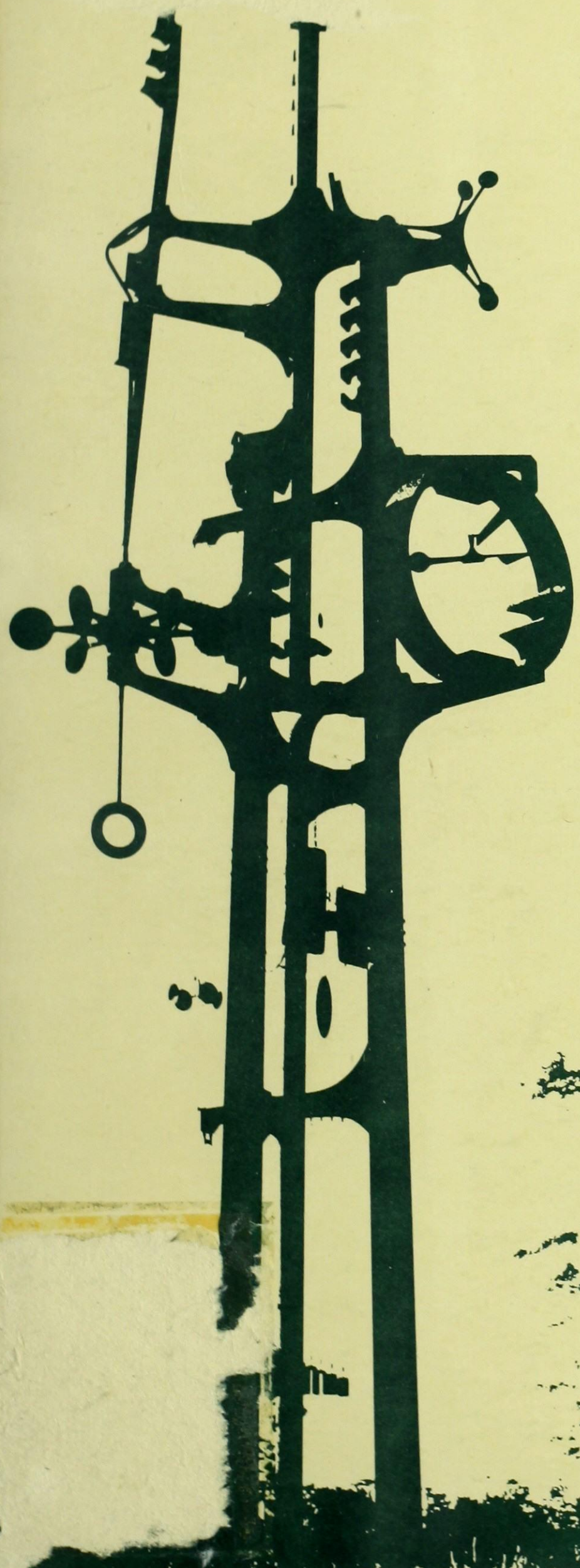
RECHERCHE ATMOSPHÉRIQUE



Air Quality and Inter-Environmental Research Branch

Annual Report

1985–86

Environment Canada / Environnement Canada

Atmospheric Environment Service / Service de l'environnement atmosphérique

REPORT: AQRB-86-M-001

AIR QUALITY AND INTER-ENVIRONMENTAL RESEARCH BRANCH

ANNUAL REPORT

1985-86

Compiled by

M.E. Still

Illustrated by

F. Fanaki

May 1986

This is one of a series of management reports produced by the Research Directorate. It is intended for internal use only.

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

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Foreword

by: James W.S. Young, Director

Air Quality & Inter-Environmental Branch (AQRB)

This year was characterized by review: the Neilsen reviews, the Auditor General's review and our own internal review of the way we do business. The general assessment of our program as stated in the Major Surveys Report (Neilsen) was:

> "In its technical and scientific dimensions, the work appears to be of high calibre and appropriately oriented from a priorities standpoint."

This is indeed high praise for a dedicated group of scientists, technicians and other support staff.

John Ruskin, a great Victorian art critic and advocate of fine art in everyday living, believed, "Quality is never an accident, it is always the result of intelligent effort." Quality isn't just for AES. We, as individuals, can strive for excellence in our day-to-day lives. It's a matter of personal choice: we can easily slip into just doing the job or we can make a commitment to meet self-imposed quality standards and refuse to accept anything less. The rewards for personal excellence are inside our own minds. Recognition and respect from those who notice may follow (and has this year) but the most important rewards are our own feelings of self-orientation and combining that with effective identification of problems and opportunities.

I congratulate you all on a very successful year and let us remind ourselves that for a successful future "the only constant is change."

3. AQRB PROGRAM FOR 1985-1986

3.1 ACID RAIN

3.1.1 Long Range Transport of Atmospheric Pollutants (LRTAP)

The Branch undertook the liaison and coordination of the LRTAP scientific program for AES. Departmental and Service program objectives and research directions, including the LRTAP Research Program Analysis (85/86 and beyond) were developed and finalized. The Service-wide operational plans and work plans were completed and submitted to the Department. Related resource information, including an analysis of resource utilization in previous years, was compiled. Program reviews were undertaken on the mid-term resource report, the 84/85 annual progress report, Muskoka '85 Conference and the existing and new LRTAP projects proposed for 1986/87 and beyond. The annual Branch meeting with AES Regional Scientific Services' Chiefs discussed LRTAP, Air Quality Services (AQS) and the AQS paper.

