mosquitoes in southern Manitoba; and assisted in the evaluation of the dispersion of the spray.

Assisted in the submission of proposals from Saskatchewan Research Council (SRC) for the utilization of TOCMEP Hi-Vol samplers.

Presented a lecture to, and prepared a handout for, the Manitoba Aerial Applicator's Course.

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7.4 ONTARIO REGION

A. Synopsis

Ontario Region's Air Quality activities during this period can be categorized into five areas of on-going responsibility.

1) Port Hope Meteorological Study
2) Environmental Emergencies
3) Review of Reports
4) Real-time pH Reports
5) General/Miscellaneous Requests

B. Description of Activities

1) Port Hope Meteorological Study

The principal objective of this study is to produce a dispersion climatology at the near site in Port Hope, Ontario. Instrumentation of the tower was completed in the Fall of 1983 with the assistance of ARQM and ARQT. Data collection commenced soon thereafter. The instruments include a Gill Bivane Anemometer at the top of a 20-metre tower and two platinum resistance thermometers, one installed at the top and one at the base of the tower. The data collected and pre-processed on site by a Campbell Scientific CRT Datalogger. Preliminary data analysis is in progress. A briefing on this study was given to the Port Hope Environmental Advisory Committee.

2) Environmental Emergencies

P. Chen attended the EPS-sponsored Technical Seminar on Chemical Spills held on October 26-28, 1983, at the Downtown Holiday Inn, Toronto.

On February 8, 1984, EPS enacted a simulated emergency. Ontario Region responded to requests for information from the emergency co-ordinator regarding the dispersion of toxic gases from an accidental spill.

3) Review of Documents

The following air quality-related documents were reviewed:

- Bruce Nuclear Safety Report (AECB)
- Proposal of a Canadian Air Quality Manual (ARQD)
- Study of Fluoridation Rates for September, 1983 (Eldorado Research Limited)
- Environmental Screening of the Proposed Plan for the relocation of Contaminated McClure Crescent Soil to Reeses Road Temporary Storage Facility (AECL)
- Environmental Contacts Manual (EPS)

4) Real Time pH Reports

Weekly pH reports issued by LLO are copied, circulated and filed for future reference. Background information related to this Program was distributed to the Weather Offices; numerous media interviews were provided at the commencement of the Program.

5) General/Miscellaneous Requests

Numerous requests for air quality information were received from the general public, students and media. These were primarily on the subject of acid rain and LRTAP.

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7.5 QUEBEC REGION

We have begun analysing the data compiled for the pH project in 1982. This analysis of 1400 samples will enable us to derive information on the spatial variability of pH, nitrates, and sulfates in southern Quebec. We have almost finished analysing the data, and will now begin writing a report on this subject.

In the next few days we will finish taking wintertime measurements of dry deposition at the Montmorency forest site. The data from this pilot project will be analysed for us under contract in 1984-85. The analysis will enable us to determinate the relative contribution of dry deposition to the acidification of the environment in southern Quebec, and will also provide us with useful information on methods of measuring dry and wet deposition and their representativity.

On behalf of EPS, we helped to plan, execute, and review studies on toxic substances; dispersion of asbestos particles in the region of Asbestos, Quebec; oxidants in Montreal and Quebec City, dioxins and furans in Quebec.

We reviewed impact statements for the following projects:

- Péchiney aluminium works;
- extension of the port of Sept-Iles;
- offshore drilling in the St Lawrence;
- relocation of the port of Chicoutimi;
- enlargement of the port of Montreal;
- extension of the port of Quebec City.

We have acquired all the UNAMAP atmospheric dispersion models from the American EPA, and have adapted three of them so that we can run them on the AS-6. An improved version of the AQPAC model was implemented on the regional HP when Dr. S. Daggupaty (ARQM) was here last May.

In co-operation with EPS, we evaluated the services provided during the environmental emergency at Delson last spring. We also provided forecasting services in support of the clean-up of two spills in the St. Lawrence.

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7.6 ATLANTIC REGION

The following were the main areas of involvement of the SSD in air quality related matters in 1983-84:

Meteorological advice was provided to EPS on their monitoring study for wood stove pollutants in two locations in Nova Scotia.

A LRTAP project to evaluate and synthesize the various agency's precipitation chemistry data was initiated.

