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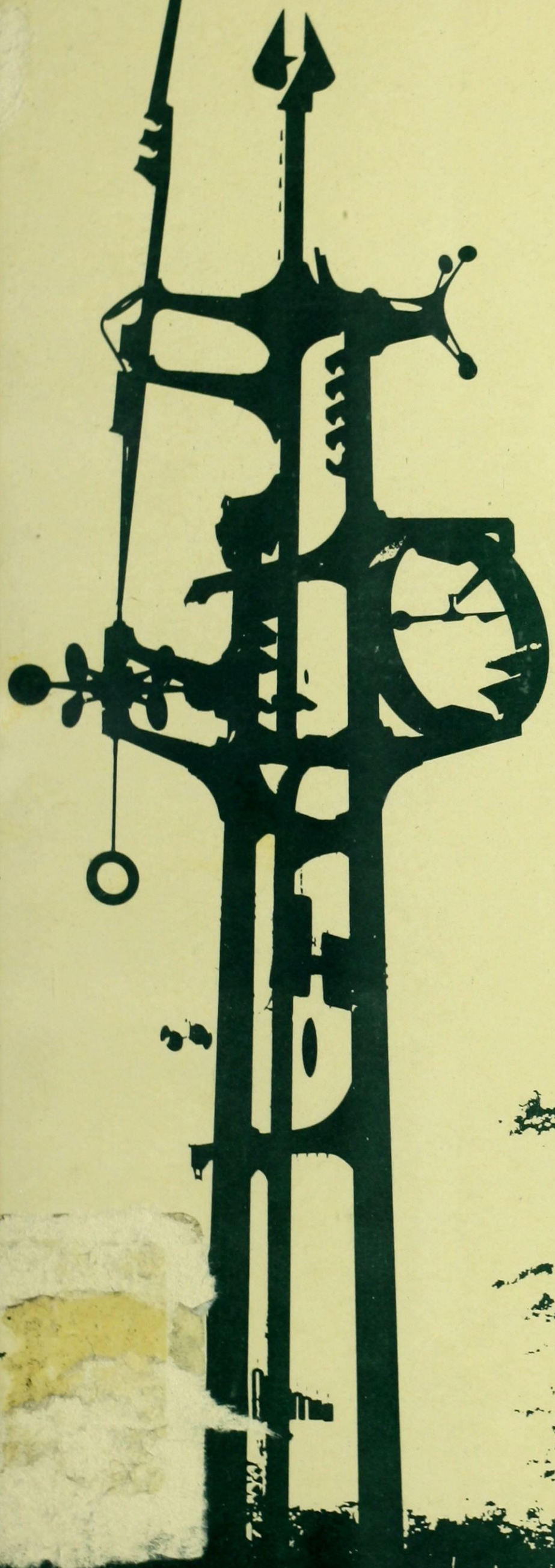

Air Quality and Inter-Environmental Research Branch

Annual Report

1984-85

Environment Canada / Environnement Canada

Atmospheric Environment Service / Service de l'environnement atmosphérique

REPORT: AQRB-85-M-002

Air Quality and Inter-Environmental Research Branch

Annual Report

1984-85

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April 1985

This is one of a series of management reports produced by the Research Directorate. It is intended for internal use only. The French version of this report will be available shortly.

Le présent rapport fait partie d'une série publiée par la Direction générale de la recherche atmosphérique et destinée à l'usage interne. La version française de ce rapport sera disponible bientôt.

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

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Foreword

by James W.S. Young, Director

Pummeled by the realities of diminishing resources and increasing complexity of air quality problems, the branch managers conducted a critical examination of priorities and thrusts. This examination led us to concentrate our efforts in five major areas in the future:

1. Acid Rain
2. Toxic Chemicals
3. Climate Change
4. Core Research and
5. Air Quality Services.

These five major thrusts will be supported by Internal Services which provide the basic administrative, financial, technical and training/development services for the research program.

The perspectives of the world's people vary in time and space and every human concern falls somewhere on the space-time graph. The majority of the world's people are concerned with matters that affect only family or friends over a short period of time. Others look farther ahead in time or over a larger area -- a city or a nation. Only a few people have a global perspective that extends far into the future.

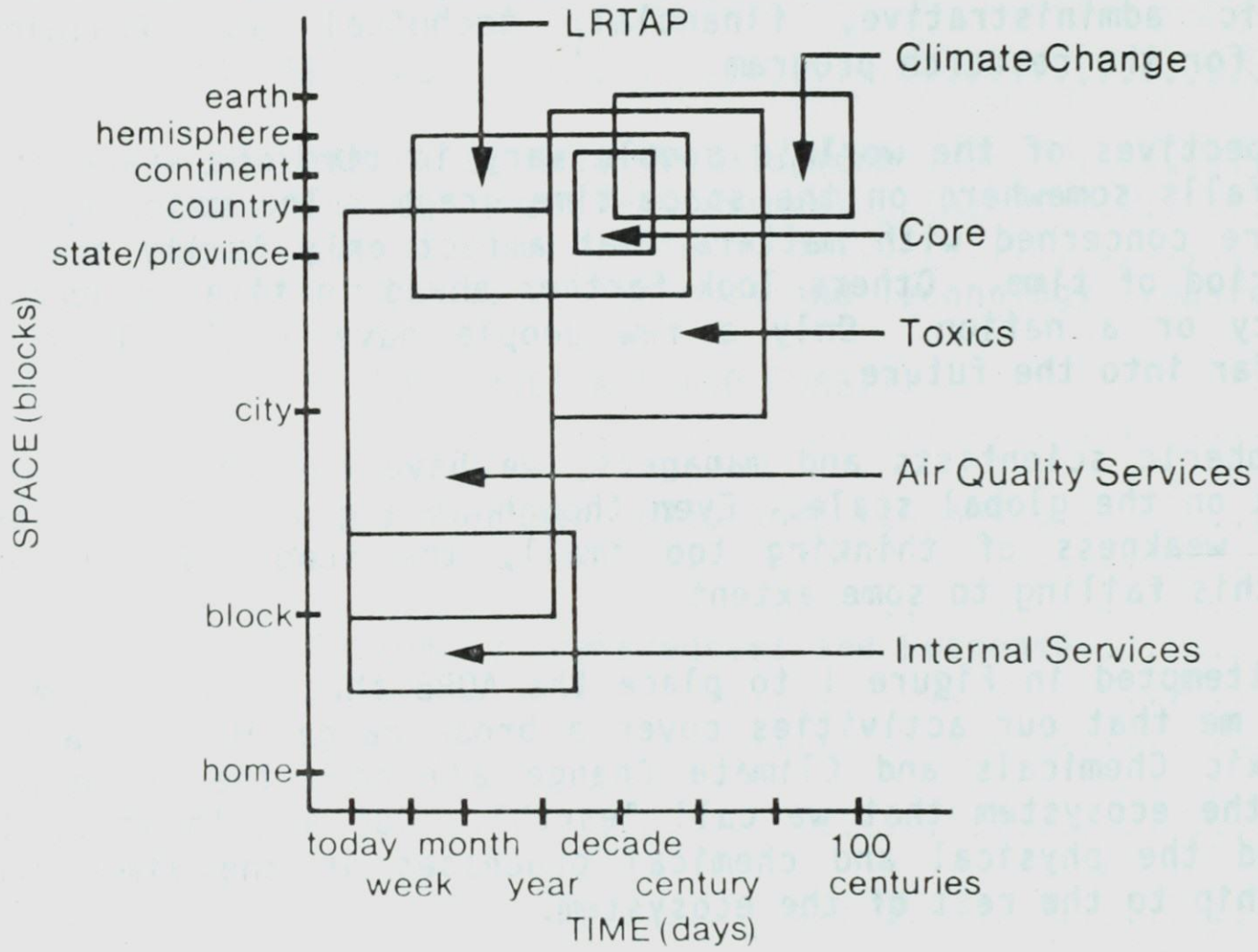
As atmospheric scientists and managers, we have the unique challenge to work and think on the global scale. Even though as a group of human beings we have the same weakness of thinking too small, the scope of our work mitigates against this failing to some extent.

I have attempted in Figure 1 to place the AQRB thrusts on a time-space scale. It shows me that our activities cover a broad range of time and space. Acid Rain, Toxic Chemicals and Climate Change all have the potential to destroy part of the ecosystem that we call "earth". Our aim in these thrusts is to understand the physical and chemical processes in the atmosphere and their relationship to the rest of the ecosystem.

One of the challenges of management is to ensure that our striving to deal with problems which have a global perspective does not blind us from the reality of personal concerns. Our Air Quality Services thrust deals with the concerns of the general public as well as municipal, provincial and federal concerns.

I think it is useful at this time to look ahead 5 - 10 years and to speculate on how our focus might change. I think that our "research" focus will move from a continental to a global scale. I can see a gradual shift from acid deposition research to the more complex toxic chemical deposition research. I can see more emphasis on the air quality aspects of climate change. Consistent with this larger view, we will become "proactive" rather than "reactive".

Figure 1 AQRB Perspectives 1985



Our "administrative" focus will also shift over the next 5-10 years toward an enhanced link between government, university and industry. Our link with university will provide a sharing of resources and costs as well as academic stimulation. Universities will be able to provide basic training in air pollution meteorology and atmospheric chemistry. Closer links with industry may well provide an enhanced ability to promote staff at all levels.

Let me close my foreword by suggesting that the future belongs to those who will take a little broader view.

3. AQRB PROGRAM FOR 1984-1985

3.1 ACID RAIN

3.1.1 LRTAP Scientific Liaison and Coordination

Cooperation has continued with provincial and US agencies through the Atmospheric Sciences Sub Group of the Research and Monitoring Coordinating Committee, and with European acid rain programs through the Steering Body of the European Monitoring and Evaluation Program.

Contact Scientists: D.M. Whelpdale, P.W. Summers

3.1.2 Oxidants Coordination

The objective of this activity is to coordinate AES activities concerning oxidants in the atmosphere with those of other federal and provincial agencies. A mechanism to ensure that modellers have an input into future measurement programs has been established.

Contact Scientist: K.G. Anlauf

3.1.3 Eulerian Model

Processes of regional scale transport, chemical transformation and removal can be represented by coupled equations that can best be solved on a grid fixed with respect to the earth's surface - an Eulerian framework.

The Acid Deposition and Oxidants Model (ADOM), jointly funded by Environment Canada, Ontario Ministry of the Environment and the Umweltbundesamt of Germany is currently approaching final assembly by ERT consultants for preliminary testing. The Canadian version of the model is "driven" by the Canadian Meteorological Centre's weather analysis and prediction model enhanced by a more detailed model of the boundary layer. The input and output fields are manipulated on the Atmospheric Environment Service Downsview Computing Centre computer in a data management system (DMS) developed and maintained by the consultants MEP Co. of Toronto.

To date, the various component processes (transport by mean and eddy motions, gas phase chemistry, chemistry in clouds, dry removal and scavenging by precipitation) and a 4-level prototype model have been numerically simulated and compared, where possible, with experimental results.

The complete 12-level model will be tested against limited data bases currently available in North America during 85-86 and will then provide strategic guidance on evaluation of control strategy options.

Full realization of the model potential however, hinges on the coordination of the model evaluation with observational programs of appropriate sophistication. Currently the Electrical Power Research Institute (EPRI) is considering funding further work "to expedite and enhance" the model and that initiative could well contribute substantively over the next few years as the methodology is generalized to respond to similar problems on regional and more localized scales.

Contact Scientist: A.D. Christie

3.1.4 Lagrangian Model

The LRTAP Lagrangian model is composed of the trajectory and the concentration/deposition models. The trajectory model is used to compute multi-level trajectories throughout North America using meteorological and supporting data bases. These data bases have been converted for use on the CRAY and are continually updated and stored on high density tapes. The concentration model uses the trajectories and the archived data to compute sulphur concentrations and depositions at specified sites during specified time periods and is continually being examined and upgraded. Both models are now running on the CRAY. A more sophisticated chemistry model incorporating sulphur and nitrogen chemistry is also being tested and evaluated in a research mode.

Trajectories have been computed and distributed to support Branch, regional, university and other agency projects. The real-time trajectory analysis program in support of the daily pH monitoring project was upgraded and is now operational on the CRAY at CMC. The daily analysis is being done by Quebec Region. The trajectory model is being evaluated using the CAPTEX-83 tracer data and a report is to be presented at the CMOS conference in June 1985. Preliminary results show a good correlation between the model trajectories and the tracer plume surface concentration data.

A project, under contract, will be completed April '85 to produce a user-friendly trajectory computation and display package for use via terminal to the CRAY and AS-6 computers. The package will allow the user to select the required time period(s), site(s), trajectory characteristics (levels, duration, etc.) and to request specific types of output, particularly in plotted form.

The sulphate wet scavenging ratio has been reformulated to be a function of precipitation rate to the power -0.4. This modification is now incorporated into the routine concentration model and has shown some minor improvements to the modelled wet deposition.

Dry deposition velocity fields of SO_2, NO_x, particulate sulphate and nitrate have been computed on a monthly climatological basis for North America. A literature review was conducted to select the most appropriate surface resistances. The finalized fields will be used in the model.

The International Sulphur Deposition Model Evaluation project (ISDME) has been delayed due to quality control difficulties with the input data. The final data were distributed to participants in November and the AES-LRT model runs were completed by the end of February, 1985. The model evaluations will start once the other model data are received and a report will be given at the Muskoka Conference, September, 1985.

A nitrogen chemistry model was published in Atmospheric Environment. The article described the formation, parameterization and evaluation of the model using APN 1980 data. The model is part of the more complete chemistry model which is being evaluated and upgraded on an ongoing basis using newer data sets containing sulphur and nitrogen (including PAN) data.

Papers on Model Evaluations and Statistical Approaches for Model Evaluations were presented at the AMS Workshop on Sources and Evaluation of Uncertainties in Long Range Transport Models at Woods Hole, Mass., September, 1984.

Contact Scientists: M.P. Olson, E.C. Voldner, J. Bottenheim

3.1.5 CAPMoN: Canadian Air and Precipitation Monitoring Network

During fiscal year 84-85, the operation and management of the network and the coordination of all related activities have been greatly improved. The lead roles for implementation, operation and maintenance of sites are being gradually taken over by the AES regional offices. The CORMACK site was relocated, ALGOMA was converted from an APN site to a CAPMoN site. New sites were opened in PORT CARTIER (Québec), and PRICEVILLE, WARSAW CAVES and BONNER LAKE (Ontario). A second collector was installed at SUTTON and at PRICEVILLE in order to conduct a precision study. Many sites have been improved, for example, by installing a CAPMoN hut as a storage and sample handling area and by relocating collectors and rearranging sites. Many site operators were re-trained. Searches for additional or better sites were carried out in Québec and Ontario. A total of 22 sites are operational now: Atlantic (6), Québec (4), Ontario (9), Central (3), and 8 of these are equipped with air sampling equipment.