Reports were completed on the AES LRTAP bibliography (1973-1985), the input to the LRTAP Research catalogue, the Climate Change and Air Quality report, and the Departmental resource information for AES. A presentation on Atmospherics-Effects linkages was made to the Interdepartmental LRTAP Committee (ILC) Science Subcommittee. Atmospheric Sciences research seminars were organized and included an Acid Rain update and poster sessions on two occasions. The LRTAP schedule of events for the atmospheric program was prepared and distributed.

Contact: E. Wilson

3.1.2 Eulerian Model Development

The development of a comprehensive model of acidic deposition in an Eulerian framework continued this year on the two program phases of development/implementation and of evaluation/upgrading. The hybrid meteorological driver model, comprising the operational V9 spectral model augmented by a high resolution boundary layer model, was completed and has gone through systematic testing and improvement. Difficulties related to balancing the energy budget arose in cases of poor analysis of cloud/precipitation fields that impact on the radiative heating and on fluxes of heat and moisture. The soil moisture and transpiration representation have also undergone critical study. Major improvements have been realized though the cloud/precipitation fields will continue to be a problem until improved data coverage becomes available.

Limited sensitivity analysis has been possible to date on the Minnesota Cray computer. The codes have been modified to use less than 400 MW memory and integrate at about 1% real time. The data from the OSCAR and PEPE/NEROS experiments will be used in the analysis.

Funding for model intercomparison with the National Center for the Atmospheric Research Regional Acid Deposition Model (RADM) and for the upgrading the cloud-wet removal processes in the ERT transport, transformation and deposition submodel has been reduced and modified work scopes are being produced. It is expected that user familiarization courses will be scheduled for interested AES and MOE staff in 1986.

Contact: A.D. Christie

3.1.3 Lagrangian Model

Trajectories were computed for Alert (Arctic Field Study), Bermuda (WATOX), Churchill and Kejimkujik (University students), Lake Couchiching (NH&W) and for the CAPMoN sites. The Interactive Trajectory Computation and Plotting System (ITACAPS) contract was completed and the users manual was distributed. The procedure has been improved and is being used regularly by the Branch and several AES regional offices. The trajectory model compared very favourably to the CAPTEX measured tracer data and results indicated that some improvements are required.

The AES-LRT model results for the International Sulphur Deposition Model Evaluation (ISDME) project were completed and submitted. A thorough data screening and analysis was completed on the measured network data prior to conducting the evaluation exercise. A total of 11 models were submitted and extensive statistical analyses have been done in Canada (U. of Ottawa) and U.S. (EPA).

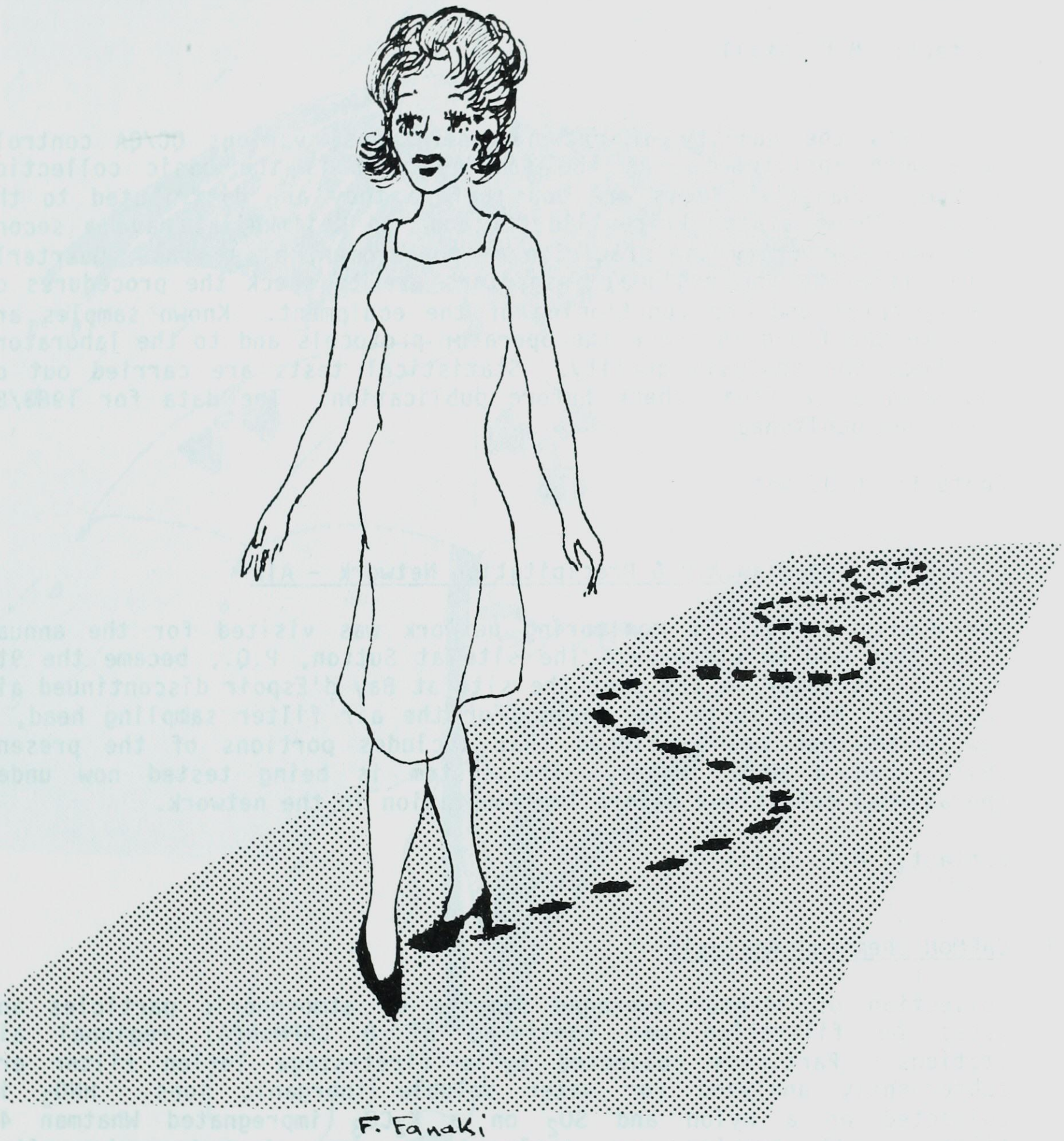
The nitrogen oxides chemistry module was run with the sulphur-nitrogen chemistry model for Longwoods (1983) and Kejimkujik (1984-85), for a preliminary comparison with observed gaseous (PAN, HNO_3) and aerosol ($p\text{-}NO_3$) data. The initial comparison showed good prediction capability of the order of magnitude and the time of occurrence of episodes.