A LRTAP project to study large acidic deposition events at a location in Nova Scotia was initiated.

Backward trajectories were prepared for a Health and Welfare study of the transport of pollutants to a site in Nova Scotia.

Meteorological input was provided for the preparation of EIS guidelines for the proposed second nuclear power plant at Point Lepreau, New Brunswick.

Trajectories were provided by the Maritime Weather Office for the Vinland drilling rig blow out.

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Isaac, G.A., K.G. Anlauf, R. Leaitch, R.S. Schemenauer, J.W. Strapp, P.W. Summers and H.A. Wiebe, 1983. "Cloud and Precipitation Chemistry Studies over Algonquin Park, Canada." IAMAP Symposium on Tropospheric Chemistry, August 24 - September 2, 1983, Oxford, England.

Isaac, G.A., P. Joe and P.W. Summers. "The Vertical Transport and Redistribution of Pollutants by Clouds." APCA Specialty Conf. on The Meteorology of Acidic Deposition, Hartford, Conn., 16-19 October 1983.

Jackson, R.A., W.C. Li and W.H. Schroeder. "Separation and Determination of Volatile Mercury Species in Air." Presented at the Pittsburgh Conference and Exposition on Analytical Chemistry and Applied Spectroscopy, March 7-12, 1983, Atlantic City, N.J.

Kerman, B.R. "A model of interfacial gas transfer for a well-roughened sea." International Symposium on Gas Transfer at Water Surfaces, 1983, Cornell University.

Kerman, B.R. "Distribution of bubbles near the ocean surface." International Symposium on Gas Transfer at Water Surfaces, 1983, Cornell University.

Kerman, B.R. "Remote sensing of wind speed and momentum flux." Presented at the air-sea interface by bottom-mounted hydrophones, 1983, Rome, Italy.

Kerman, B.R., R.E. Mickle, N.B. Trivett and P.K. Misra. "Shoreline fumigation and internal boundary layer structure studies using acoustic sounding." Presented at the Second International Symposium on Acoutic Remote Sensing of the Atmosphere and Oceans, 1983, Rome, Italy.

Kerman, B.R., S. Peteherych and H. Zwick. "Whitecap Coverage Measurements using an Airborne Multi-spectral Scanner." Whitecap Workshop, 1983, Galway, Ireland.

McBean, G.A. "Boundary layer structure over the ocean." CMOS, May, 1983, Banff, Alberta.

McBean, G.A. "Precipitation chemistry in Pacific coastal regions." CMOS, May, 1983, Banff, Alberta.

Mickle, R.E. and J.D. Reid. "Airflow Measurements above a Forest Canopy During Spray Trials in New Brunswick." Presented at the Forest Environment Measurements Conference, 1983, Oak Ridge, Tenn.

Neumann, H.H., and G. den Hartog. "Eddy correlation measurements of atmospheric fluxes of ozone, sulphur, and particulates during the Champaign Intercomparison Study, June 1982." Presented at the Spring Meetings of the American Geophysical Union (poster), May 31, 1983, Baltimore, Md.

Olson, M.P. and K.K. Oikawa. "A Preliminary Evaluation of the Sulfate Concentration Forecasts for the PEPE Project." Presented at the APCA Specialty Conference on The Meteorology of Acid Deposition, October 17-19, 1983, Hartford, Conn.

Schroeder, W.H. "An Instrumental Analytical Technique for Gaseous Forms of Mercury in Ambient Air." Presented at the 76th Annual APCA Meeting, June 19-24, 1983, Atlanta, GA.

Schroeder, W.H. and R. Jackson. "An Instrumental Method for the Measurement of Vapour-Phase Mercury Species in Air." Presented at the APCA Specialty Conference on Measurement and Monitoring of Non-Criteria (Toxic) Contaminants, March 22-4, 1983, Chicago, IL.

Schroeder, W.H. and R.A. Jackson. "A Method for the Separation of Several Volatile Mercury Species in the Atmosphere." Presented at the VIth World Congress on Air Quality, May 16-20, 1983 Paris, France.

Summers, P.W. "Air Quality and the Mesoscale." Presented at the CMOS Mesoscale Meteorology Research Planning Workshop, January 24-26, 1983, Toronto, Ontario.

Summers, P.W. "Wet Deposition to Forests." Presented at the Acid Rain and Forest Resources Conference, June 14-17, 1983, Quebec City.