A comprehensive Quality Control and Quality Assurance (QC/QA) Program was developed following an audit of the CAPMoN operating and laboratory systems. Implementation of this QC/QA program will be complete early in fiscal year 85-86. Mandatory changes in CAPMoN operating procedures were identified and are being implemented. The CAPMoN history form was redesigned and inspection procedures and forms were developed. A Blind Sample Submission Program was started at one CAPMoN site. An analysis of field blank data indicated a number of problems in the field and laboratory operations of the network.

A training course for regional inspectors and field operators has been developed which includes new manuals in both official languages: CAPMoN Site Operation Reference Manual, CAPMoN Operator Instruction Manual, CAPMoN Inspector Manual and CAPMoN Instrument Maintenance Manual. A supplies and materials procurement manual and a typical CAPMoN operator contract were written. A CAPMoN Observer Bulletin (Reminder and Upgrade) was issued. The design and development of the second generation and final working prototype of a CAPMoN precipitation collector Telescopic Crank Stand has been completed. Actions were taken in order to improve the reliability of the precipitation collector and to develop second generation Air Sampling Equipment.

A preliminary audit of the CAPMoN Data Base Management System was conducted. A new data base management system called the Precipitation Quality Observation Management System has been partially developed as a sub-system of the new Climate Data Base Management System (CDMS). This sub-system should be comparable to the EPA Acid Deposition System (ADS) for Statistical Reporting.

Ten CANSAP sites in Eastern Canada and seventeen in Western Canada were maintained in operation. The 1983 CANSAP Data Summary was published with the 1983 CANSAP Annual Report.

Contact Meteorologist: R. Gilbert

3.1.6 CAPMoN Chemical Analyses

The objective of this project is to support the ongoing program of measurement of atmospheric gases and particulate matter at eight CAPMoN stations. Daily samples are collected on filters at the stations, which are sent to the laboratory at AES for chemical analyses of inorganic constituents. Additional support is provided through abstraction and recording of field and laboratory parameters, preparation of filters, and participation in inter- and intra-laboratory quality assurance programs.

Contact Scientist: H.A. Wiebe

3.1.7 Dry Deposition Project

Understanding and measurement of the processes of the dry component of acidic deposition is an important goal of LRTAP research. Studies over the past few years have been over relatively short vegetation and have emphasized development of measurement techniques. Since much of the acid sensitive area of North America is covered with forest a project was initiated for a comprehensive Forest Dry Deposition Study.

A suitable forest site was identified last year at Canadian Forces Base Borden near Barrie, Ontario. Consequently a lease-agreement was reached with the Department of National Defense for use of the site

over the next several years. Installation of a 40m stairway tower within the forest was completed as was the provision of electrical power and telephone services. Preparation of instrumentation for the tower is now proceeding. Experimental studies will begin during early summer 1985 and will be designed to provide routine continuous monitoring of relevant atmospheric pollutants and meteorological parameters. Short term intensive studies will be carried out to directly measure the fluxes or deposition of the pollutants and these measurements will be used in conjunction with routinely monitored data to estimate dry deposition loading to the forest.

Examination of the SO_2, SO_4 and particulate data collected at Powassan, Ontario (near North Bay) during January-February 1984 continued and tabulated data is now available. Excellent agreement was found between our SO_2 and SO_4 data (6 samples per hour) and filter data collected by the Brookhaven National Laboratory. Pollution levels during the study periodically reached high levels for a rural site, higher than expected for warm season values. Two pollution regimes have been tentatively identified, mild weather episodes characterized by maximum values during the day, and cold weather episodes characterized by maximum pollution at night. These aspects, as well as correlations between various pollutants and meteorological factors, are being investigated further.

Development of eddy-accumulator instrumentation for measurement of mass fluxes of atmospheric trace constituents was continued. The system utilized a micro-processor to control a digital valve and hence modulate flow through accumulating columns or filters proportionately with the vertical wind velocity. By separately accumulating for upward and for downward velocities, the net eddy fluxes can be determined from the differences in material collected on the accumulators, In late Summer 1984 the technique was evaluated during a field study by collecting water vapour in drying columns. Good agreement was achieved between eddy accumulator results and eddy correlation measurements of evaporative flux. The method appears promising for determination of deposition rates of reactive species such as nitric acid. The precision of available analytic techniques for determining small differences in accumulated mass may limit application of the technique for species with deposition velocities less than 1 cm s^{-1}.

Data analysis from an experiment conducted at Elora, Ontario from August 1983 to March 1984 was completed. Results are summarized as hourly means on a monthly basis. Data for ozone, sulphur dioxide, wind speed, direction, temperature, humidity and net radiation will be used to estimate monthly values of dry pollutant loading.

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

3.1.8 Snowmelt Acidic Shock

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 has been undertaken by the Hydrometeorology Division with funding from the AES LRTAP Program. The project now in its second season consists of two parts. The first part is to develop a snowmelt acidic shock model suitable for application to specific basins and provide time series of the snowmelt, snowpack and meltwater chemistry. The second part is to design and implement a field study 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 used as the basis for the snowmelt acidic shock model. Routines to handle the acid concentration in the snowpack and melt water have been incorporated into the model. The model has been used to generate snowmelt acidic shock scenarios using climate data. The model is being implemented onto a microcomputer and will be made available for field testing at several study sites.

The field study is intended to complement and support the modelling work. The initial phase of the study conducted in the 1983/84 winter season, consisted of the design, implementation, and operation of a snowmelt runoff plot at the Ontario Ministry of the Environment (OME) Dorset Research Centre. The primary purpose of this initial phase was to test and evaluate the design of the snowmelt plot and to develop the necessary observation procedures. This has been completed with one season of data collected. For the 1984/85 winter season two snowmelt plots are being used. One plot is being operated at an open site and the other in a forested site.

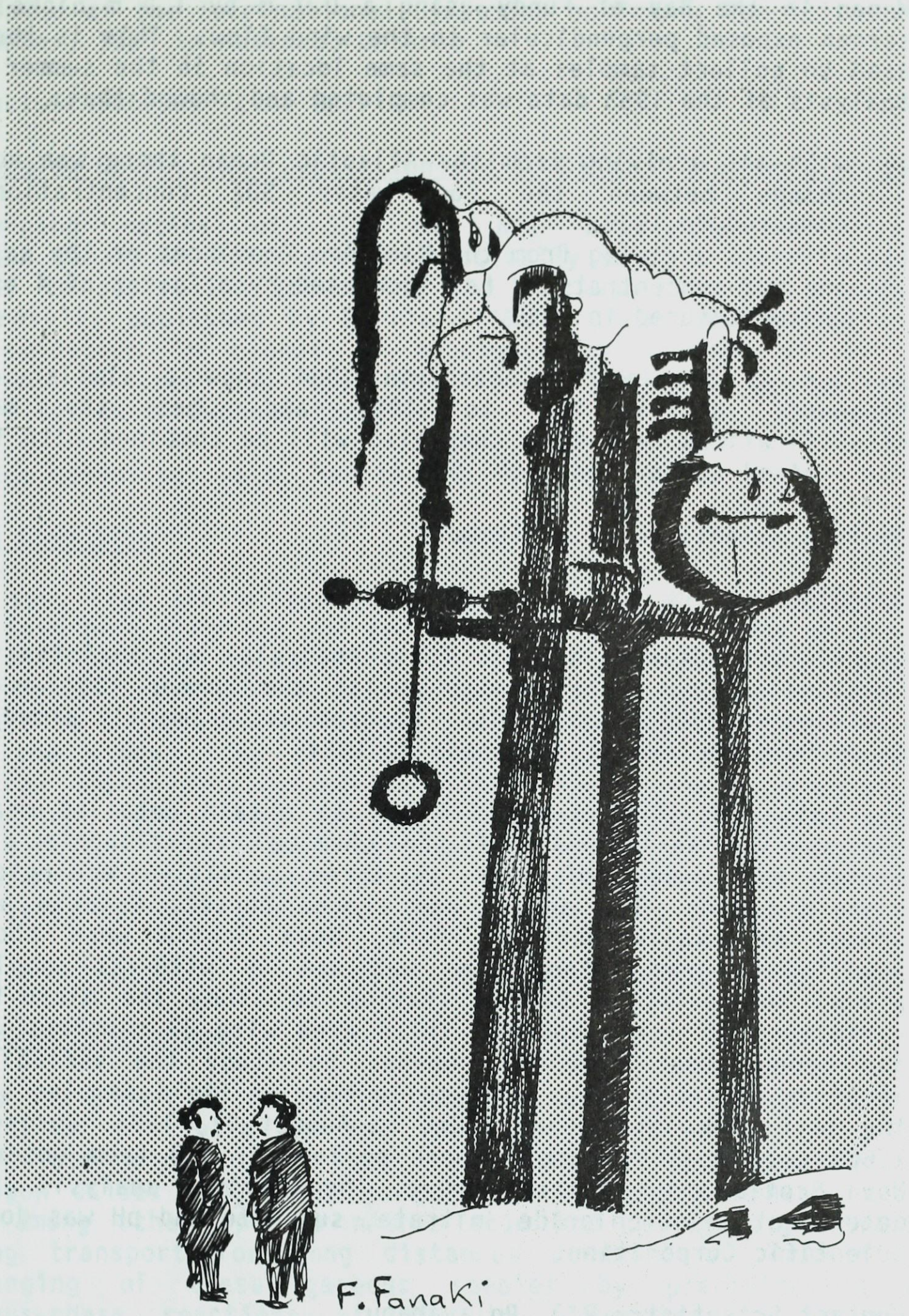
Contact Scientists: P.Y.T. Louie, B.E. Goodison

In addition, a cooperative project with Prof. H. Harvey, University of Toronto, which combines forecasts of major acid deposition and snow melt events with field monitoring of melt- and stream-water chemistry, and fish plasma and muscle ions continued this year. During spring 1984 snow melts, surface waters showed a decline to pH 4 and zero alkalinity, and rainbow trout held in such waters lost plasma Na and Cl rapidly and died within 28h.

Contact Scientist: D.M. Whelpdale

3.1.9 Bay of Fundy Fog Sampling

Following on from a successful pilot project carried out in the summer of 1983, sampling was continued in the summer of 1984. Fog was sampled



- I guess it snowed a lot last night.

on Kent Island (a small unpopulated bird sanctuary) just south of Grand Manan in the Bay of Fundy using a 0.7 m by 1.3 m nickel-plated mesh screen exposed perpendicular to the wind flow. This is the same screen used to collect samples at the same location in the summer of 1939. An analysis of the 1983 data was completed and showed that:

a) with air arriving from the Atlantic Ocean there was no significant change between the fog water $SO_4^{=}$ concentrations in 1983 compared to 1939;
b) with air arriving from the Maritime Provinces or the eastern U.S., the $SO_4^{=}$ concentrations had increased by a factor of 4 over those measured in 1939.

Another 35 samples collected in 1984 show a similar concentration frequency distribution to 1983 and when the meteorological stratifications have been completed will be combined with the 1983 data for a final comparison with 1939.

Contact Scientist: P.W. Summers

3.1.10 CanASTA

CanASTA (Canadian Acid Storm Toxic Analysis) was an intensive acid rain sampling project carried out during the Summer 1984 as part of the Environment 2000 Program. This program was primarily aimed at providing short term employment in Canada in 1984.

The main objective of CanASTA was to obtain detailed measurements of the spatial variability of the chemical constituents of rain water during the summer of 1984 at three sensitive ecological areas in eastern Canada. Two areas, one around Dorset, Ontario and the other around Kejimkujik National Park, Nova Scotia were chosen for the sampling program. Each area was set up with 33 sampling stations around the existing CAPMoN station to study the micro-to meso-scale variations in acid input. A third area with 33 samplers was set up on and around Mont Tremblant, Québec to study the variability of acid input on elevated areas. The collection of field samples started during the last week in May and ended on August 31, 1984. During that period 1,603 good quality samples were collected; 510 from Ontario, 399 from Nova Scotia and 694 from Québec. The chemical analysis of samples for determination of chloride, nitrate, sulphate and pH was done by Concord Scientific Corporation.

Contact Scientist: R.J. Polavarapu

3.1.11 Trace Elements in Aerosol and Precipitation

Between October 1 and December 10, 1984 at Dorset, Ontario measurements of the concentrations and size distributions of toxic trace elements in aerosols was made simultaneously with their concentration in precipi-

tation. Sampling was usually done on a 24-h basis. Results will be presented at the International Symposium on Acidic Precipitation, 15-20 September, 1985 in Muskoka, Ontario.

Contact Scientist: L.A. Barrie

3.1.12 Scavenging Ratios, Wet Deposition and In-Cloud Oxidation of $SO_4^=$ and NO_3^-

Scavenging ratios of $SO_4^=$ and NO_3^- from the APN network in eastern Canada were analyzed statistically using a model relating daily ratios to nucleation scavenging and in-cloud chemical transformation. The results published by Barrie (1985b) yield indirect evidence that SO_2 oxidation in clouds is a significant source of $SO_4^=$ in rain but not in snow and that NO_2 is an important source of NO_3^- in precipitation throughout the year.

Contact Scientist: L.A. Barrie

3.1.13 Cloud Chemistry

Data sets from the winter study at North Bay during January/February, 1984 have been compiled and are being analyzed in terms of the chemical and microphysical properties of winter clouds and precipitation. Information regarding the characterization of winter air masses with respect to vertical profiles and chemical composition has been obtained from the study. The data set should provide further insight into chemical and physical processes within cloud systems including chemical conversion mechanisms, physical scavenging by cloud droplets and precipitation and the horizontal and vertical variations of pollutants. A paper based on the results obtained from ground sampling activities has been published (see Publications section).

Contact Scientists: K. Anlauf, H.A. Wiebe

3.1.14 Atmospheric Nitrogen

It is now generally recognized that nitrogen species contribute to the acidity of precipitation and lead to the formation of gaseous and particulate acids in the lower atmosphere. Anthropogenic emissions of nitrogen oxides (NO_x) undergo gaseous- and aqueous-phase reactions to form among other species nitric acid and peroxyacetylnitrate (PAN), during transport for long distances downwind of industrial areas. Scavenging of these gaseous species by precipitation and the aqueous-phase reactions of NO_x in cloudwater and raindrops can account for the significant quantities of nitrate found. The formulation and verification of the chemical mechanisims and atmospheric processes by which the nitrogen oxides are converted to atmospheric acids requires the measurement of several key atmospheric nitrogen species. These include NO, NO_2, HNO_3, PAN, NH_3 and particulate nitrate.

One of the objectives of this project was to develop and construct instrumentation with suitable sensitivities for the measurement of these nitrogen species. Through a science subvention awarded to York University, several prototype instruments for the measurement of NO_2 have been built and tested. Using the principle of luminol chemiluminescence, a working range of 0.01 to 500 ppb(v) has been demonstrated. Several of these units have been sold to the U.S. Environmental Protection Agency. Commercial NO_x monitors using chemiluminescence techniques have also been modified to extend the measurement of NO and NO_x to concentrations encountered in regional air masses (0.2 to 50 ppb(v)).