Climatological monthly mean dry deposition velocity fields of oxides of sulphur and nitrogen were computed for North America. The dry deposition velocities, which compare favourably with long term measurements, were used to estimate dry deposition from measured air concentrations.

Contacts: M.P. Olson, E.C. Voldner, J.W. Bottenheim

3.1.4 CAPMoN(P): Canadian Air & Precipitation Network - Precipitation

This was the first year that AES Regions undertook fully the operations and maintenance of the 18-site CAPMoN precipitation monitoring network. The Regions are responsible for the continued operation of all the sites by arranging operator contracts, by ensuring adequate supplies, by training operators and by inspecting quarterly each site and each operator. The Branch is responsible for the training of the inspectors and the centralized functions of laboratory analysis, quality control/assurance and data publications.



MODEL TRAJECTORY

A training course was organized in May by the Branch for the Central, Ontario, Quebec and Atlantic Regions. During the year the following sites were improved: Cormack (new location); Port Cartier (re-siting); Kejimkujik (clearing); and Jackson (hydro installation). The Branch discussed with all Regions in November the operations and costs to run the network in the Region for input to the 1986/87 operating budget for CAPMoN.

Contact: M.E. Still

To assess the quality of network operations, various QC/QA controls have been instituted. As the sampling bag is the basic collection method, exhaustive tests are done before they are distributed to the sites. Three sites (Priceville, Sutton and Kejimkujik) have a second collector to verify the precision of measurement at a site. Quarterly site visits by the regional inspectors are to check the procedures of the operator and the functioning of the equipment. Known samples are sent to the field to check the operator protocols and to the laboratory to check the analysis quality. Statistical tests are carried out on the data as a final check before publication. The data for 1983/84 have been published.

Contact: R.J. Vet

3.1.5 CAPMoN(A): Canadian Air & Precipitation Network - Air

The 8-site CAPMoN air monitoring network was visited for the annual inspection and maintenance. The site at Sutton, P.Q., became the 9th station but later in the year the site at Bay d'Espoir discontinued air sampling. Based on a new design for the air filter sampling head, a new system has been designed that includes portions of the present system and a data logger. The system is being tested now under operational conditions before implementation in the network.

Contact: M.E. Still

3.1.6 CAPMoN Chemical Analysis

Collection of 24-hour averaged samples of atmospheric particles and gases by filtration was continued at 8 CAPMoN(A) regional air stations. Particles collected by a first-stage Teflon filter are subsequently analyzed for water soluble inorganic ions. HNO_3 is collected on a nylon and SO_2 on a K_2CO_3 impregnated Whatman 41 filter. All species are analyzed by ion chromatography after extraction of the filters. A routine quality assurance program is used for validation of the chemical analyses of samples.

Contact: H.A. Wiebe

AN UMBRELLA FOR ALL OCCASIONS

3.1.7 APN/CANSAP Air Chemistry Data Analysis

After four years of operation, the Canadian Air and Precipitation Network (APN) offers a unique data set with which to determine wet and dry deposition of acid-related sulphates and nitrates. The network consists of 8 stations sampling air and precipitation on a daily basis east of Manitoba. A comparison of the wet and dry deposition of sulphates and nitrates was made for the period 1979-1982. To estimate dry deposition, air concentarations were multiplied by the deposition velocities estimated by Sirois and Voldner.