Summers, P.W. "Meteorological Aspects of Regional and Global Air Quality and Pollutant Deposition." Symposium on Air Quality, Institute for Environmental Sciences, Academy of Science, September 2-3, 1983, Beijing, China.

Summers, P.W. "Review of Airborne Cloud and Precipitation Chemistry Measurements and the Implications for Global Chemical Climatology." WMO Technical Conf. on Observations and Measurement of Atmospheric Contaminants (TECOMAC), October 17-21, 1983, Vienna, Austria.

Taylor, P.A. "A linearized model of microscale flow in complex terrain." CMOS Workshop on Mesoscale Meteorology, 106-112, 1983.

Taylor, P.A. "Flow over complex topography." Lecture Notes, SMHI Course on Mesoscale Meteorology, May-June, 1983, Pinnarpsbaden, Sweden.

Taylor, P.A. "Numerical modelling of the mesoscale - topographic flow models." Lecture notes, SMHI Course on Mesoscale Meteorology, May-June, 1983, Pinnarpsbaden, Sweden.

Voldner, E.C. and M.P. Olson. "Analysis of MOI Transfer Matrices." Presented at the George P. Aiken Lectures: Acid Precipitation - A Technical Symposium on Acid Rain Transport and Transformation Phenomena, September 21-23, 1983, Burlington, VT.

Voldner, E.C. and J.D. Shannon. "Evaluation of Predicted Wet Sulfur Deposition Fields in Eastern Canada." Presented at the APCA Specialty Conference "The Meteorology of Acid Deposition", October, 17-19, 1983, Hartford, Conn.

Walmsley, J.L. "Application of a Boundary-Layer Model to Flow over a Barchan Sand Dune." CMOS 17th Annual Congress, 1983, Banff, Alberta.

Walmsley, J.L. "Some Effects of Thermal Stratification on Air Flow over Three-Dimensional Hills." Presented at the Euromech-173 Conference on Airflow and Dispersion in Rough Terrain, 1983, Delphi, Greece.

Walmsley, J.L. and P.A. Taylor. "Internal and Inhomogeneous Planetary Boundary-Layers." AMS Specialty Conference on Air Quality Modeling of the Nonhomogeneous, Nonstationary Urban Boundary-Layer, 1983, Baltimore, MD.

Whelpdale, D.M. "The Flux of S and N Eastward from North America." CACGP Symposium on Tropospheric Chemistry With Emphasis on Sulphur and Nitrogen Cycles and the Chemistry of Clouds and Precipitation, August 29 to September 2, 1983, Christ Church, Oxford, England.

Wiebe H.A., K.G. Anlauf, J.W. Strapp, Isaac, G.A. and T. Leaitch, 1983. "Chemical Interactions in Cumulus Clouds." Presented at the 185th American Chemical Society Meeting, Seattle, Washington, D.C.

Young, J.W.S. and R.W. Shaw. "A science-based strategy for the control of Acidic Deposition in North America." Presented at VIth World Congress on Air Quality, May 1983, Paris, France.

"I'd like you to meet our local expert on long range transport."