A joint research venture is being supported by ARQA/ARQD and ARPP/ARPD through the unsolicited proposal entitled "A Tunable Diode Laser Absorption Spectrometer for Trace Gas Analysis from an Aircraft" with Unisearch Associates Inc. of Concord, Ontario. This U.P. will support the development of an airborne laser system for measuring NO, NO_2 and HNO_3. The project is co-sponsored by NASA, who will supply the American-made hardware and test fly the system onboard their DFV-990 aircraft during the Global Tropospheric Experiment missions (GTE/CITE-2).

Measurement of PAN, using gas chromatography, was implemented on a continuing basis at Kejimkujik National Park, N.S. in June, 1984. Previous data obtained at Longwoods and Chalk River, Ontario indicates that PAN constitutes 20-30% of the products formed during the atmospheric oxidation of NO_x. This data set should prove useful in modifying the advanced chemistry module of the Lagrangian Trajectory Module.

Contact Scientists: K.G. Anlauf, J.W. Bottenheim, H.A. Wiebe

3.1.15 Cross-Appalachian Tracer Experiment (CAPTEX)

Following the actual field experiment in September-October 1983 (for details see 1983-1984 Annual Report) quality-controlled data sets of the meteorological information and ground tracer concentrations were prepared by the U.S. agencies involved. These were released for general use in October 1984 and January 1985 respectively.

A preliminary comparison between the ground tracer concentrations and the diagnostic air parcel trajectories has been made. For each of the experiments the tracer was clearly tracked through the network with synoptic maps showing the 6 hour average ground-level concentration every 6 hours up to 2 days after release time. Starting at the tracer release point, air parcel positions were calculated every six hours out to 2 days using the AES-LRTAP model at four levels: 1000 mb, 925 mb, 850 mb and 700 mb. Qualitatively, the features of the tracer pattern were simulated very well by the model with the tracer concentration maxima usually confined to the region between the 1000 mb and 925 mb trajectories. Comparing the arrival time of the tracer at stations

along the plume centre line with the model predictions showed good agreement for the first 24 hours after which the model tended to underestimate the speed of tracer motion. The errors in the direction of motion varied from experiment to experiment and best fit was obtained sometimes by including, and at other times excluding, a frictional tuning term at the 1000 mb level.

Scientific input was provided by AES to a design team assembled by ERT Inc. who were under contract to EPRI to carry out a feasibility study for a much larger type of tracer experiment dubbed MATEX (Massive Aerometric Tracer Experiment) covering most of eastern North America.

Contact Scientist: P.W. Summers

3.1.16 Western Atlantic Ocean Experiment

The objective of the Western Atlantic Ocean Experiment is to determine the magnitude of the transport and deposition of North American pollutants, particularly acidic S and N species, over the Atlantic Ocean. This is a cooperative research project involving AES and York University, and several US universities and agencies. Using the meteorological and mass budget framework prepared earlier (Whelpdale et al., 1984; Galloway et al., 1984) routine and intensive measurement programs have been undertaken at Lewes, De., Bermuda; on-board cruise, research and container ships; and on the NOAA King Air aircraft flying off the east coast. AES has been responsible for acidic particle and gas measurements using a filter pack system.

Contact Scientist: D.M. Whelpdale

3.1.17 Trans-Atlantic Pollution

Research is continuing towards the possibility of air pollution detection by meteorological satellites. AES false colour technique using Channels 1,2 and 4 of AVHRR was compared with techniques employed at NOAA and NASA in the USA, and it was found that the AES method is superior in its ability to distinguish air pollution from cloud.

AES satellite imagery has been scrutinized to find evidence of cross-Atlantic transport of air pollution. Pollution masses from industrial areas often move out over the Atlantic Ocean with synoptic-scale motion systems. However, the pollution mass is generally steered by convergent flows and fronts of extra-tropical cyclones, and wet deposition and scavenging of air pollutants within clouds occur primarily over the cold ocean, especially during the occlusion stage of a cyclone. As a result, the oceanic area from Newfoundland to 1500 km eastwards (and the Icelandic low area!) is often "a dumping ground" (sink region!) of air pollution from North America. In turn, air pollution transport from many industrial sources to beyond 30° W rarely occurs, and consequently only very small fluctuations in back-ground levels of air pollution are observed at sites of the west coast in Europe.

Contact Scientist: Y.S. Chung

3.2 TOXIC CHEMICALS

3.2.1 Toxics Communication

Although the atmosphere has been shown to be a major pathway through which many important toxic chemicals are transported to natural ecosystems, very little had been written about the problem and the programs carried out to address it. Consequently, preparation of information fact sheets on atmospheric toxic chemicals were undertaken this fiscal year as part of the TCMP Communications Plan. The topics addressed include:

(1) PCBs and the Atmosphere
(2) Heavy Metals and the Atmosphere
(3) Pesticides and the Atmosphere
(4) PAH and the Atmosphere
(5) Environmental Emergencies.

In each case, technical reports on the subject were prepared and reviewed by AES scientists. From these reports, additional guidance material provided and direct consultation with the scientists, Mr. P. McLaughlin of P. McLaughlin and Associates, Toronto, has developed public information fact sheets. The intention of these reports, which will be printed in the standard AES fact sheet format, is to raise public awareness of the issues and the significance of the atmospheric pathways, and to support effective action through the scientific analysis of the problem.

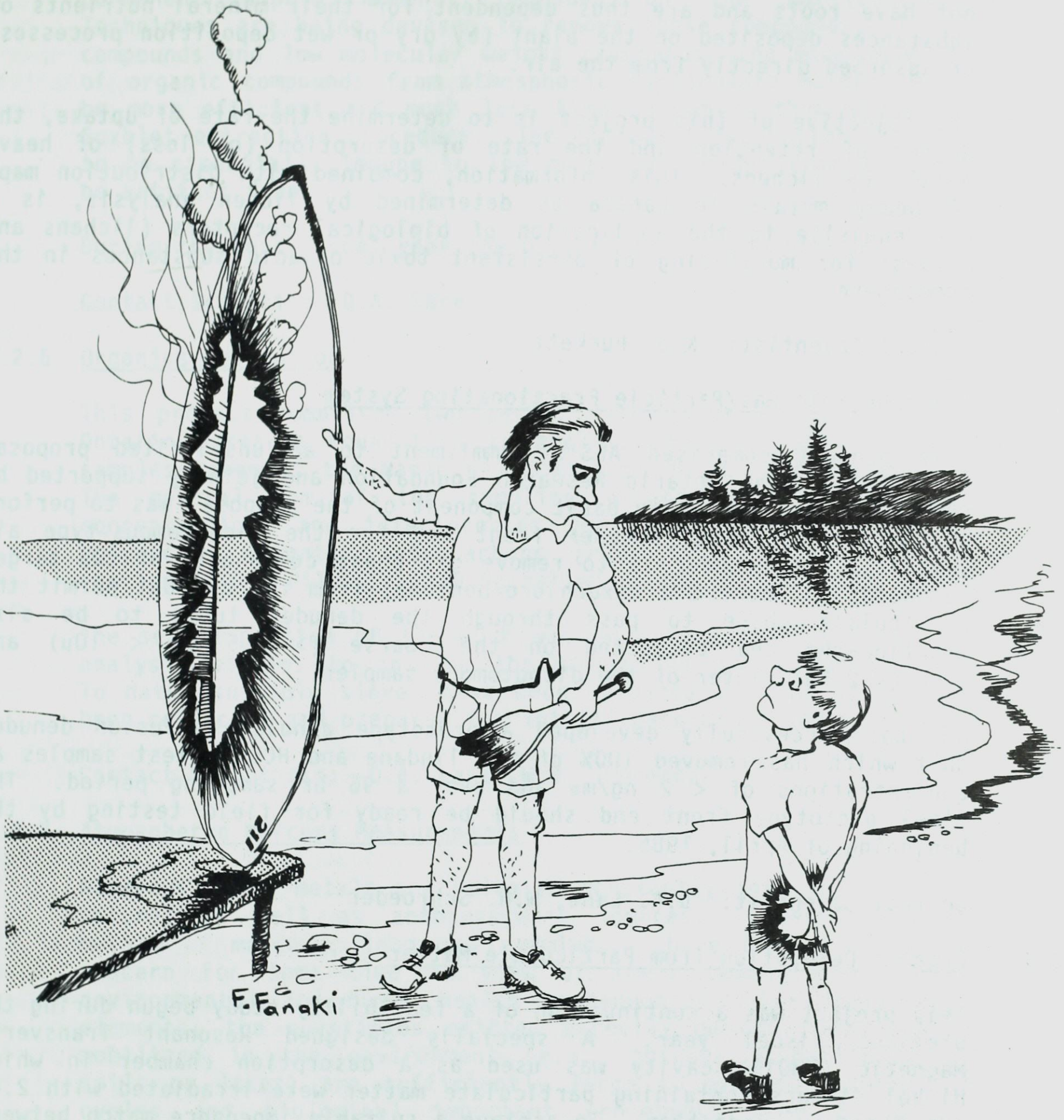
The publication of the public fact sheets will be completed in April. The technical reports will also be available for departmental distribution in May.

Contact Meteorologist: E. Wilson

3.2.2 Air Quality Objectives

During fiscal year 1984-85, this project provided support to the Federal-Provincial Advisory Committee on Air Quality (FPACAQ) and its Subcommittee on National Air Quality Objectives: Desirable and Acceptable Levels constituted under the authority of the Clean Air Act. Air quality criteria information and documentation is being assembled, both in-house and through external contract work. Currently in progress are: criteria digests for ozone, carbon monoxide and nitrogen dioxide, as well as efforts to compile information on respirable particulate matter, ethylene, and hydrogen sulphide.

Contact Scientist: H.P. Sanderson



- I told you not to take the canoe to the lake!!

3.2.3 Biological Receptors

Lichens and mosses have been used with success as biomonitoring agents for measuring airborne heavy metals and toxic trace elements in both rural and industrial areas of Canada. Lichens, unlike other plants, do not have roots and are thus dependent for their mineral nutrients on substances deposited on the plant (by dry or wet deposition processes) or adsorbed directly from the air.

The objective of this project is to determine the rate of uptake, the degree of retention and the rate of desorption (or loss) of heavy metals by lichens. This information, combined with distribution maps of heavy metals in Canada as determined by lichen analysis, is a pre-requisite to the application of biological receptors (lichens and mosses) for monitoring of persistent toxic organic substances in the atmosphere.

Contact Scientist: K.J. Puckett

3.2.4 Trace Organic Gas/Particle Fractionating System

This project comprised AES's commitment to an unsolicited proposal submitted by the Ontario Research Foundation and jointly supported by DSS, GLWQP and AES. The basic component of the proposal was to perform R&D for a diffusion denuder front end for the dichotomous-type air sampler. The denuder is to remove gas phase components of two target compounds (lindane and hexachloro-benzene) from the air but permit the particulate phase to pass through the denuder tubes to be size fractionated and collected on the coarse (> 2.5 μ, < 10μ) and fine (< 2.5μ) filter of the dichotomous sampler.

ORF has successfully developed a prototype annular diffusion denuder unit which has removed 100% of the lindane and HCB in test samples at concentrations of < 2 ng/m$_3$ and over a 96 hr sampling period. The final prototype front end should be ready for field testing by the beginning of April, 1985.

Contact Scientist: D.A. Lane, W.H. Schroeder

3.2.5 Organic Desorption from Particulate Matter

This project was a continuation of a feasibility study begun during the previous fiscal year. A specially designed Resonant Transverse Magnetic (TM010) cavity was used as a desorption chamber in which Hi-Vol filters containing particulate matter were irradiated with 2.45 GHz microwave radiation. To achieve a suitable impedance match between the transmitter and the cavity, the filter to be desorbed was first misted with distilled water. The cavity could then be tuned at 20 watts power and subsequently the incident power could be increased to 200 watts for the desorption step.

The technique successfully removed 100 percent of standard compounds (Lindane, Phenanthrene, 2,4,5-Trichlorobiphenyl, Aldrin, Pyrene, Dieldrin, Benz(a)anthracene, Mirex and Decachlorobiphenyl) doped on the particulate matter. The desorption was not complete for all compounds, however. Some high molecular weight, non-polarizable compounds without permanent dipole moments remained on the particulate matter. Techniques are being devised to remove these compounds. For the test compounds and low molecular weight compounds, the microwave desorption of organic compounds from atmospheric particulate matter was found to be more efficient and much less time consuming then the conventional Soxhlet extraction procedure. The microwave desorption process appears to be essentially immune to low molecular weight compound loss and to be artifact free.

During the next fiscal year the process will be quantified.

Contact Scientist D.A. Lane

3.2.6 Organics Desorption

This project comprised two parts. The first was a contract to the Ontario Research Foundation to analyse, by HPLC and GC/MS, 57 field samples taken at the Maple pilot station during the winter of 1983-84. The general aim of the sampling program was to establish blank concentrations and interferences pertaining to the analysis of the Polycyclic Aromatic Hydrocarbons (PAH) (the reader is referred to section 6.10.8 Pilot Station Operation of the 1983-84 AQRB Report).

The second portion of the work was to extend the microwave desorption analysis studies to include the desorption of pesticides from soils. To date, suitable sieves have been obtained and the soil samples have been collected and prepared for initial desorption tests.

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

3.2.7 Atmospheric Mercury Measurements

Numerous heavy metals are released constantly into the atmosphere from natural as well as anthropogenic sources. However, certain heavy metals -- mercury, lead and cadmium -- have been causing particular concern for some time in view of their demonstrated or potential environmental and human health consequences. For these toxic trace elements, the quantities emitted directly due to human activities or mobilized in the environment (e.g., through acidification of rain, soils or lakes) are sufficiently large to perturb naturally existing cycles and biological important processes, some of which depend critically upon the concentration of metals or metallic compounds. Determination of the total amounts as well as the physical and chemical forms in which this toxic trace element exists in ambient air is important to an understanding of its ecological behaviour and biogeochemical cycle.

This project combined two areas of investigation. The first of these involved collection, analysis and interpretation of data from environmental measurements of mercury at several locations in southern Ontario. For the purposes of analysis and interpretation, data are now available from field measurements (both ground-based and aircraft sampling) for vapour-phase and particulate-phase mercury which were made at Long Point, Ontario (APN site). This site is situated on the northern shore of Lake Erie. In addition, by applying a novel instrumental analytical system developed through an unsolicited proposal sponsored by AES, information was obtained at 4 different locations in and around metropolitan Toronto with respect to atmospheric concentrations of the major volatile mercury species.

The second area of investigation revolved around an assessment of the use of noble metal amalgamation for sampling and analysis of gaseous mercury species. The results of published work on the utilization of noble metals (primarily silver or gold) for the collection and speciation of vapour-phase mercury in the atmosphere were summarized and critically reviewed in a paper to be published in 1985.

Contact Scientist: W.H. Schroeder

3.2.8 Trace Element Survey

A pilot survey was carried out between October 1 and December 10, 1984 at three sites in Eastern Canada: Kejimkujik, N.S., Forêt Montmorency, Que. and Dorset, Ont. A daily and weekly air sampling program was conducted during this period using a hi-volume air sampler and replaceable filter cartridges to ensure sample integrity. At the Dorset site, in addition to collecting atmospheric aerosols, precipitation samples were collected and analyzed for metals and organics, in cooperation with OME. All air samples are undergoing neutron activation analysis techniques (McMaster University Labs) for a multiple of trace elements and heavy metals including: I, Br, Mn, Na, V, Al, and Cl. The filters also will undergo ICP (ion-coupled plasma spectroscopy) analysis for metals including Zn, Pb, Mg and Fe. (The latter analysis, initially, for Dorset filters only). Data analysis will be completed in April.