In another study APN air data from ELA-Kenora and Cree Lake (Saskatchewan) were used to investigate the influence of Eurasia pollution which is so prevalent in the Arctic in the winter on background levels of acidic sulphates and nitrates in western Canada. The results indicate that in winter Eurasian pollution is present as an elevated background in the North American air shed.

Contacts: A. Sirois, L.A. Barrie

3.1.8 Data Analysis, Integration and Synthesis (DIAS) Project

A small data analysis, integration and synthesis group was established in AES. Their objectives were to combine data and research results from many sources and, by integrating and interpreting these results, to provide a "higher level" of useful information to other scientists and for addressing policy issues. In the initial stages only atmospheric inputs have been considered but eventually other media (water, forestry) will be incorporated.

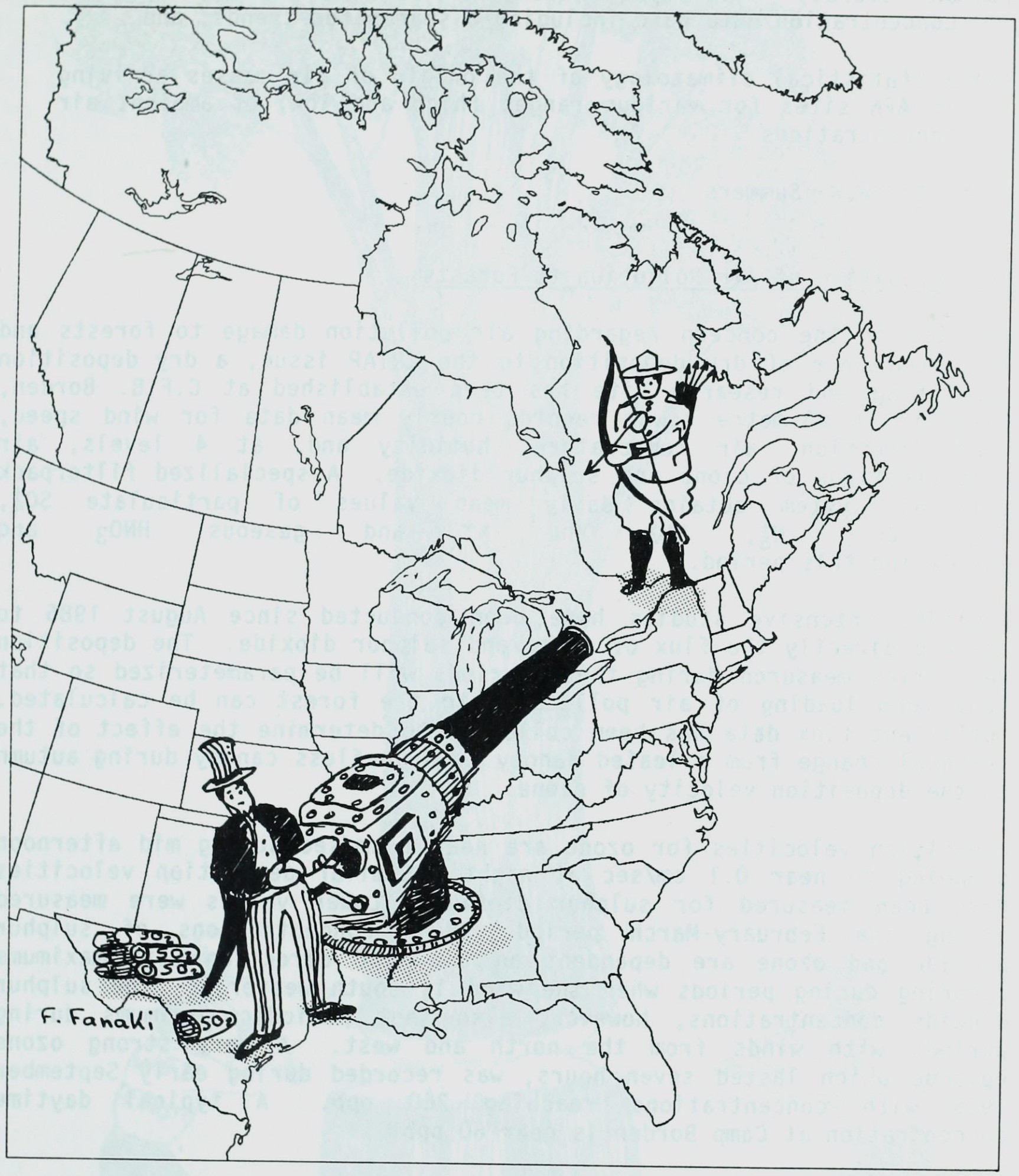
The main tasks completed in 1985/86, using combined Canadian and US data bases, were:

(1) studies on the relative contributions of sulphate and nitrate to acidity; the relative importance of wet and dry deposition in eastern Canada; and the comparison of tracer gas measurements with model-generated air mass trajectories;

(2) an overview of the seasonal variation of deposition in eastern North America;

(3) contributions to an updated assessment of the scientific knowledge base of LRTAP/Acid Rain; and

(4) a review of the observational data base on atmospheric nitrogen compounds in eastern North America prepared for the Economic Commission for Europe.