9. MAJOR CONTRACTS

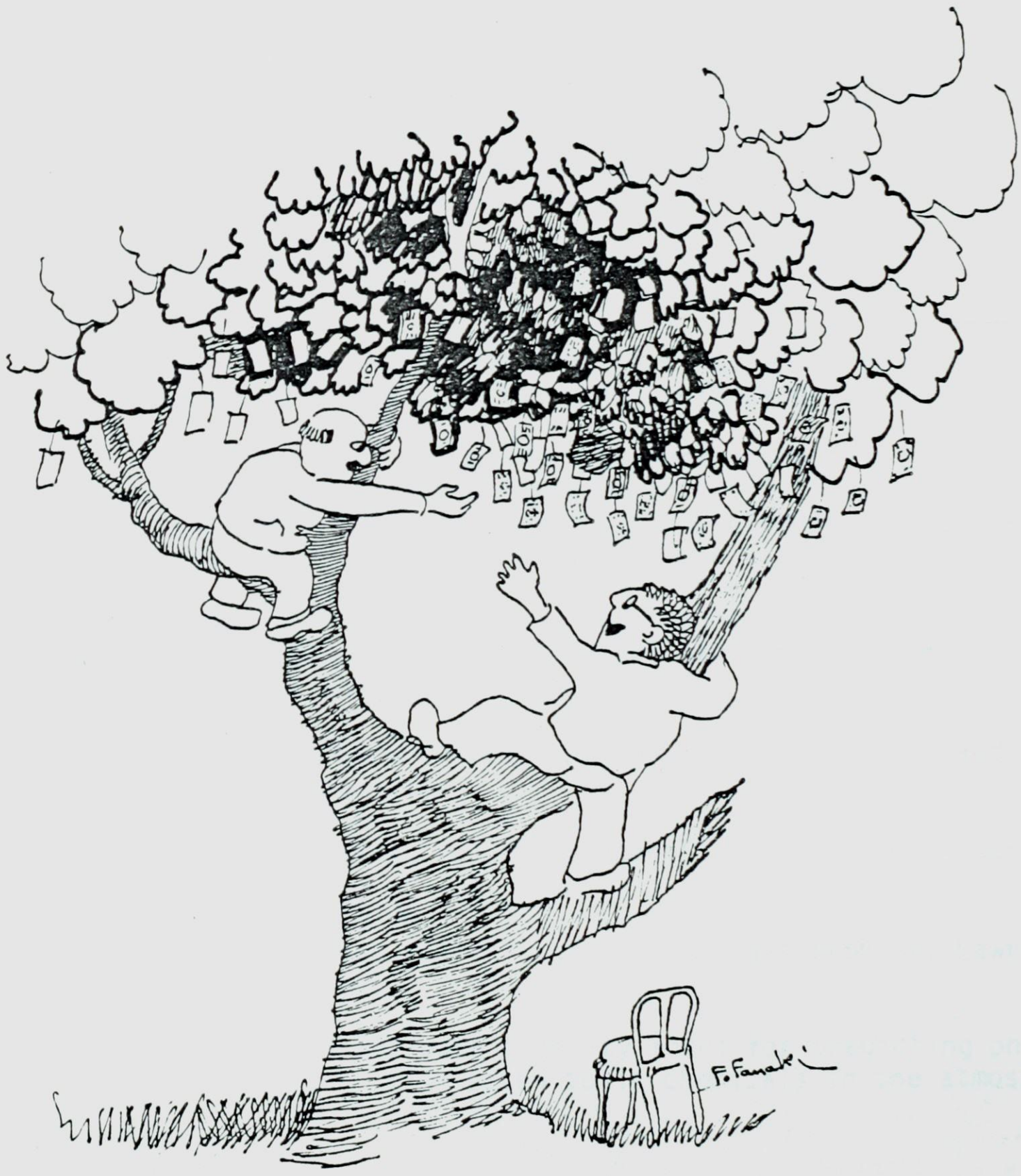
CONTRACTOR/AMOUNT	PURPOSE
M.R. Austerberry $ 9,600	Redesign of signal conditioning for use with St. Lawrence Valley Wind Energy Study
Barringer Magenta $ 7,366	Development, testing, verification and documentation of real time automatic oxygen titration process and instrumentation
Brock University $ 5,500	Investigation of the chemical reaction between solid mercuric oxide and sulphur dioxide.
K.W. Chan Chemical $ 4,900	analysis and interpretation of data from the Niagara River Survey
Concord Scientific $ 36,454	Liquid natural gas dispersion model for the atmospheric interactive modelling system.
Concord Scientific $ 20,000	Preparation of air sampling filters for the Canadian Air Precipitation Monitoring Network (CAPMoN).
Concord Scientific $ 19,756	Data analysis for wind power potential in the St. Lawrence Valley
Concord Scientific $ 12,629	Data evaluation of nitric acid sampling.
Concord Scientific $ 6,083	Preparation of air sampling filters from the Canadian Air and Precipitation Monitoring Network (APN) for the field and the laboratory.
Concord Scientific $ 4,984	Environmental evaluation of priority atmosperhic toxic chemicals
Concord Scientific $ 2,000	Preparation of updated information and an executive summary for a literature review.
Concord Scientific $ 1,460	Statistical analysis of oxidant climatology in Ontario.
E. Dillon $ 2,000	Preparation of scientific paper describing biological indicator studies
A. Feuerverger $ 3,900	Statistical evaluation of LRTAP model
J.N. Gallaway $ 4,000	Analysis of the transport and Fate of airborne pollutants over the Atlantic ocean.
Gas Research Inst. $ 49,908	Liquid gas three dimensional model evaluation