The measurement program was supported by Atlantic and Quebec Region DOE TOXFUNDS and by AES Regional operators. The data generated will be quality-controlled, logged and reported early in the next fiscal year. It will then undergo evaluation using meteorological and statistical analysis techniques to determine the origins and atmospheric trajectories of the elements present. A preliminary paper will be presented at the Muskoka Conference in September.

Contact Meteorologist: E. Wilson

3.2.9 Analysis of PCBs in Air and Precipitation

One of the major problems associated with the analysis of PCBs in air samples when using a gas chromatograph and an electron capture (GC/ECD) detector is the severe interference from other sample components. These interferences persist even after a column chromatographic clean-up step. In recognition of the resistance to oxidation characteristics of PCBs, oxidizing agents were used to selectively destroy the interfering components and subsequently separate them from the PCBs of interest by using column chromatography. Among the three oxidizing agents used, sulfuric acid (H_2SO_4), chromic acid (CrO_3) and potassium permanganate ($KMnO_4$), sulfuric acid is the most promising. Whereas $KMnO_4$ was unable to oxidize most of the interferences, chromic acid oxidizes some of the PCBs. Although H_2SO_4 cannot destroy all the interferences, positive identification and quantification of individual PCB isomers can be achieved by using dual capillary column GC/ECD. More accurate quantitative results have been achieved. This method will be used to analyze field samples during the next fiscal year.

Contact Scientist: K.W. Chan

3.2.10 Pathways and Characteristics Research

The physical, chemical and biological properties of any given toxic substance are of paramount importance in determining its environmental behaviour and its toxicological characteristics. Several program activities of this Branch, including laboratory research, field measurements and mathematical modelling in relation to the atmospheric pathways of toxic chemicals, frequently require knowledge of various physico-chemical and thermodynamic parameters. Obtaining such data has, in the past, been a tedious and time-consuming process requiring manual searching of primary and secondary information resources.

In recent years, so-called scientific-numeric data bases (SNDs) have been established by several government agencies and private consultants/vendors on a commercial basis. On-line access to several of these SNDs is now possible with the appropriate hardware and software facilities. Furthermore, micro-computer technology has made it feasible to handle, store and retrieve large amounts of data.

The objective of this project was to establish, within the Atmospheric Chemistry, Criteria and Standards Division, the capability for efficient acquisition, storage and retrieval of up-to-date scientific-numeric data pertinent to atmospheric research on toxic substances. Canadian and U.S. data bases with on-line search features were identified and their characteristics were compared. Subsequently, link-up requirements were defined for the most promising candidates. The system ultimately chosen employs a software package (called Sci Mate) marketed by ISI (Institute for Scientific Information;

- You should have bought a stainless steel umbrella!!

Philadelphia, PA) coupled with an IBM PC-XT micro-computer. The Sci-Mate software enables one to search the major computerized databases without having to know the languages and search strategies used in these systems. In addition, it provides a means of filing, organizing and retrieving -- in a scientifically designed data management system -- the material of interest. A particularly attractive feature of this software is the degree to which it is user-friendly: the user can communicate with Sci-Mate in plain English -- no keywords are required. This technology has been used in ARQA during the current fiscal year to establish a comprehensive data base on physical, chemical and thermodynamic properties of PAH and their derivatives which are relevant to their environmental behaviour and fate.

Contact Scientist: W.H. Schroeder

3.2.11 PAHs and Derivatives

Nitrated and oxygenated polycyclic aromatic hydrocarbons have been found recently in the atmosphere as photochemical reaction products of PAHs. They are also present in substantial quantities in exhaust from diesel engines. Although these compounds have attracted the attention of toxicologists because of their mutagenic properties (many of them are more toxic than their parent PAHs), environmentally relevant scientific/technical information pertaining to these compounds is scarce and scattered in the literature. In order to concentrate the current knowledge and improve scientific understanding of these substances, a literature search was conducted on a contract basis. The review emphasized the biological toxicity, formation, pathway, distribution and analytical methodologies pertaining to these compounds. Physical and chemical properties of some of these compounds have also been included in the report from this literature survey.

Contact Scientist: K.W. Chan

3.2.12 Atmospheric Loading

It has been shown that several priority toxic chemicals enter the Great Lakes via the atmosphere. However, the amount of atmospheric loading, its significance relative to other inputs and its important sources are not known. Design of effective control policies and strategies is therefore difficult. In this ongoing project, toxic chemicals (priority and emerging) will be assessed to determine the importance of atmospheric transport, transformation and deposition to the Great Lakes ecosystem and potential sources of emissions.

The ASTRAP model, suitable for estimating long-range transport of acidic material, has been modified for use in the toxic chemicals program, installed on the AS/6 computer and is currently being tested. Work on estimating emissions inventories of toxic chemicals is progressing.

Under the sponsorship of the International Joint Commission a workshop on Atmospheric Loading to the Great Lakes is being organized. A contract for assessing networks in the Great Lakes region was awarded to Concord Scientific Corporation and the atmospheric component of the Great Lakes Surveillance Plans was reviewed and recommendations for improvements provided.

Contact Scientist: E.C. Voldner

3.2.13 Niagara River Air Organics Survey and the Arctic Chlordane Project

Since 1982, a survey has been conducted along the Niagara River in an attempt to measure air concentrations of toxic chemicals above the river. Sampling has been conducted in Niagara-on-the-Lake, Niagara Falls and Fort Erie, Ontario. Samples have been analysed for polynuclear aromatic hydrocarbons, phthalate esters and polychlorinated biphenyls using both glass fibre filters and polyurethane foam plugs. Results from the study have shown that an appreciable fraction of the air concentration for all but the heaviest PAHs are not collected efficiently on the glass fibre filter but rather on the foam plugs. This is consistent with the conclusion that many PCB isomers, phthalates and PAH compounds are gaseous in the atmosphere rather than in particulate form. The gaseous compounds show air concentrations which vary like regional and synoptic scale features rather than from local influence. Certain PAH isomers, however, show clear evidence of local input into the atmosphere.

An additional study was conducted in support of Canadian Wildlife Service findings of organochlorine compounds in the livers of polar bears in the Western Arctic. In July, 1984, air sampling for chlordane was conducted in Mould Bay, N.W.T. Gas-phase chlordane (a pesticide used at mid-latitudes) was trapped on polyurethane foam plugs and was found on all samples. Quality assurance of the results and a study of the implications of the concentrations levels is being carried into 1985. Clearly long-range air transport into the Arctic is involved with these findings.

Contact Scientist: R.M. Hoff

3.2.14 PAHs: Nitrate and Oxygenated Derivatives

Recent studies indicate that polycyclic aromatic hydrocarbons undergo photochemical reactions with oxidants present in the air to form nitrated and oxygenated PAHs.

An analytical method has been developed to determine the presence of these chemicals in ambient air. Normal-phase high pressure liquid chromatography (HPLC) was used to separate the CH_2Cl_2 extract of the samples into non-polar and moderately polar fractions. The non-polar fraction containing PAHs was subsequently analysed on a

reverse-phase PHLC using UV and fluorescence detections. The moderately polar fraction contained nitrated and oxygenated PAHs. Due to their low concentration in the air, nitrated PAHs were analyzed using negative chemical ionization mass spectrometry and gas chromatography with a special nitrogen/phosphorous detector to obtain the selectivity and sensitivity required. Oxygenated PAHs were analyzed by reverse-phase HPLC with photo array diode UV detection. Field samples were collected in the Hamilton area and analysis is expected to be completed by the end of March.

Contact Scientist: K.W. Chan

3.2.15 Canopy Pesticide Dispersion Model

With the large quantities of pesticides used in agricultural and forestry operations there is continuing concern for environmental damage resulting. Effort this year has concentrated on putting in place a pesticide spray drift assessment model suitable for evaluating the fate of aircraft applied sprays over forests. This builds on our previous cooperative experimental work in this area.

Under contract existing spray drift models were surveyed and one, the U.S. Forest Service Model, selected as most appropriate for regulatory purposes. It was implemented on an IBM microcomputer. A user guide is available. A user workshop was held.

In a parallel effort a contract has been let for the further development of a research grade model with explicit and detailed treatment of the spray aircraft trailing vortices. Full development of this model should permit more accurate parameterization of the regulatory model.

Contact Scientists: J.D. Reid, R.E. Mickle

3.3 CLIMATE CHANGE

3.3.1 AES Carbon Dioxide Monitoring Program

Present AES research into atmospheric CO_2 concentration and its trends involves a basic "grab flask sample" monitoring program, the development of a continuous CO_2 monitoring capability and studies into sources and sinks of atmospheric CO_2.

AES monitoring of atmospheric CO_2 concentrations in support of the WMO BAPMoN program has been operational since 1975. This activity primarily involves the collection of grab flask samples at Alert, NWT (weekly) and Sable Island, N.S. (weekly). In addition, AES and NOAA cooperate with a flask sampling station at Mould Bay, and IOS operates a fourth Canadian flask sampling station at Cape St. James, B.C.

AES is preparing to up-grade its BAPMoN station to a continuous CO_2 monitoring capability. A calibration laboratory has been established at AES in Downsview and the first two continuous monitoring systems (one to be used in the laboratory) have been assembled and will be tested soon. BAPMoN station Alert will be the first to be equipped with a continuous CO_2 monitoring capability. Two temporary stations monitoring aerosol and surface meteorology have been established in the Alert environs to determine optimum siting for a permanent BAPMoN station.

An AES program for measuring CO_2 fluxes over vegetation canopies is presently under development to qualify experimentally the natural sources and sinks of atmospheric CO_2 according to land use and season.

Contact Scientist: N.B.A. Trivett

3.3.2 Carbon Dioxide Analysis and Modelling

Carbon budget studies were initiated in ARQM in April 1984. The primary objective of these research activities is to identify and understand CO_2 exchange processes and mechanisms among global carbon reservoirs so that reliable predictions of future CO_2 concentrations in the atmosphere can be made. At present there are two basic models of the global carbon cycle: (1) a multi-box model, and (2) a box-diffusion model. These models are constantly tested and improved where possible. A third model recently obtained from the Oak Ridge National Laboratory is now being implemented and will be tested very shortly. Scientific advance in the modelling effort has been limited by the complexity of the global biogeochemical cycle of carbon and by resource limitations.

In order to identify regional distribution of carbon sources and sinks in the Arctic, data from Alert were analyzed and interpreted in terms of the synoptic-scale atmospheric circulation. Using a trajectory model, it was possible to determine, with some degree of confidence, spatial and seasonal distribution of CO_2 sources and sinks in the Arctic. Results of the study were presented at the Third Symposium on Arctic Air Chemistry, May 7-9, 1984, Toronto, and submitted for publication in Atmospheric Environment.

Contact Scientist: K. Higuchi

3.3.3 Atmospheric Turbidity at Resolute

Atmospheric turbidity was evaluated at Resolute, a remote station located in the Canadian Arctic to provide reference levels, and ground truth for satellite and aircraft observations and to assess trends. Global solar and diffuse sky radiation data and upper-air measurements were used for the period March 1969 to April 1980. At Resolute, the turbidity shows a slight increasing trend having an 11-year mean value of 0.038.

The mean monthly turbidity variations from year-to-year are high in March and April, low in June and August and practically non-existent in September. The fairly constant turbidity in September implies that most of the atmospheric turbidity in that month is due mainly to stratospheric aerosol. This agrees with Mauna Loa observations in that there exists a thin stratospheric aerosol layer of volcanic origin.

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 urban and non-urban areas where the monthly average turbidity shows a consistent annual pattern with low values in winter or spring and high values in summer. However, the present finding of a late winter or early spring maximum and a summer minimum is in agreement with aerosol measurements in the Canadian Arctic and at Barrow, Alaska.

Contact Scientist: R.J. Polavarapu

3.3.4 Arctic Air Pollution

The third symposium on Arctic air chemistry was held at AES in May 1984. Sixty participants heard thirty papers presented by scientists from five northern countries. Six papers were based on AES research. The proceedings will be published in a dedicated issue of Atmospheric Environment in 1985.

The Arctic Aerosol Sampling Network (AASN) which ran at Mould Bay, Igloolik and Alert between July 1980 and June 1984 was replaced by BAPMoN Alert, a global background monitoring station at which future trends in aerosols and gases interfering with climate will be monitored. An analysis of the aerosol measurements made with the AASN was presented by Barrie and Hoff (1985) at the symposium.

Contact Scientist: L.A. Barrie

3.4 CORE RESEARCH

3.4.1 Nanticoke II Shoreline Dispersion Experiment

Follow up studies to the 1982 Nanticoke II project continued into 1984. Papers, using data taken during the project, have been prepared by Bottenheim et al. (1985), Anlauf et al. (1984 a,b) and by Ogawa, Ohara and Wahamatsu (1984, submitted to Boundary Layer Meteorology). The final project synthesis report is in preparation and shows that additional industry added at Nanticoke, Ontario, since the 1978 study has had little additional environmental impact for sulphur dioxide. The main fumigation episodes in lake breeze flows is due to the Thermal Generation Station of Ontario Hydro. The project showed that thermal internal boundary layer (TIBL) development was, on at least one

ARCTIC HAZE

occasion, strongly influenced by mechanical entrainment at the top of the boundary layer and that downward vertical heat flux at that altitude was less than expected. These results are being applied to numerical simulations of TIBL growth.

Contact Scientist: R.M. Hoff

3.4.2 Cooperation with the Commission of the European Communities (CEC)

Reporting on the 1983 Sixth Remote Sensing Campaign of the CEC was completed. This project sponsored by the Government of France and the CEC was an international study of the complex meteorology and atmospheric dispersion around the Etang (Pond) d'Berre in southern France. The AES component consisted of a vertically pointing Lidar, Correlation Spectrometers and a ground SO_2 analyser in a mobile van. The results have been presented in a project report and at the 12th International Laser Radar Conference.

Contact Scientist: R.M. Hoff

3.4.3 Development of a Differential Absorption Lidar System

One of the crucial components in understanding the Long-Range and Transboundary Transport of Air Pollutants is a knowledge of the altitude at which the pollutants are advected. In order to determine vertical profiles of sulphur dioxide and ozone, construction of a differential absorption lidar (DIAL) system has begun at AES. The system consists of a specialized Lumonics/J.K. Lasers Hyperyag Neodymium-YAG laser with frequency doubling crystals on the fundamental wavelength and on the pumped dye laser output. Oscillation of the tuning mirror of the dye laser provides output on two wavelengths around 300 nm. The difference in absorption due to SO_2 or ozone on these two lines gives a measure of gas concentration as a function of range from the lidar. The return signal is detected by a 0.4 m diameter Cassegrain telescope, solar blind PMT and high speed digitization electronics. Demonstration phases of the system are planned for late 1985.