SO_2 WAR

Continuing studies are :

(5) an overall statistical analysis of the total APN air concentration data base including a search for trends; and

(6) a statistical climatology of the origin of air masses arriving at APN sites for various ranges (high and low) of ambient air concentrations.

Contact: P.W. Summers

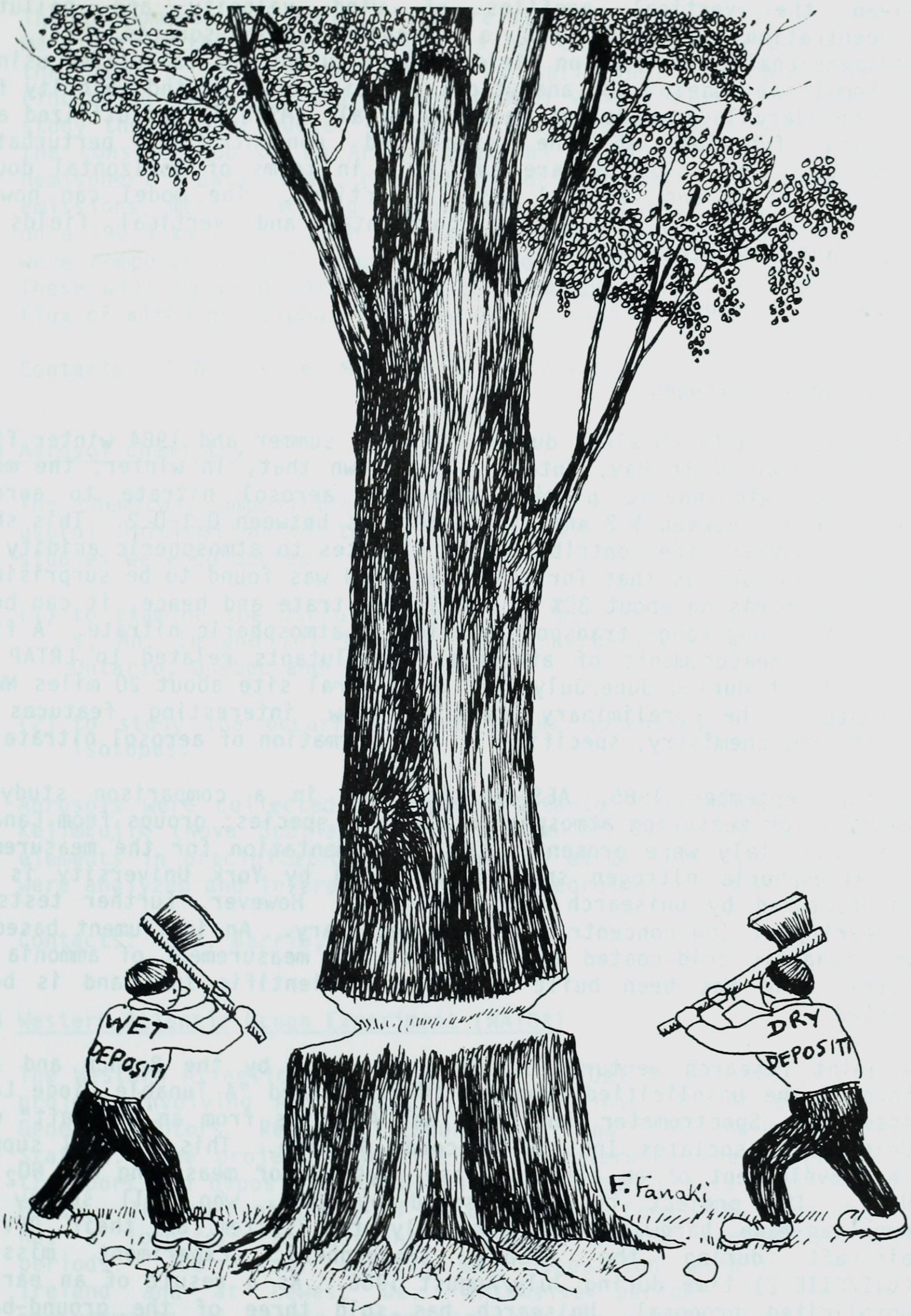
3.1.9 Dry Deposition of Air Pollution to Forests

In view of the concern regarding air pollution damage to forests and the importance of dry deposition to the LRTAP issue, a dry deposition monitoring and research site has been established at C.F.B. Borden, Ontario. A 43-metre tower records hourly mean data for wind speed, wind direction, air temperature, humidity and, at 4 levels, air concentrations of ozone and sulphur dioxide. A specialized filterpack sampling system obtains daily mean values of particulate $SO_4^{=}$, NO_3^{-}, Cp^{-}, N_a^{+}, NH_4^{+} and K^{+} and gaseous HNO_3 and SO_2 during this period.