CONTRACTOR/AMOUNT	PURPOSE
R. Hancock $ 6,600	Analyze Arctic aerosol filter samples.
Janssen Environmental Consultants $ 6,000	Analyse Arctic aerosol filter samples by ion-coupled plasma method using a JY spectrometer.
A.G. Johnston $ 30,000	Experimental Program of large-scale released of heavier-than-air-gases -- Phase II.
L. Jun $ 3,600	Deposition of nutrients, trace elements and toxic chemicals.
E. Livermore $ 1,300	Provide monitoring service at Longwoods Conservation Area
C.F. Luxton $ 3,199	Provide a long range transportation of airborne pollutants study in Kejimkujik National Park, N.S.
C.F. Luxton $ 3,199	To provide a long range transportation of airborne pollutants monitoring service.
MEP Company $220,224	Data archiving for the Eulerian LRT model
MEP Company $ 35,094	Development and implementation of computer programs required by the Eulerian (LRT) acid deposition model.
Ontario Research Foundation $ 5,937	Preparation of scientific document summarizing and critically reviewing existing scientific literature on selected aspects of toxic ctrace elements in ambient air with special emphasis on heavy metals.
M. Peden $ 1,725	Seminar - 'The Analytical and Quality Control and Assurance Procedures of the U.S. National Atmospheric Deposition Program's Analytical Laboratory.'
A. Robertson $ 9,975	Modify and test a Meloy sulphur dioxide analyzer and an AID ozone analyzer.
J. Salmon $ 13,385	Microscale modelling of boundary layer in complex terrain.
J. Salmon $ 13,385	Processing and analysis of initial data from St. Lawrence Valley project.
University of Toronto $ 15,000	Develop and evaluate fugacity model for predicting phase partitioning of selected toxic chemicals in the atmosphere.

CONTRACTOR/AMOUNT	PURPOSE
University of Toronto $ 9,953	Workshop on the ability of wet deposition networks to detect changes in regional air pollution emissions.
University of Toronto $ 5,000	Impact of acid precipitation on fish hatchery operations.
Unisearch $ 35,000	Development, fabrication, testing of an analytical system capable of continuously measuring NO, NO_2 and HNO_3 in ambient air.

10. UNSOLICITED PROPOSALS

CONTRACTOR	UP-No.	PROJECT TITLE
JASCO Research $162K	UP-J-45	Contribution to Undersea Ambient Acoustic Noise Due to Rain
Ontario Research Foundation $165K	UP-O-173	Development of a Trace Organic Gas/Particle Fractionating Sampler System.
University of Windsor $804K	UP-G-175	Case Study of Selected Toxic Substances in the Essex Region



"This sure is easier than getting funds out of AES."

11. SCIENCE SUBVENTIONS

APPLICANT/ INSTITUTION	SCIENTIFIC AUTHORITY	TITLE
Bunce, N.J. University of Guelph $ 7,000	D.A. Lane	Vapour Phase Photolysis of Polychlorinated Biphenyls
Chatt, A. Dalhousie University $ 6,000	H.A. Wiebe	Trace Elements in Snow
David, M. University of Montreal $ 5,000	A. Sirois	The Reliability of Contour Maps Showing Atmospheric Pollutants
East, C. Université du Québec à Montréal (UQAM) $ 5,000	J. L. Walmsley	Transfers Par Turbulence de Pollutant Gazeux
Hastie, D.R. York University $11,000	K.G. Anlauf	Development and Testing of a Tropospheric NO_2 Instrument
Keffer, J.F. University of Toronto $ 5,000	Y. Chung	Digital Image Analysis of Meteorological Phenomena
Leighton, H. McGill University $20,000	P.W. Summers	Interaction of Sulfur Dioxide and Sulfates with Clouds and Haze
Lewis, J. McGill University $ 7,000	R. M. Hoff	Acid Rain Events in Quebec
Lozowski, E.P. University of Alberta $12,000	D.M. Whelpdale	Analysis of Sulfate Wet Deposition in Canada During the Intensive Sulfate Study, August, 1976
McConnell, J.C. York University $ 7,000	A.D. Christie	Effects of Chemistry on Climate
Megaw, W.J. York University $10,000	R.M. Hoff	A Detailed Study of the Sub-Micron Atmospheric Aerosol
Munn, R.E. University of Toronto $ 6,500	A.D. Christie	Carbon Dioxide and the Carbon Cycle