Contact Scientist: R.M. Hoff

3.4.4 MIZEX

In July, the Boundary Layer Research Division participated in the International Marginal Ice Zone Experiment (MIZEX) which took place in the Fram Strait near 80°N 0°W. The MIZ is a significant region in two senses, firstly as a location for man's activities and secondly as an important geophysical boundary zone involving energy exchanges which require parameterization in larger-scale ocean-atmosphere models. It is subject to fluctuations due to short term forcing (e.g. cyclone passages, marginal eddy generation) and to long-term factors (seasonal). Successful modeling and prediction of variations in the edge position and ice concentration would be of value in furthering man's activities in the region.

The main purpose of the MIZEX was to characterize and understand the sea-ice processes occurring in the MIZ. The approach in achieving this goal was to intensively measure the ice drift, and deformation, due to oceanographic and meteorological forcing. The substudies involved ice flow drift and ablation experiments, characterization of eddies along the ice edge important in flow movement and, melt due to warm upwelling, and characterization of the boundary-layer and turbulence processes across the MIZ. The experiments were conducted from a number of platforms including aircraft and various oceanographic vessels.

The intensive boundary-layer studies were undertaken as a joint AES/BIO experiment aboard the Kvitbjorn, a converted fishing vessel some 130 feet in length. Although the smallest ship of the 5 ship fleet, its size contributed to easy accessibility to ice flows within the ice pack. During the 5 week field phase on the Kvitbjorn, the boundary-layer studies using sonics, tethersondes and ship based surface network were aimed at:

1. measuring the surface wind stress field with varying ice conditions;

2. characterizing the energy fluxes (heat, moisture and radiation) and their relation to conditions in the MIZ;

3. measuring the modification of the boundary-layer across the MIZ.

The MIZEX '84 timing was chosen to yield as much information as possible about the transition to summer conditions in the MIZ. Plans are presently being made for a similar study to be conducted during the winter of '86 or '87.

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

3.4.5 Liquid Natural Gas (LNG)

With increasing transport of denser-than-air gases, including the recent Canada LNG project for export from the west coast, contract work continued to develop the knowledge base necessary for the evaluation of hazards of spills of such gases. Experimental large scale releases ($2000m^3$) of gas up to 4.2 times as dense-as-air were completed and preliminary analyses conducted. These studies, for which AES was one of more than 30 co-sponsors, are rapidly being recognized as the definitive data set in the field.

Contracts for the further development of an LNG spill assessment model and evaluation of advanced 3-dimensional spill model were funded. A comprehensive state-of-the-art assessment model is now available to AES computer users with good documentation available. Evaluation of the advanced models has uncovered some significant numerical diffusion problems.

A major two-day "Heavy Gas (LNP/LPG) Workshop" was organized in January. Over ninety people participated including a broad representation from Canadian industry and government. We were fortunate to be able to assemble most of the world's experts to speak at the meeting.

Contact Scientists: J.D. Reid, C.S. Matthias

3.4.6 Northern Oil and Gas Action Plan (NOGAP)

Increased energy processing activity at the Beaufort/Mackenzie delta has resulted in a demand for measured meteorological and dispersion data that is relevant to the Arctic.

The general objective of this project is to obtain and disseminate relevant baseline meteorological and dispersion data required as input to and verification of air quality models for the Arctic.

To obtain a continuous record of wind and temperature, the CBC 100 m tower at Inuvik, N.W.T. was instrumented at 6 levels. At each level measurements of wind speed, wind direction and temperature are made. The tower also includes a humidity sensor at the 20 m level and solar radiation detectors at the 2 meter level. All sensors are in operation as of the middle of February 1985 and archiving the data is currently proceeding. Additional meteorological data are obtained from the existing weather stations.

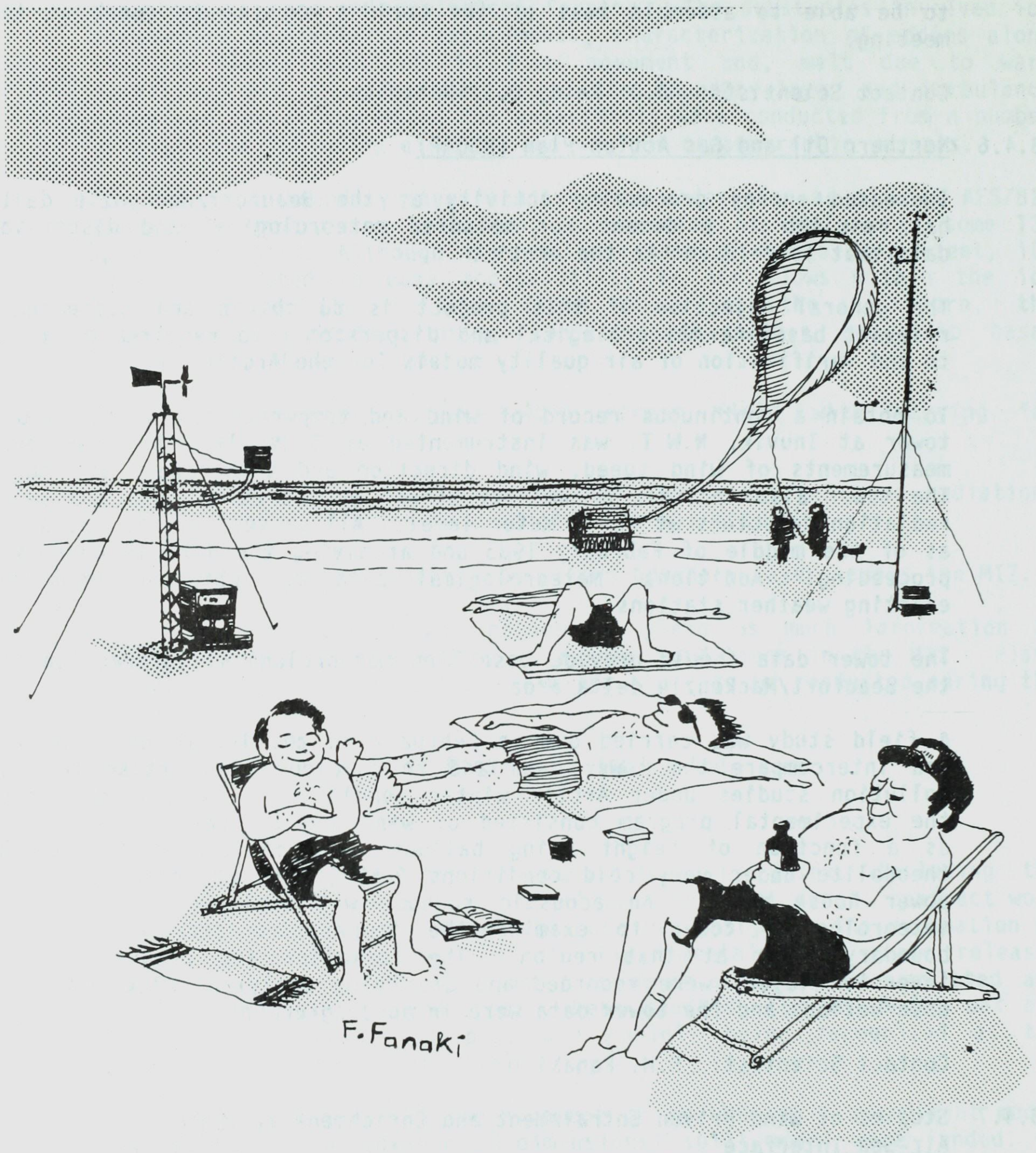
The tower data should provide base line meteorological information for the Beaufort/Mackenzie delta area.

A field study was carried out in February in the Inuvik area to test and intercompare the tower data and to develop an expertise for air pollution studies under Arctic winter conditions. As a consequence, the experimental program consisted of wind and temperture measurement as a function of height using balloon-borne minisondes tracked by theodolite under very cold conditions (-50°C) and photography of the power house plume. An acoustic sounder was employed close to the meteorological tower to examine the temperature structure of the boundary layer at that region. The formation and breakup of the inversion layers were recorded and are being analyzed. The minisonde observations and the tower data were in good agreement.

Contact Scientist: F.H. Fanaki

3.4.7 Studies of Wind-Driven Entrainment and Enrichment at the Air-Sea Interface

One of the mechanisms responsible for exchanging gases and particulates at the interface of the atmosphere with either lakes or oceans is the breaking wave process. The formation of bubbles, their downward



- I'm glad that I'm not with AES or I would be in Inuvik or Alert!!

transport in a violently turbulent jet and their subsequent diffusion during their rise is suspected of greatly enhancing the exchange ('deposition') of gases between the atmosphere and water. The process has important implications in the transport of pollutants such as gaseous organics and CO_2. Also occurring in the breaking wave event are the entrainment, production and resuspension of particulates. The skin of a water body is rich in organics both natural lipids and anthropogenic pollutants. Local overturning simply provides a way to mix this layer into the water. Much of the particulate load is retransported to the surface by bubble scavenging, some of which is further resuspended as enriched aerosols. The rest is left in neutral buoyancy as enriched aggregates. It is thought that the surface feeding biota may themselves be enriched in anthropogenic organics such as PCB's by eating this residual surface skin rather than by eating natural plants which themselves have chemically absorbed pollutants. To address some of the issues associated with understanding and quantifying these processes, a multi-pronged program has been undertaken in the Boundary-Layer Division.

Studies of gas transfer have been conducted to further previous theoretical modelling conducted in this Division. An experiment was mounted in the Fall of 1984 to examine the rate of change of oxygen levels in the upper centimeters of Lake Ontario during wind mixing. The study was conducted on the CCIW Burlington tower from October to December, during the gas injestion stage of the lake. The enrichment aspects of wave breaking have been studied within the Division both by modelling the enrichment of resuspended aerosols and by awarding a contract to Drs. Wangersky and Johnson of the Department of Oceanography at Dalhousie University to perform both laboratory and field studies of enrichment and particle formation by bubbling. Their results have indicated significant enrichment of some trace metals of environmental concern, such as cadmium.

Since the extent and vigour of the breaking wave field are controlling factors, common to any modelling of either entrainment, production, or resuspension, extensive research has been conducted to quantify these aspects. Multi-channel imagery of the ocean off Nova Scotia taken in March has been analyzed to develop computer algorithms to separated breaking waves from foam and from the background. Considerable knowledge has been gained about the statistical simplicity of the field which will greatly enhance further physical studies. This work has been advanced by a contract to Dr. R. Bloxam for analytical and numerical studies. Another aspect of the breaking wave field is the level of turbulence in individual events associated with the entrainment. To estimate the depth to which gas in the form of bubbles is carried, a new instrument has been developed in the Division. Because both the variation of bubble density with depth, and the variation with time of light intensity of a breaking wave as seen from above are similar, it is possible to estimate the depth of mixing from the duration of breaking waves. The new instrument uses a television

camera, mounted in an aircraft, swinging fore and aft to maintain a sufficiently long dwell time on the same area on the water surface. Previous research was instrumental in the design of the optical filters and sampling strategies. Much of the development was achieved through a studentship and contract to Mr. R. Mitchell.

Another aspect the vertical mixing of oil by breaking waves has been considered. An existing model, based on a lengthly research program for the U.S. Coast Guard, has been acquired. Its main weaknesses, namely the formulation of the bubble density and areal extent of the breaking wave field, are currently being addressed by incorporating the results of studies in this Division in the past year which address these aspects. Other activities this year have been associated with the submission of a joint proposal from several laboratories in the U.S. and Europe as well as our own, to the Office of Naval Research. The research is concerned with aspects of radar scattering and acoustics near the ocean surface in the presence of breaking waves. Another activity saw the formulation of a joint experiment with a NATO laboratory in Italy for the measurement of entrainment acoustically. However, the experiment was postponed due to equipment constraints.

Contact Scientist: B.R. Kerman

3.4.8 Flow Over Complex Terrain

The MS3DJH model was converted to the CRAY 1-S computer. A comparison was made between model results and the Askervein 83 data (see below). A new version incorporating variable surface roughness has been developed and applied, on behalf of Hydro-Québec, to the Iles-de-la-Madeleine. A preliminary version of a computer package for estimating wind speeds in complex terrain, based on the guidelines of Taylor and Lee (1984) has been implemented. A contract has been let to develop a transportable FORTRAN 77 code for the MS3DJH model and its peripheral programs.

Contact Scientist: J.L. Walmsley

3.4.9 Askervein and Kettles Hill Projects

This project is part of the International Energy Agency program of R&D on Wind Energy Conversion Systems. Major field experiments on the flow over Askervein (a 116m high hill in Scotland) were conducted in September/October 1982 and 1983. Branch activities during FY84-85 have concentrated on the detailed analysis and interpretation of the data and the preparation of reports and journal papers. As a part of this activity the data have been compared with numerical model results from MS3DJH (the section above) and with the results of wind tunnel simulations conducted by the Meteorological Services Research Branch in the AES wind tunnel. These comparisons show that both numerical and wind tunnel models perform well on the upstream side of the hill but that flow on the lee side is not simulated well for some wind directions.

A short field study of velocity profiles to heights of up to 200m above the summit of Kettles Hill (southern Alberta) was conducted in March/April 1984. The data show clear interesting variations in near surface speed-up on the hilltop as a result of differences in the shape of the upstream profile.

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

3.4.10 St. Lawrence Valley Study/Projet Eôle

Final analysis and interpretation of the data from three 60m towers at candidate wind turbine sites in the lower St. Lawrence Valley and at a Hydro-Québec tower on the Iles-de-la-Madeleine is being carried out by CCAI. Branch scientists have continued to provide guidance and advice to Hydro-Québec and the National Research Council on site selection and related activities for Projet Eôle.

Contact Scientist: P.A. Taylor

3.4.11 Mesoscale Studies - CASP

Following the AES decision to mount a Canadian Atlantic Storms Programme with the first major field project during January-March 1986, branch scientists prepared proposals for participation. These centred on the development and deployment of two surface 'mesonets' based on the use of 10m posts instrumented with windmonitors, temperature, humidity and pressure sensors. Each post will have its own data logger. Acquisition and testing of the equipment has begun and detailed scientific plans for the experiment have been prepared.