Periodic intensive studies have been conducted since August 1985 to measure directly the flux of ozone and sulphur dioxide. The deposition velocities measured during these periods will be parameterized so that long term loading of air pollutants to the forest can be calculated. Sufficient flux data has been collected to determine the effect of the seasonal change from a leafed canopy to a leafless canopy during autumn on the deposition velocity of ozone.

Deposition velocities for ozone are near 1 cm/sec during mid afternoon dropping to near 0.1 cm/sec at night. Similar deposition velocities have been measured for sulphur dioxide. Lower values were measured during the February-March period. Mean concentrations of sulphur dioxide and ozone are dependent on the wind direction with maximums occuring during periods when the wind is south westerly. The sulphur dioxide concentrations, however, also show periodic maximums during periods with winds from the north and west. A very strong ozone episode which lasted seven hours, was recorded during early September 1985 with concentrations reaching 260 ppb. A typical daytime concentration at Camp Borden is near 60 ppb.

Contacts: G. den Hartog, H.H. Neumann


WET
DEPOSITI
DRY
DEPOSITI
F. Fanaki

3.1.10 Dry Deposition - Complex Terrain

Given the vertical profiles of wind velocity and pollutant concentration incident upon a circular cosine-squared hill, the 3-dimensional concentration field of a pollutant was calculated using a mathematical model. The analytical solution of the wind velocity from the boundary layer model of Walmsley et al. (MS3DJH) was utilized as a forcing function in the simplified concentration perturbation equation. The solutions are available in terms of horizontal double Fourier series and vertical Bessel functions. The model can now be used operationally to output horizontal and vertical fields of pollutant concentration.

Contact: J. Padro

3.1.11 Atmospheric Nitrogen

Analysis of data obtained during the 1982 summer and 1984 winter field studies near North Bay, Ontario, has shown that, in winter, the molar ratio of atmospheric nitric acid plus aerosol nitrate to aerosol sulphate is between 1-2 and, in summer, is between 0.1-0.2. This shows that in winter, the contribution of nitrates to atmospheric acidity can be as important as that for sulphate. PAN was found to be surprisingly large, comprising about 30% of oxidized nitrate and hence, it can be an important long range transport carrier of atmospheric nitrate. A field study on measurements of atmospheric pollutants related to LRTAP was carried out during June/July 1985 at a rural site about 20 miles NW of Toronto. The preliminary results show interesting features of night-time chemistry, specifically, the formation of aerosol nitrate.

During September 1985, AES participated in a comparison study on methods for measuring atmospheric nitrogen species; groups from Canada, U.S. and Italy were present. The instrumentation for the measurement of atmospheric nitrogen species developed by York University is now manufactured by Unisearch Associates Inc. However, further tests on linearity at low concentrations are necessary. An instrument based on the tungstic acid-coated denuder tubes for measurement of ammonia and nitric acid has been built by Concord Scientific Inc. and is being tested.

A joint research venture is being supported by the Branch and APRB through the unsolicitied proposal (UP) entitled "A Tunable Diode Laser Absorption Spectrometer for Trace Gas Analysis from an Aircraft" with Unisearch Associates Inc. of Concord, Ontario. This UP 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 on their DFV-990 aircraft during the Global Tropospheric Experiment missions (GTE/CITE-2) time during July/August 1986. As a result of an earlier unsolicited proposal, Unisearch has sold three of the ground-based laser systems to EPA and SUNY of the U.S. and the Federal Republic of Germany.

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

3.1.12 Arctic Air Chemistry Model

The phenomenon of Arctic haze related to air pollution originating mainly from the Eurasian land mass has been studied experimentally for the past 5 years. Now there is sufficient information available (including emissions and meteorological wind fields) to diagnostically study the sulphur budget of the Arctic using computer models. In 1985 the construction of an Arctic chemical transport model was initiated. Hemispheric data sets consisting of European and North American emissions, monthly mixing heights and daily precipitation were prepared on a 190.5 km grid. Five day back-trajectories twice a day at 3 levels were computed at 10° intervals around the Arctic circle for one year. These will be used with a chemical transport algorithm to compute the flux of airborne sulphur into the Arctic region.

Contacts: L.A. Barrie, M.P. Olson, K. Oikawa

3.1.13 Aerosol Chemistry

The chemical composition of atmospheric aerosols contains potentially useful information on their origin. With this in mind a number of studies were conducted:

(1) to examine the usefulness of seven aerosol tracers (As Sb, Se, V, Mn, In and Zn) in identifying aerosol sources in southern Ontario, Quebec and the Maritimes.

(2) to study the occurrence and tracer potential of stable lead isotopes.

Aerosols were collected at Dorset (Ontario), Montmorency (Quebec) and Kejimkujik (Nova Scotia) in the autumn of 1984. In addition, trace elements in precipitation were measured at Dorset. In 1985 these data were analyzed and interpreted from a meteorological point of view.