APPLICANT/ INSTITUTION	SCIENTIFIC AUTHORITY	TITLE
Naylor, D. University of Lethbridge $ 3,000	R.M. Hoff	High Resolution Studies of the Far Infrared Emission Spectrum of the Stratosphere
Nicholls, R.W. York University $ 4,500	R.M. Hoff	Experiment and Theoretical Studies on: a) fundamental spectroscopic properties of atmospheric molecules; b) realistic spectral absorption coefficients of atmospheres; c) solar radiation and its extinction in urban atmospheres.
Ormrod, D.P. University of Guelph $ 4,000	H.P. Sanderson	Effects of Air Pollutant Mixtures on Plants
Peltier, W.R. University of Toronto $12,000	P.A. Taylor	Atmospheric Waves and Turbulence
Picot, J. University of New Brunswick $ 7,000	J.D. Reid	Lagrangian Simulation of Insecticide Spray Dispersal and Deposition
Schiff, H.I. York University $17,000	K.G. Anlauf	Development of an Inexpensive Sensitive Instrument for Measuring NO_2
Schneider, G.E. University of Waterloo $ 6,000	P.A. Taylor	Numerical Non-Hydrostatic Modelling of the Planetary Boundary Layer
Stubley, G.D. University of Waterloo $ 2,000	P.A. Taylor	Parameterization of Planetary Boundary Layer Structure
Yau, M.K. McGill University $20,500	P.W. Summers	Modelling of Cloud Dynamics - Pollutant Interactions in a Rainband

12. PERSONNEL

Dr. J.W.S. Young, Director

DIRECTOR'S OFFICE

Senior Research Scientists:
Dr. P.W. Summers
Dr. A.D. Christie
Dr. G.A. McBean

LRTAP & Toxics Coordinator:
Mrs. E.E. Wilson

Executive Assistant — Ms S.J. Pettibone
Administrative Officer — Mrs. K.M. Ford
Secretary — Miss B.N. Grogan

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Mrs. D.I. Bardeau, Secretary

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Dr. K.G. Anlauf
Dr. K.W. Chan
Dr. D.A. Lane
Dr. H.H. Neumann
Dr. K.J. Puckett
Dr. W.H. Schroeder
Dr. H.A. Wiebe

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Mr. D. MacTavish
Mr. Y. Tham

PDF Dr. S. Sang

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Ms E. Mathis, Secretary

Senior Scientist:
Dr. P.A. Taylor

Scientists:
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Dr. B.R. Kerman
Dr. R.E. Mickle
Dr. A.K. Lo
Dr. R.J. Polavarapu
Dr. J.L. Walmsley
Mr. V.S. Derco
* Mr. N. Bussières
PDF Dr. R.J. Bloxam

Computer Scientist:
Mr. J. Arnold

Technicians:
Mr. L. Guise-Bagley
Mr. W.F. Kobelka
Mr. N. Koshyk

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(Office Designator ARQM)

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Miss C. Grant, Secretary

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Dr. S.M. Daggupaty
Dr. N.B.A. Trivett

Meteorologist:
Mr. D. Bagg

Networks and Surveys Section
Mr. M.E. Still, Head

Computer Scientist:
Mr. W. Sukloff

Technicians:
Mr. J. McLernon
Mr. S. Iqbal
Mr. A. Smith
Mr. A. Gaudenzi

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(Office Designator: ARQT)

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Mrs. P. G. Pearson, Secretary

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Dr. R.M. Hoff
PDF Dr. M. Ibrahim

Technicians:
Mr. F. Froude
Mr. J. Kovalick
Mr. J. Markes

Modelling and Applications Section
Mr. M. Olson, Head

Scientists:
Dr. J.W. Bottenheim
Dr. Y. Chung
Dr. E.C. Voldner
Mr. K. Oikawa
PDF Dr. K. Brice

Technicians:
Mr. A. Gallant

Computer Scientist:
* Miss A. Panigas

Special Studies Section

Scientists:
Dr. D.M. Whelpdale
Dr. A. Sirois

* Denotes a term position
PDF Denotes a Post Doctoral Fellowship