Contact Scientists: P.A. Taylor, J.D. Reid

3.4.12 Canada Olympic Park Study

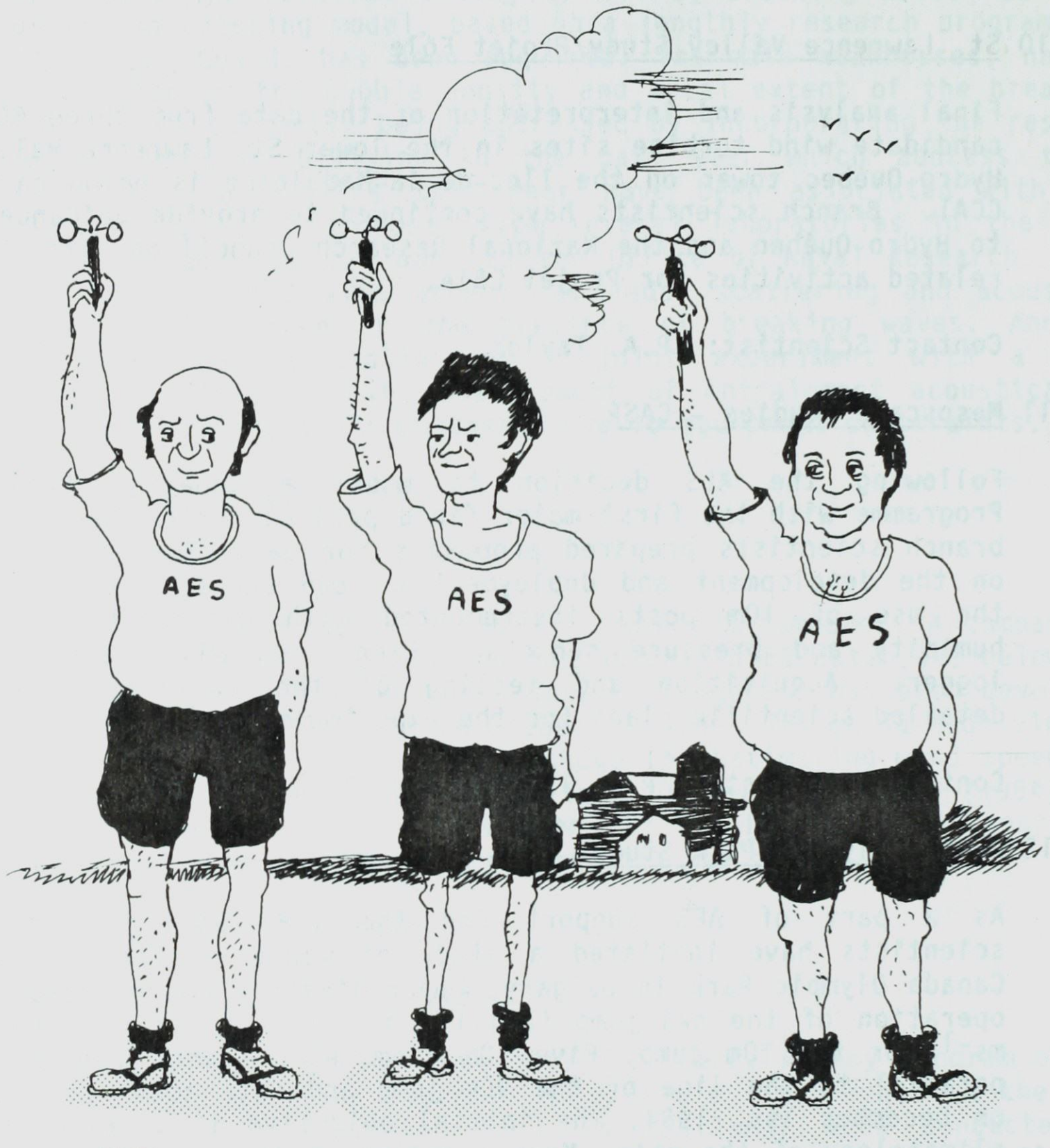
As a part of AES support for the 1988 Winter Olympics, branch scientists have initiated a study of winds at the ski-jump site at Canada Olympic Park in Calgary. Upper limits on wind speed for the safe operation of the ski-jump facility are 4 ms^{-1} for the 90m jump and 6 ms^{-1} for the 70m jump. Five 10m anemometer towers have been installed parallel to the line of the 90m jump and data acquisition was started on December 1st, 1984. The initial objective is to establish the wind climatology of the site. More detailed studies of flow at the site may be necessary if the data suggest that the threshold wind speeds are being exceeded too frequently.

Contact Scientist: P.A. Taylor

3.5 AIR QUALITY SERVICES

3.5.1 AIMS/UNAMAP/EIA Model Development

AIMS began operation in June 1983 as a set of 3 interactive point source plume models available to users across the country through the facilities of Dataline, Inc. During 1984, a liquid natural gas (LNG)



F. Fanaki

OLYMPIC PARK STUDY TEAM

spill model was added to the system. The model estimates the liquid pool size and evaporation rate of LNG pouring into water at a constant rate from a ruptured container, and determines the hazard zone defining the ignitable portion of the ensuing gas cloud. Several additional models were examined as possible candidates for AIMS. However, due to the lack of demand and resources, the program was cancelled at the end of 1984.

Work on the LNG model continued under contract. The physical processes of heat and moisture transfer from the ground and from the air were added, resulting in a significant improvement in the comparison of modelled and measured concentrations. The model is operational on the AS/6 and documentation will be available by April 1, 1985.

The 21 UNAMAP models purchased last year from EPA are operational on the AS/6. They have been separated into modules for easier application and a user guide is being prepared. However, they cannot be used interactively.

A climatological model (PLUMELT) was prepared in order to calculate long-term average air concentration and ground deposition of dioxins issuing from incinerators stacks. The pollutant is assumed to decay as a first order process following formation in the stack and to continue that decay whether dispersing in the air or deposited on the ground, thus allowing ground deposition to reach an equilibrium value. A similar model for short-term concentration and deposition estimates (PLUMEST) using source depletion and Briggs dispersion curves was prepared.

The REM (Regional Episode Model) developed earlier at AES is now being evaluated using several days of data from each season for St. John, N.B. The model was designed for regions of complex terrain and complex meteorology. Mixing height data from a single station and meteorological and concentration data from several stations are being used.

Contact Scientist: C.S. Matthias

3.5.2 Environmental Impact Assessment (EIA)

The Air Quality Monitoring and Assessment Division was involved in several EIA reviews concerning (1) a suggested technique for calculating minimum chimney height, (2) a review of dispersion models used for EIA's in Canada, (3) the impact of the B.C. Hydro Burrard Thermal Generating Plant upon Vancouver air quality, (4) the radiological impact of uranium mining in northern Saskatchewan, (5) DOE policy on meteorological services during emergencies, and (6) disposal of waste in the Arctic atmosphere. The division also prepared an EIA which used the UNAMAP models PAL and ISCST in order to estimate the source strength of several slag piles at the phosphorus reduction plant in Newfoundland.

Contact Scientists: A.K. Lo, C.S. Matthias, S.M. Daggupaty.

3.5.3 Environmental Emergencies

A workshop for AQPAC (Air Quality Package for Environmental Emergencies) users was conducted to consolidate user experience with AQPAC and to plan future needs. An AQPAC newsletter was written and distributed to provide a common forum for ideas related to AQPAC and to environmental emergencies in general.

Bullet-proofing of AQPAC version-2 is in progress in Central region (Barrie Atkinson), and AQPAC version-3 is being developed. The chemicals directory was expanded to 22 chemicals and six radionuclides. A graphical display capability and a diffusion model for heavy gas application are being added.

Funding was received to develop specifications for a mobile emergency response unit, and a preliminary assessment of various sounding instruments was done.

Contact Scientist: S.M. Daggupaty

3.5.4 Support to Outside Agencies and Technology Transfer

The dioxin concentrations in the air and on the ground in the vicinity of 3 incinerators in Ontario were modelled for 1-year and 10-year periods in reponse to an NRC request for a project entitled "A Regional Assessment of Human Exposure to Dioxins and Related Compounds".

A mixed layer analysis, was conducted at the request of The British Columbia Ministry of Environment at 3 B.C. upper air stations and at Annette, Alaska, showing the joint frequency distributions of mixed layer height, wind speed, and wind direction over a 6 year period.

A briefing note was prepared following the accidental release of Methyl Isocyanate in Bhopal, India and AQPAC model runs were made based on this scenario. Technical advice was given to regional AES staff under two occasions involving accidents. One was the explosion in Montreal Harbour (January 31, 1985) and the second concerned an overturned railway tank car containing propylene oxide, near Sarnia, Ontario (Febrary 12, 1985).

The Ontario provincial Nuclear Emergency Committee Working Group 4 on modelling recommended the puff model from AQPAC for their package of models. The updated version (from version 2 of AQPAC) was made available to them.

An overview report on "the State of the Canadian Environment" was written and a Fact Sheet on "Toxic chemicals dispersion in Environmental Emergencies" was prepared for the Information Directorate.

"Guidelines for Calculation of Radiation Dose to the Public from an Accidental Release of Radioactive Material into the Atmosphere" were revised at the request of the Technical Committee for Canadian Standards Association.

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

4. FIELD SERVICES DIRECTORATE REGIONAL AIR QUALITY ACTIVITY REPORT

4.1 Long Range Transportation of Air Pollutants (LRTAP)

4.1.1 The Atlantic Region LRTAP Monitoring and Effects Working Group initiated a project in 1983 to assess, analyze and interpret the deposition data collected in the region through various agencies and networks. Station siting and lab analysis technique assessments have now been completed, and the data quality assessment is nearing completion, except for one provincial data set (Nova Scotia) which is not yet available.

A revised edition of the regional Inventory of Precipitation Chemistry Stations was prepared.

Episodes of large acidic and sulphate depositions at a site in the region have been investigated, and have been found to occur during a certain type of synoptic situation. However, as this type of situation also produces less significant deposition events, forecasting large deposition episodes may not be feasible.

The annual meeting of the Atlantic Region LRTAP Monitoring and Effects Working Group, chaired by Ms. B. Taylor was held in November 1984.

4.1.2 A report on the 1982 project on a mesoscale pH network in southern Quebec was completed by the end of March 1985. It shows that the spatial variability of pH, nitrates and sulphates in the summer months of 1982 was very large. The report also examined the value of data obtained from open bucket collectors operated by voluntary observers. It was concluded that, although the data were reliable, the precipitation yielded by open collectors was less than that achieved by using Sangamo collectors.

In order to remove some deficiencies in determining trajectories for weekly pH reports a more thorough meteorological analysis is now being performed. In December 1984, Quebec region assumed the responsibility from LLO for the preparation and dissemination of AES' weekly acid rain bulletins for publication in newspapers.

The first year's data (December 1983 - December 1984) collected for the weekly pH report at Forêt Montmorency has been analysed. Relationships between the mean pH values and some source regions have been identified.

Following the 1983-84 study (contract OSD83-00149) entitled: "Techniques de prélèvement et analyses physico-chimiques de la neige recueillie en lieu ouvert à la station APN de la Forêt Montmorency, Québec, janvier-mars 1984", a new contract was given to H.G. Jones (INRS-Eau, Ste-Foy, Québec). The project is called: "Evaluation d'une métheodologie pour la détermination du taux de déposition sèche des pollutants acides sur la couverture de neige à la station CAPMoN, Forêt Montmorency, Québec". The objective was to determine the feasibility of measuring dry deposition from chemical analysis of snow samples. It was concluded that it is very difficult to measure dry deposition.

4.1.3 In consultation with ARQD/ARQT and the Ontario Ministry of the Environment, plans were made by Ontario Region to conduct an "Extreme Deposition Episodes in Ontario" study based on 1982 APN Data from Chalk River, Ontario.

4.1.4 Pacific Region's Steve Nikleva replaced Av Mann as Secretary of the Western LRTAP Technical Committee. Western Region continues to provide support to the Western Canada LRTAP program by coordinating input from federal agencies within Western Region and acting as a liaison with provincial and private agencies. A three-year plan for Central, Pacific and Western Regions' involvement in air quality and LRT programs was forwarded to WLTC for their consideration.

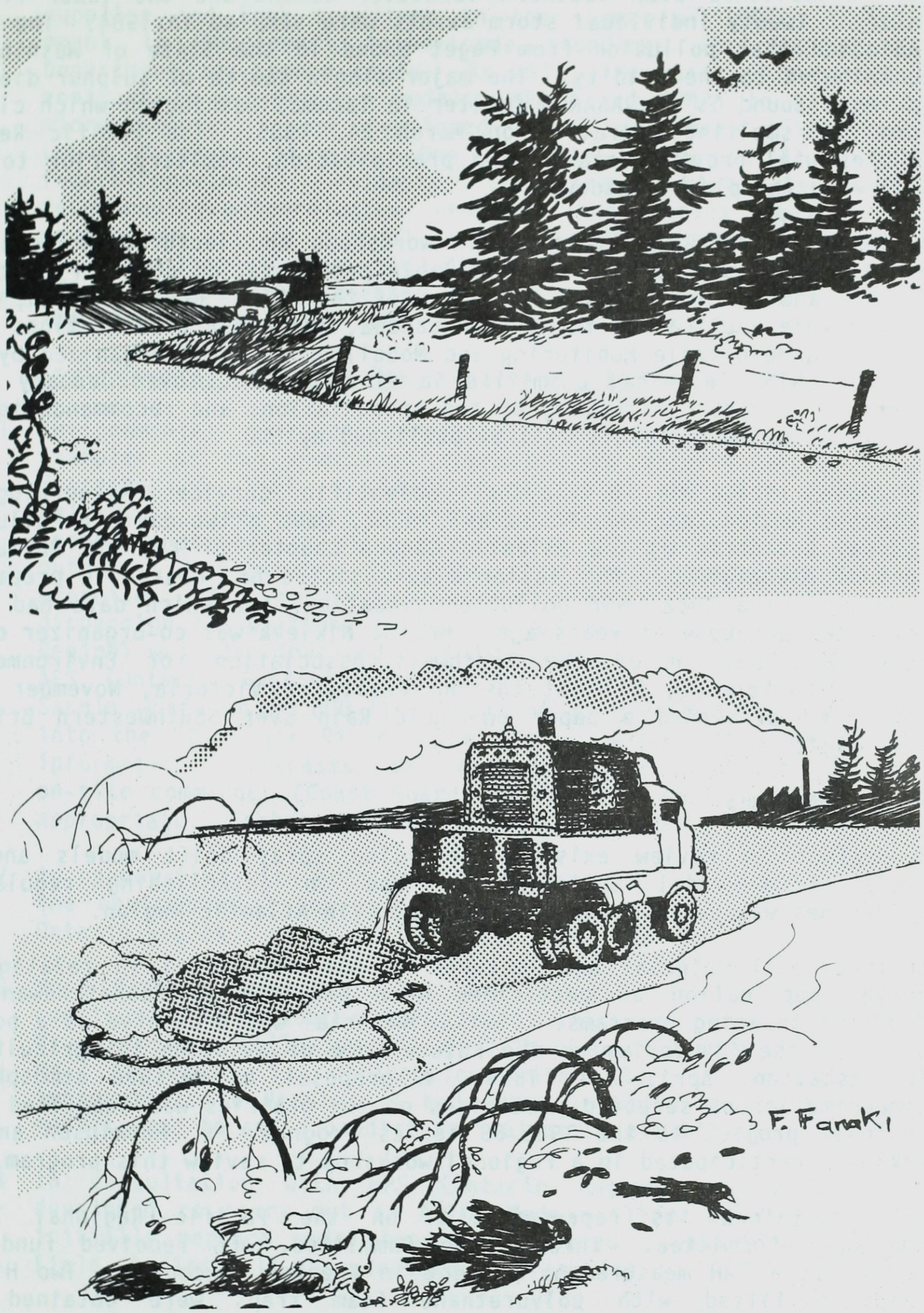
4.1.5 Two joint projects were undertaken by Central, Western and Pacific Regions. Project 80202-8, to evaluate and analyze precipitation chemistry data in Western Canada, has been undertaken for Saskatchewan and Manitoba. Project 80202-6, LRT Modelling in Western Canada, has been delayed and reduced in scope. This was basically an extension of the 1978 study to 1982, a year with better precipitation chemistry data.