Contacts: L.A. Barrie, W. Sturges

3.1.14 Western Atlantic Ocean Experiment (WATOX)

The Western Atlantic Ocean Experiment (WATOX) is a cooperative research project involving AES, NOAA, U. of Virginia, U. of Delaware, NASA, General Motors Research Laboratory, and the Bermuda Biological Station. The project objective is to determine the magnitude of the transport and deposition of North American pollutants over the Atlantic Ocean. The current phase of WATOX extends from 1985 through 1987; it has a long-term measurement component and a number of intensive periods. The former entails wet deposition sampling on Bermuda, Ireland and at Lewes, De. Intensive periods involve shipboard measurements of acidic, metal and organic species during spring and autumn cruises, and coordinated land/aircraft measurements of the same species during summer and winter experiments. AES participation in the program entails the measurement of acidic species on ship, aircraft and at Bermuda, and meteorological analysis using the AES-LRTAP model.

Analysis was completed of data from cruises of the Knorr in April-May 1984 and the Oceanic in October 1984. Data analysis from the 1985 winter intensive study in the Western Atlantic is in progress. During the January-March 1986 intensive period measurements were made on the NOAA P-3 and King air using a filterpack system (aerosol, SO_2, HNO_3), the airborne PAN-system II, and the LMA-3 NO_2 detector, based on luminol-luminescence.

Contacts: D.M. Whelpdale, J.W. Bottenheim

3.1.15 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. The Climate Centre has collected data on the melt rate, snow pack chemistry and melt water chemistry data from field experiments at Dorset, Ontario. Data have been analyzed for three winter seasons . An acidic snowmelt shock potential model has been developed and implemented on a microcomputer. This model is being tested with the field data collected at the Dorset site and has been made available to researchers at other Canadian basins.

Contacts: P.Y.T. Louie, B.E. Goodison

3.1.16 Chemistry of High Elevation Fog (CHEF)

In recent years, it has been recognized that an important component of wet deposition is that due to low clouds and fog coming in direct contact with vegetation. The United States are undertaking an extensive research project to investigate mountain cloud chemistry/forest exposure at sites along the Appalachian chain in the eastern U.S. Environment Canada and the Canadian Forestry Service are partners in the Canadian portion (CHEF) of this project. The objectives are:

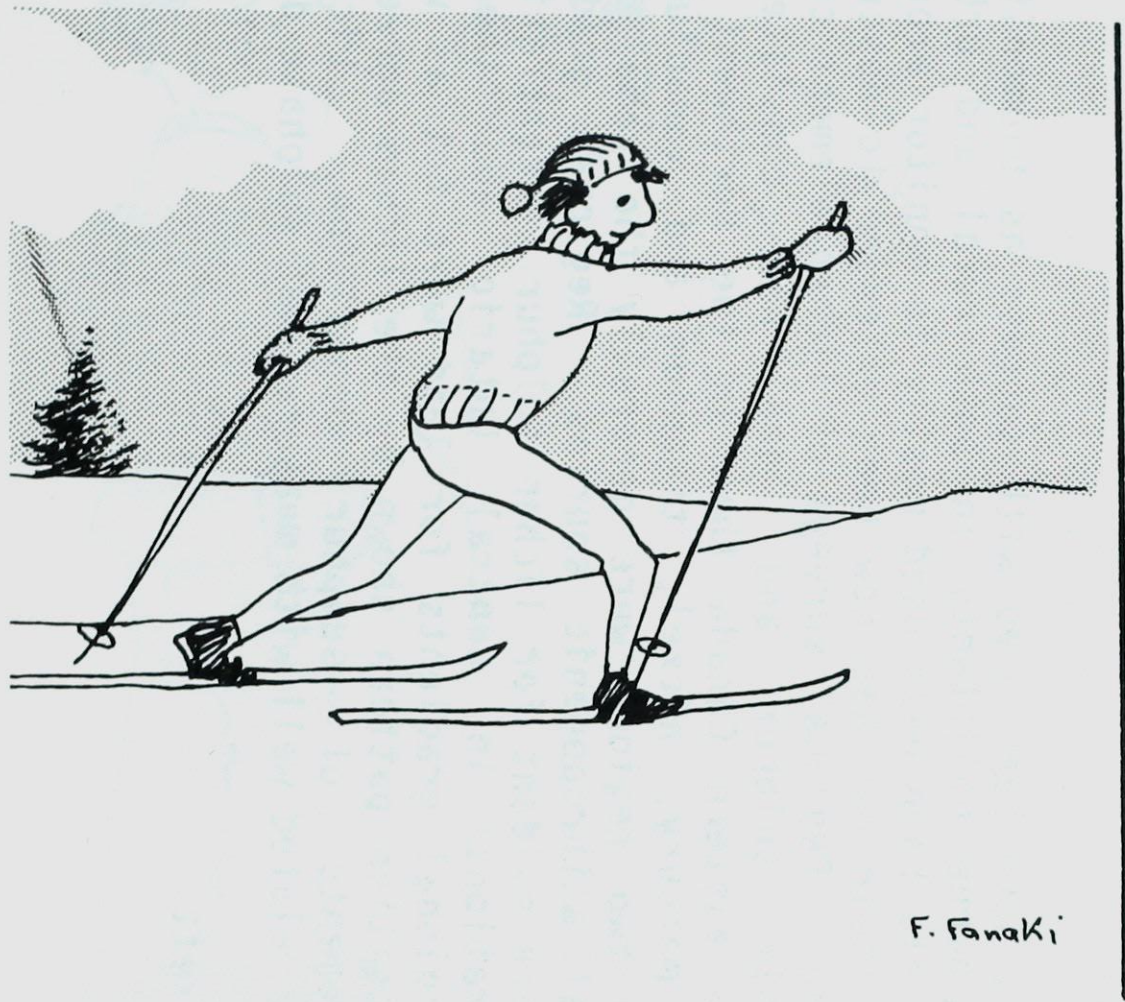
(1) to provide air chemistry and meteorological information for the interdisciplinary study of the effects of atmospheric deposition on high elevation forests in eastern Canada; and