Testing of the hydrometeorology of the CANSAP and CAPMoN collectors commenced at Regina as part of an approved two-year project.

4.1.6 A report on "Sulphur Deposition in Western Canada" will be available by April 1985. This study includes the four western provinces as well as the Territories. Another study addressing AES-LRTAP model runs for 1982 will be completed by April 1985. This latter study will compare model runs for 1978 with those of 1982. From this analysis, recommendations for further work will be proposed.

Western Region participated in a technology transfer project with ARQT. Expertise on running the AES-LRTAP model was transferred to the Region. Further development of "user-friendly" software by ARQT will complete this transfer allowing regional staff to perform model runs remotely.

4.1.7 An event precipitation chemistry sampling network has been established in the Northwest Territories. This is a joint project with the Pollution Control Division of the Government of the Northwest Territories' Department of Renewable Resources in Yellowknife. Network and sampling protocol follow CAPMoN guidelines, with chemical analysis being done at Burlington. All six sites are expected to be in full operation in the spring of 1985.



Long Range Transport

4.1.8 Pacific Region is continuing its studies of acid rain along the B.C. coast. A transboundary network of 13 event monitoring stations has been established over southern Vancouver Island and the lower Fraser Valley. Twenty individual storm events were sampled in 1984. The data indicated that pollution from Puget Sound in the State of Washington contributed to the acidity. The major single source of sulphur dioxide in Puget Sound is the ASARCO smelter in Tacoma, Washington which closed down its smelting operation on March 24, 1985. The Pacific Region studies will provide data on the precipitation chemistry prior to and following the plant shutdown.

4.1.9 Regional personnel participated in workshops and lectured on occasion on air pollution topics. The available precipitation chemistry data in Alberta and the Territories, a review of the ASTRAP model with emphasis on possible application to western Canada, and other presentations were made at a Meso-scale Monitoring and Modelling Workshop organized by the Western LRTAP Technical Committee in Victoria, B.C. over January 31 - February 1, 1985. A summary of the presentations and recommendation of the workshop participants will be published by LLO.

4.1.10 In June 1984, Ms. B. Taylor, Scientific Services Meteorologist, Atlantic Region, and Dr. F. Fanaki, AQRB, gave a two-day Air Pollution Course, sponsored by the Atlantic Canada Chapter of the Air Pollution Control Association. Ms. Taylor also assisted Dr. Fanaki in preparing a report on a local air pollution situation, for which data had been collected a couple of years ago. Mr. S. Nikleva was co-organizer of an acid rain session at the Northwest Association for Environmental Studies Conference, held at the University of Victoria, November 1-3, 1984. He presented a paper on "Acid Rain over Southwestern British Columbia".

4.2 Toxic Chemicals

4.2.1 A project to review existing pesticide spray drift models and to implement a model suitable for use in establishing regulatory guidelines was carried out under contract in Atlantic Region.

4.2.2 Instructional material and lectures in air dispersion in relation to aerial application of pesticides were provided to Saskatchewan and Manitoba training programs. Similar material was presented as a poster paper at the "Symposium on the Future Role of Aviation in Agriculture" in Saskatoon, April 3-4, 1984. A proposal to measure atmospheric concentration of selected pesticides on the prairies was submitted as a regional project to the 1985-88 Toxics Program. R. Hopkinson and B. Atkinson participated in a regional workshop to review this program.

4.2.3 AES maintained its representation on the Pacific Regional Toxic Chemicals Committee. Through the Committee, AES received funds to carry out a PAH measurement project in Greater Vancouver. Two Hi-vol samplers fitted with polyurethane foam traps were obtained and deployed, one in downtown Vancouver, one at a rural site (Westham Island). Sampling at three-day intervals commenced in February, 1985; data will be analysed and reported on in 1985-86.

4.3 Oxidants

4.3.1 With funds obtained from ARQD, Pacific Region SSD obtained minisonde supplies and took soundings in the summer of 1984. These data are meant to supplement tethersonde soundings for the UBC Geography Department sea-breeze study. As well, the funds allowed SSD to let a contract to convert two models (MPACT and RPM2) to be run on an IBM micro-computer. Work continued on a sea-breeze climatology of the Lower Mainland of B.C. Don Faulkner served on a sub-group of a federal/provincial oxidants committee, which is tasked with recommending meteorological and modelling studies required in order to develop an oxidant control strategy. SSD obtained the latest version of Ozone Isopleth Plotting with Optional Mechanisms (OZIPM-2) from US EPA. The model was adapted to run on the AS/6 computer in Downsview, and several test cases were tried.

4.4 Environmental Emergency Preparedness and Response

4.4.1 Environmental emergency exercises were conducted in many Regions. Examples of two exercises conducted in Ontario Region follow. On September 25, 1984, a simulated oil spill emergency was conducted by Gulf Oil. The Region's participation included provision of weather forecasts as well as oil spread/motion information based on SLICK model output. On September 26, 1984, the Region conducted this simulated exercise. The response required weather information as well as dispersion calculations (AQPAC) to estimate hazard zones. EPS (Ontario Region) was also involved in this exercise. On February 12 & 13, 1985, AES (Ontario Region) responded to an environmental emergency near Sarnia where an 80,000-litre tank of propylene oxide fell off a barge into the St. Clair River. The Region responded by providing weather information, forecasts and dispersion calculations to assist the on-site commander (Coast Guard) in deciding what recovery actions were appropriate. Fortunately, no release occurred.

4.4.2 In cooperation with EPS (Ontario Region) and in consultation with ARQM, the environmental emergency response information kit was upgraded by Ontario Region.

4.4.3 Most Regions have installed and tested the revised version of the continuous point source AQPAC model which was "bullet-proofed" by Mr. B. Atkinson. Following the distribution of Version I of this model, Mr. Atkinson, in conjunction with ARQD, began making similar improvements to Version II and other segments of the AQPAC package of models, and to add a predictive trajectory capability.

4.4.4 In consultation with EPS (Ontario Region) and ARQM, plans were developed to carry out an AQPAC Model Validation Project. ARQM will initially perform model experiments based on existing published data. Field studies will be undertaken if required.

4.4.5 Regional staff, including T.R. Allsopp, P. Chen and R.B. Thomson attended the AES-sponsored Heavy Gas (LNG/LPG) Workshop in January, 1985 held in Toronto. Dr. Bhartendu attended the EPS-sponsored 2nd Technical Seminar on Chemical Spills in February, 1985 held in Toronto.

4.5 EARP

4.5.1 A significant contribution was made by AES Regions in preparing detailed responses to several EARP-related documents. These included: plans to implement some of the 83 recommendations in FEARO'S Report No. 25, which is the Panel's report on the Beaufort Sea Hydrocarbon Production and Transportation proposal; reviewing and commenting on two draft versions of an EPS document by T.N. Raistrick entitled "A Study of the Initial Environmental Assessment Stages of EARP in the Federal Government"; and reviewing and commenting on FEARO'S "Guide for Environmental Screening and Initial Assessment of Federal Action Impacting the Environment".

4.5.2 It is difficult to qualitatively gauge the effect of AES involvement in EARP, since our interventions are usually incorporated into a broader departmental (or inter-departmental) submission. Reviews of several projects were conducted for sub-committees of RSCCs. Review of EIS's, contingency plans, and EARP-related documents is a significant on-going activity. The number of these documents to be reviewed varies with the level of off-shore activity, exploration and the number of operators. For example in 1984, SSD meteorologists in Atlantic Region provided input into the review of 28 EARP-related documents. Examples of reviews performed include:

Point Lepreau II EIS
Venture Development Plan
Cantera PCI et al Port au Port Contingency Plan
Labrador Inuit Association and Northern Labrador Sea
Home Oil Contingency Plan
Husky-Bow Valley Contingency Plan
Husky-Bow Valley Emergency Response Plan,
Vol. I - East Coast Project
Petro Canada Scotia Shelf, Vol. 1 - Amendments
Home Oil Response Plan
COGLA Emergency Response Plan
Overview of Environmental Issues generated by Hydrocarbon Development on the Scotian Shelf
Literature Review of Icebergs in the Venture/Sable Area
Labrador Airstrips EIS
Bell Helicopter installation at Mirabel Airport
Projects to enlarge the ports at Quebec City and Sept-Iles
Regina Rail re-location
Shoal Lakes Development
Saskatchewan Power Corporation
Manitoba Pesticide Application Regulations
Baseline studies for Dawn Lake

Rafferty Dam EIS guidelines
Federal Water Strategy
An Overview of Impacts of Agriculture in the Western and Northern Region
Heavy Oil Upgrader for Regina
Storm Surge Modelling Project
Land Use Planning in the Northwest Territories
Qu'Appelle River Channel Conveyance
Husky Upgrading Plant - Lloydminster
Guidelines for Heavy Oil Plants
EPS LRTAP Strategy for Western Canada
Abandonment of Offshore Artificial Islands in the Beaufort Sea
Problem identification for Polar Gas project
Vancouver International Airport
Rogers Pass Tunnel
Kitimat Development
Quinsam Coal Mine
Sage Creek Coal Mine
Vancouver Island Natural Gas Pipeline
Lower Fraser River Flow Diversion

4.5.3 A few examples of EARP-related activities undertaken by Ontario Region include:

- providing environmental screening advice to AES headquarters and the University of Toronto on a proposed project at the Woodbridge Research Facility to study evaporation of chemicals from pans.

- providing meteorological data in court for the Crown in a Civil action initiated by a community group arising from the re-location of contaminated soil in Scarborough.

- reviewing an Eldorado Resources Ltd. (ERL) site planning document and Dillon Consultant report regarding spill and dispersion calculations for ammonia at the ERL Port Hope refinery.

- reviewing a lead agency IWD position paper re U.S. Corps of Engineers proposal "Winter Navigation Extension in the Great Lakes and St. Lawrence Seaway".

4.5.4 A major on-going monitoring project by AES (Ontario Region) in conjunction with EPS is the Port Hope Meteorological Study. This field project (observing program began in late 1983) represents a follow-up activity to validate meteorological data used as a basis for EIS and site approval document for ERL uranium refinery plant expansion at Port Hope. At the request of EPS and with their financial support, this study was initiated to determine the local dispersion climatology in the immediate vicinity of the expanded facility. Field project will terminate by the end of FY 85/86. The study is also invaluable to us since it is enabling us to improve our expertise in micro-meteorology and air quality meteorological applications.

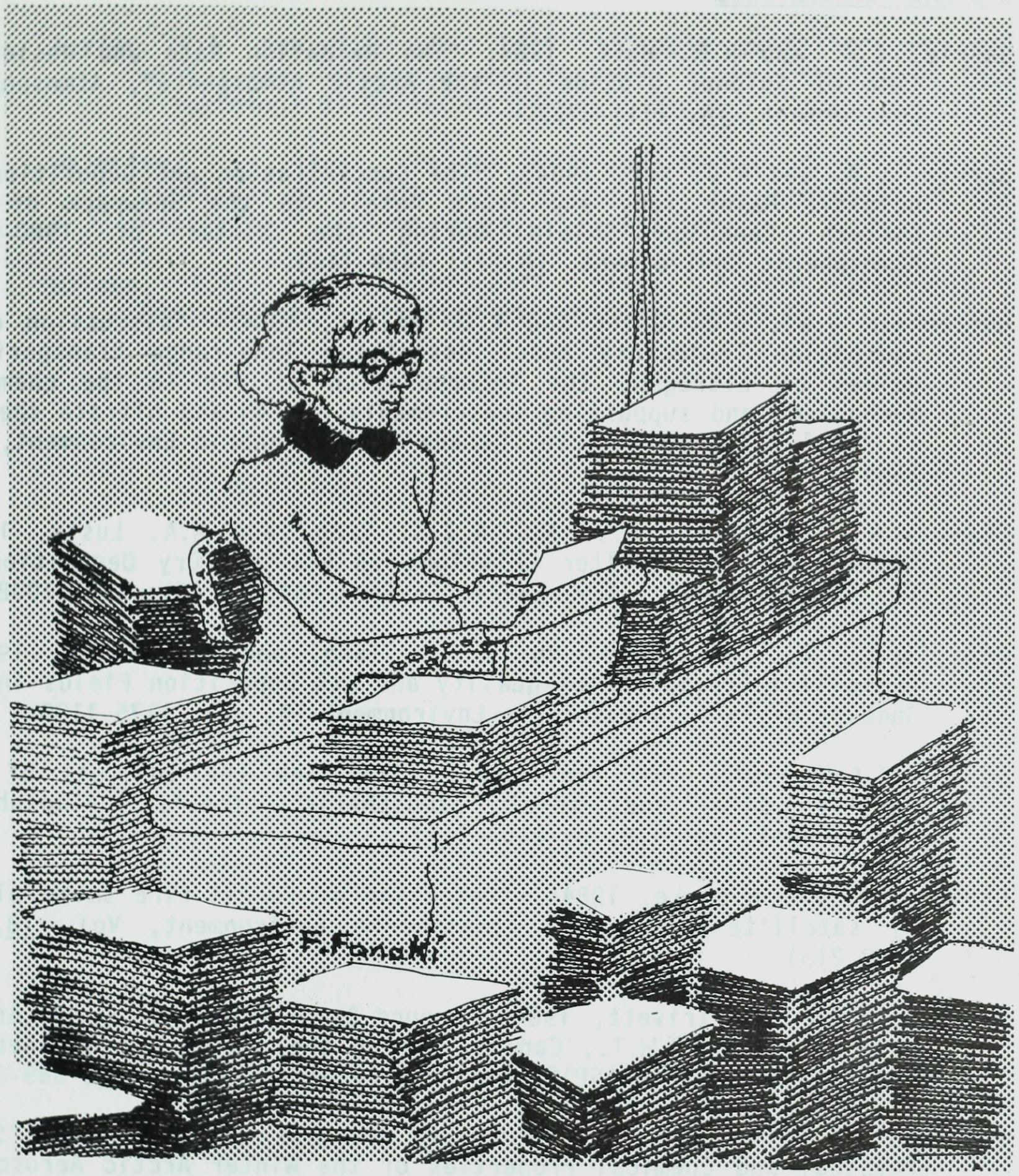
4.5.5 Western Region's involvement in EARP over the last year has allowed them to identify data gaps (resulting in appropriate revisions to the NOGAP submissions); focus their involvement with the Beaufort Sea Team; maintain updated knowledge of matters of concern to northerners (project to assess impact of artificial islands on shorefast ice); assist OGDs and industry in assessing the impact of the environment on industrial activity (meetings to discuss North Yukon port facility); and to assess the impact of industrial activity on the environment (e.g. Whitehorse wood smoke problems, etc.). The net sum of the EARP activity is that the Region fulfills its role as a knowledgeable information broker in addressing public concern. The Region provides informed responses in an organized, timely fashion to problems posed to EARP committees, thereby assisting in the resolution of questions posed by the public and industry in Western and Northern Canada.

4.5.6 Atlantic Regional SSD staff participated in an Offshore and Environmental Coordinating Committee, which is an Environment Canada committee chaired by EPS. This committee provides support to the departmental representative on the Environmental Coordinating Committee (ECC), which deals with environmental concerns arising from the Canada/Nova Scotia Offshore Agreement.

4.5.7 Ontario Region reviewed the atmospheric/climate-related components of Eldorado Nuclear Limited's "Systematic Modelling Tool for the Analysis of Chronic and Intrusion Exposures from Waste Disposal Sites".

4.6. Air Quality Services

4.6.1 Scientific Services Divisions continued to provide general air quality services. Numerous requests for information were received from the general public, students, the media, etc. In Ontario, most of these were related to acid rain and urban air quality. In B.C., approximately 20 pollution permit applications were reviewed at the request of the Greater Vancouver Regional District. One of these, the B.C. Hydro application to operate the Burrard Thermal Generating Plant, required a fairly detailed investigation and was also referred to ARQD for comments. The regional climatology for air quality applications was upgraded by obtaining STAR analysis for several locations in B.C.



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6. MAJOR CONTRACTS

All Systems Go $ 4,000.00	Implementation of RS/1 Quality Control Analysis package on VAX 11/750 of IWD.
Alpha Env. Cons. $ 6,000.00	Analyze Arctic Aerosol Bilter Samples by Ion-coupled plasma method using a JY Spectrometer.
R. Bloxam $ 20,000.00	To carry out a study on the determination and quantification of the role of bubble scavenging of gaseous and particulate toxic organics.
G. Carlyle $ 1,500.00	To conduct specialized observations and record data on forms for acidic snowmelt shock potential study.
Cirrus Resource Cons. Inc. $ 9,200.00	Development of Air Quality Model for use on Micro Computer.
R. Cohen $ 3,500.00	Updating of chemicals directory and graphical display of AQPAC model results.
Concord Scientific $36,454.00	Liquid Natural Gas Dispersion for AIMS.
Concord Scientific $ 26,400.00	Preparation of Air Sampling Filters for CAPMoN.
Concord Scientific $ 12,629.00	Data Evaluation of Nitric Acid Sampling.
Concord Scientific $ 6,967.00	To provide data summary report on 1980 PEPE field study.
Concord Scientific $ 4,984.00	Environmental evaluation of priority atmospheric toxic chemicals.
Concord Scientific $ 27,921.00	Organization and Conduct of Workshop on LNG/LPG and other heavy gas hazard assessment.
Concord Scientific $ 18,355.00	Preparation of a discussion paper on priorization strategies for air toxics.
Concord Scientific $ 38,215.00	Improvements to AIMS Liquid Natural Gas Dispersion Model.

Concord Scientific $ 39,162.00	Development of monitoring methods based on state-of-the-art Gas Chromatographic Techniques.
Concord Scientific $ 19,085.00	Critical Review of Nitro- and Oxy-PAN Compounds in the Atmosphere.
Concord Scientific $ 5,940.00	Analysis of 55 Ice Core Samples.
J.D. deLaurier $ 5,000.00	To design, construct and test tethered airplane kites for support of tethersonde packages.
D.M.E.R. $ 2,350.00	A compilation of Concentration Data for Selected Toxic Substances in the Great Lakes.
D. Ernst $ 1,800.00	To document data and carry out analysis for the Carbon Dioxide Monitoring Program.
ERT $138,738.00	Development of Modules for the Eulerian Acid Deposition Model.
Gage Res. Inst. $ 5,580.00	Preparation of a criteria document on the the effects of ozone on humans and animals.
Gas Res. Inst. $ 49,908.00	LNG Three-Dimensional Model Evaluation.
R.G.V. Hancock $ 6,090.00	Chemical Analysis of Vegetation.
A. Johnston $ 27,800.00	Experimental program of Large-Scale Release of Heavier-than-air Gases - Phase II.
B. Loescher $ 10,000.00	Prepare samples and analyze for metals in lichens, precipitation and filters.
F. Luxton $ 31,000.00	To provide monitoring, air sampling and precipitation sampling for the Long-Range Transportation of Airborne Pollutants Monitoring Service at Kejimkujik Park, Nova Scotia.
D.M.A. McCurvin $ 7,257.00	To compile and enter into an IBM PC-XT computer data on the physical and thermodynamic properties of polycyclic aromatic hydrocarbons (PAH) and related species and to produce a draft paper for publication.

T. McGrath $ 1,130.00	Provision of Advice and Consultation on Effects of Ozone on Humans and Animals.
R. McLaughlin $ 2,500.00	To prepare public information fact sheets on five atmospheric toxic chemical issues.
MEP Company $ 39,500.00	To provide technical services for the modification and maintenance of the LRTAP Data Archive at CMC.
MEP Company $ 12,000.00	Revised Derivative Program - Teletype Data-base.
MEP Company $100,000.00	To provide technical services associated with the Eulerian Long Range Transport Model.
MEP Company $ 29,350.00	Development and Implementation of a Regional Scale Photo-Oxidants Model for Eastern North America.
MEP Company $125,000.00	Data Archiving system for the Eulerian LRT Model.
Dr. Mintz $ 5,580.00	Criteria Document on the Effects of Ozone on Humans and Animals.
R. Mitchell $ 4,500.00	To assemble and test airborne fixed point scanners.
Morrison-Herschfeld Ltd. $ 1,500.00	Engineering study on loading effects on CBC Inuvik TV transmission tower.
E. Nieboer $ 7,656.00	To analyze a number of vegetation samples for sulphur, lead, nickel, vanadium, titanium, iron and chromium.
Nuclear Act. Serv. Ltd. $ 22,000.00	Instrument Neutron Activation analysis of Aerosol and Precipitation samples.
Ont. Res. Foundation $ 6,000.00	Literature review on selected aspects of toxic trace elements in ambient air.
Ont. Res. Foundation $ 18,500.00	Analysis of samples for PAH using HPLC and GC/MS techniques.
A. Panigas $ 13,650.00	Develop an interactive trajectory computation and plotting package.

A. Panigas $ 4,560.00	To install the ASTRAP model on the AS/6 computer at AES. To modify computer code to allow estimation of loading of selected trace elements and toxic chemicals. To run model scenarios.
A. Robertson $ 9,975.00	To modify and test a Meloy Sulphur Dioxide Analyzer and an AID Ozone Analyzer for the Acid Rain/Long-Range Transport of Air Pollutants Program.
B. Saini $ 7,000.00	Heavy Gas and LNG diffusion models-programming interactively for AQPAC.
J. Salmon $ 19,990.00	Microscale Modelling of Boundary-Layer flow in complex terrain.
J.D. Shannon $ 5,600.00	To consult in the installation of the ASTRAP model on the AS/6 computer system and to consult in the modification of the estimation of selected trace elements and toxic chemicals load in the Great Lakes region.
Unisearch Assoc. Inc. $ 11,674.00	To modify the AES tunable diode laser system.
U. of New Brunswick $ 30,969.00	Incorporation of a Vortex-Atmosphere Interaction Model with a Forest Pesticide Spray Dispersion and Deposition Model.
U. of Toronto $ 11,123.00	Workshop on the ability of wet deposition networks to detect changes in Regional Air Pollution Emissions.
U. of Toronto $ 4,998.00	Impact of Acid Precipitation on Fish Hatchery Operations.
J. Wangersky $ 7,862.00	Examination of enrichment of specific trace metals in particles produced by surface coagulation.

7. UNSOLICITED PROPOSALS

CONTRACTOR	UP NO.	PROJECT TITLE
Ontario Research Foundation $165,000	UP-O-173	Development of a Trace Organic Gas/ Particle Fractionating Sampler System. (Carry over from last F.Y.).
Unisearch Associates, Inc. $250,000	UP-66	A tunable diode laser absorption spectrometer for trace gas analysis from an aircraft.

8. SCIENCE SUBVENTIONS

APPLICANT/ INSTITUTION	SCIENTIFIC AUTHORITY	TITLE
BUNCE, N.J. University of Guelph $10,000.00	D. Lane	Vapour Phase Photolysis of Chloroaromatic Compounds.
CAMPBELL, P.G.C. University of Quebec $ 7,000.00	W. Schroeder	Spéciation chimique de certains métaux présents dans les aérosols atmosphériques.
CHAKRABARTI, C.L. Carleton University $ 7,000.00	W. Schroeder	Development of a new analytical method for direct determination of heavy metals content in atmospheric particulates.
CHATT, A. Dalhousie University	A. Wiebe	Chemical Characterization of Acid Fog.
Kreuzer, H.J. Dalhousie University $ 5,000.00	A. Wiebe	Aerosol microphysics: adsorption phenomena and heterogeneous catalysis.
LEE-RUFF, E. York University $ 8,000.00	D. Lane	Characterization of Environmental Polynuclear Aromatic Hydrocarbons (PAH).
MOORE, T.R. McGill University $ 3,000.00	L. Barrie	Winter acid loading in a sub-arctic environment.
ORMROD, D. University of Guelph $ 6,000.00	M. Phillips	Effects of air pollutant mixtures on plants.
PELTIER, W. University of Toronto $20,000.00	P. Taylor	Atmospheric Waves and Turbulence.
SCHIFF, H.I. York University $ 8,000.00	K. Anlauf	Development of an inexpensive sensitive instrument for measuring NO_2.
STEYN, D.G. University of British Columbia $ 5,000.00	H.E. Turner	Sea Breeze Dynamics in the Lower Fraser Valley, B.C.

STUBLEY, G. University of Guelph $ 6,000.00	P. Taylor	Parameterization of Planetary Boundary Layer Structure.
THURTELL, G. University of Guelph $ 5,000.00	G. den Hartog	Modelling the dry deposition of gaseous materials and particulate matter.
WANGERSKY, P. Dalhousie University $ 5,000.00	B. Kerman	Bubble populations and transport of marine toxins.

9. PERSONNEL

AIR QUALITY AND INTER-ENVIRONMENTAL RESEARCH BRANCH

			PHONE NO.	ROOM NO.
ARQD	**OFFICE OF THE DIRECTOR**			
	Director:	Dr. J.W.S. Young	4937	4S260
	Secretary:	Miss B. Grogan	4969	4S250
	Secretary:	Mrs. M. Stasyshyn	4969	4S250
	Admin. Officer:	Mrs. K. Ford	4802	4S240
	Exec. Assistant:	Mrs. S.J. Kirkpatrick	4982	4S270
	Senior Res. Scientists:	Dr. P.W. Summers	4796	4S190
		Dr. A.D. Christie	4981	4S160
	*Co-ordinator:	Mrs. E.E. Wilson	4796	4S180
ARQA	**ATMOSPHERIC CHEMISTRY, CRITERIA & STANDARDS DIVISION**			
	*A/Chief:	Dr. W.H. Schroeder	4798/4794	4S140
	Secretary:	Mrs. D. Bardeau	4798	4S015
		Dr. K. Anlauf	4794	4S080
		Dr. H.H. Neumann	4954	4S830
		Dr. K.J. Puckett	4797	4S110
		Dr. H.A. Wiebe	4797	4S120
		Dr. D. Lane	4965	4S132
		Mr. D. MacTavish	4965	4S130
		Mrs. O. Hunt	4965	4S130
		Mr. S. Jenkins	4901	4S130
		Mr. Y. Tham	4901	4S130
		Dr. S. Ahmed	4965	4S132
ARQL	**BOUNDARY LAYER RESEARCH DIVISION**			
	Chief:	Dr. J. Reid	4789	4S815
	Secretary:	Miss E. Mathis	4789	4S810
		Dr. G. den Hartog	4780	4S814
		Dr. B.R. Kerman	4792	4S813
		Dr. A.K. Lo	4824	4S821
		Dr. J. Padro	4962	4S900
		Dr. R.J. Polavarapu	4791	4S824
		Dr. P.A. Taylor	4824	4S823
		Dr. J.L. Walmsley	4780	4S816
		Mr. V.S. Derco	4791	4S822
	*	Mr. M. Austerberry	4680	4S640A
		Mr. L. Guise-Bagley	4680	4S640A
		Mr. N. Koshyk	4680	4S640A
		Mr. J. Arnold	4791	4S820
	**	Dr. A. Beljaars	4792	4S811

* Denotes term or assignment
** Visiting Scientist from Royal Netherlands Met. Institute

ARQM AIR QUALITY MONITORING AND ASSESSMENT DIVISION

Chief:	Dr. M.L. Phillips	4610	4S835
*Secretary:	Miss I. Gandhi	4610	4S833

Air Quality Assessment and Technology Transfer

	Dr. C.S. Matthias	4954	4S832
	Dr. S.M. Daggupaty	4980	4S841
	Mr. D. Bagg	4988	4S842
	Dr. K. Higuchi	4839	3S
	Dr. N.B.A. Trivett	4954	4S831

Networks and Surveys Section

*A/Head:	Mr. R. Gilbert	4988	4S844
	Mr. W. Kobelka	4970	4S670
	Mr. S. Iqbal	4987	4S640B
	Mr. A. Smith	4970	4S670
	Mr. A. Gaudenzi	4987	4S640B
	Mr. W. Sukloff	4801	4S620
*	Mr. R. Vet	4801	4S620

ARQT ATMOSPHERIC DISPERSION DIVISION

*A/Chief:	Dr. R.E. Mickle	4984	4S310
Secretary:	Mrs. P. Pearson	4984	4S300

Experimental Studies Section

Head:	Dr. F. Fanaki	4786	4S290
	Dr. L.A. Barrie	4785	4S330
	Dr. R.M. Hoff	4786	4S280
	Mr. F. Froude	4941	4S650
	Mr. J. Kovalick	4983	4S660
	Mr. J. Markes	4983	4S660
*	Mr. J.B. Martin	4941	4S650
	Mr. S. Melnichuk	4941	4S650
PDF:	Dr. W. Sturges	4839	3S690A

Modelling and Applications Section

Head:	Mr. M. Olson	4903	4S370
	Dr. J.W. Bottenheim	4778	4S845
	Dr. Y. Chung	4980	4S840
	Dr. E.C. Voldner	4788	4S620
	Mr. A. Gallant	4983	4S660
	Mr. K. Oikawa	4788	4S620

Special Studies Section

	Dr. D.M. Whelpdale	4903	4S340
	Dr. A. Sirois	4796	4S180

* Denotes term or assignment

Dr. H.E. Turner - Project Assignment - Univ. of Toronto - September 1985
Mr. M.E. Still - Assignment in APEC - September 1985

10. ACKNOWLEDGEMENTS

This year, each division within the Branch contributed completed drafts to the Annual Report which made my job much easier. For their efforts in supplying their timely input, I am most grateful. I would also like to thank Mr. J. McBride for compilation of the Region's input and Fouad Fanaki for his humouous cartoons on the lighter side of research. On behalf of the chiefs and the director, I would like to express our appreciation to the scientists for their input and our secretarial staff, Doris Bardeau, Evonna Mathis, Ila Gandhi and Barb Grogan for their dedicated efforts. In particular my very special thanks to Pat Pearson for assisting me in coordinating the report and especially for her patience despite my many changes.

R.E. Mickle