(2) to monitor selected air pollutants and the concentrations of pollutants in cloud water for the estimation of time trends.

Two observing sites are established at Mt. Tremblant (PQ) and Roundtop Mountain (near Sutton, PQ) and a third will be established at Forêt Montmorency.

Preliminary data indicate that mountains in Quebec, with summits in the 900 to 1000 m range, may be in cloud as much as 44% of the year compared to 23% for elevations around 530 m. On two mountain summits, the mean pH value of fog water was calculated to be 3.7 -3.8 which was lower than the mean pH for precipitation at the same elevation.

Contact: R.S. Schemenauer



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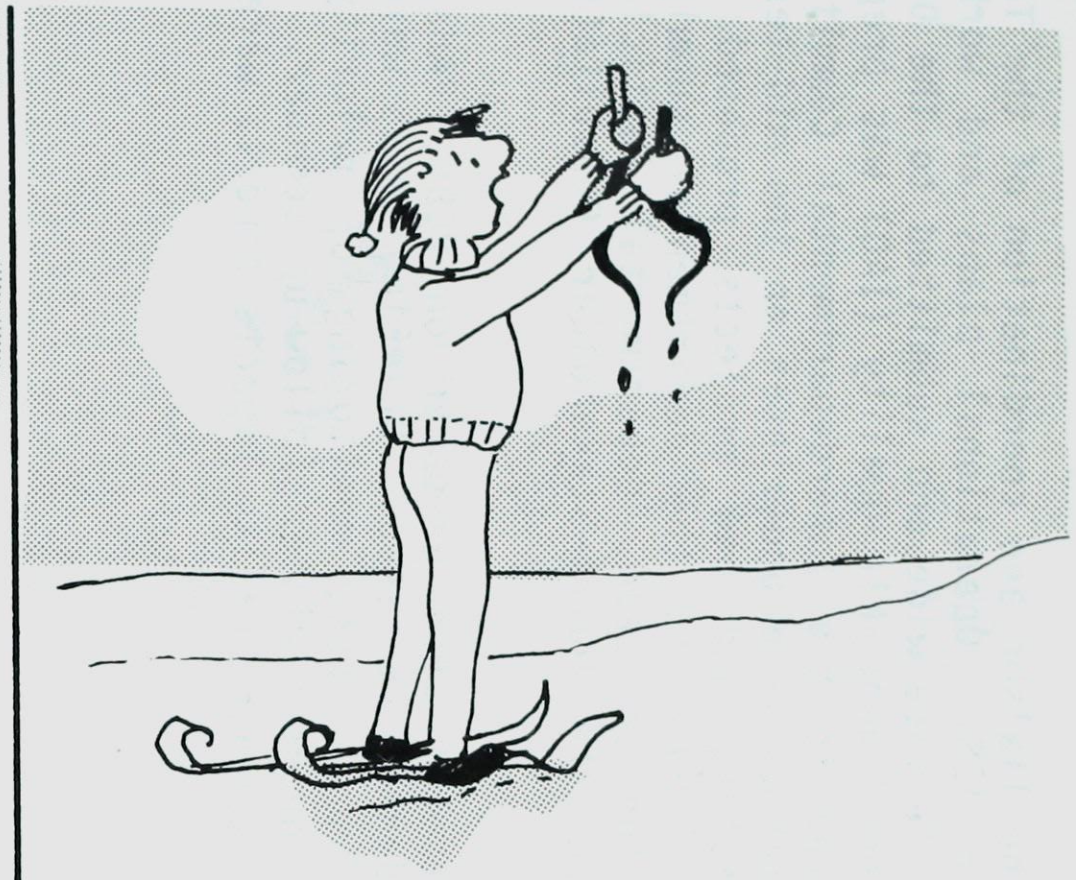


SNOWMELT SHOCK

3.2 TOXIC CHEMICALS

3.2.1 Toxic Communications

The Branch undertook the liaison and coordination of the Toxic Chemical scientific program for AES. Operational plans and work plans were developed, coordinated Service-wide and submitted to the Department. A draft Plan of Action on Indoor Air Quality (IAQ) was prepared for the Department and submitted to the Interdepartmental Committee on Toxic Chemicals. Program reviews were undertaken on the mid-term and annual progress reports, existing and new projects proposed for 1986/87, atmospheric component inputs to the departmental submission to the Royal Society Commission on Lead, departmental Pesticides and Pest Management Program and the Multi-Stakeholder Consultation on Toxic Chemicals.

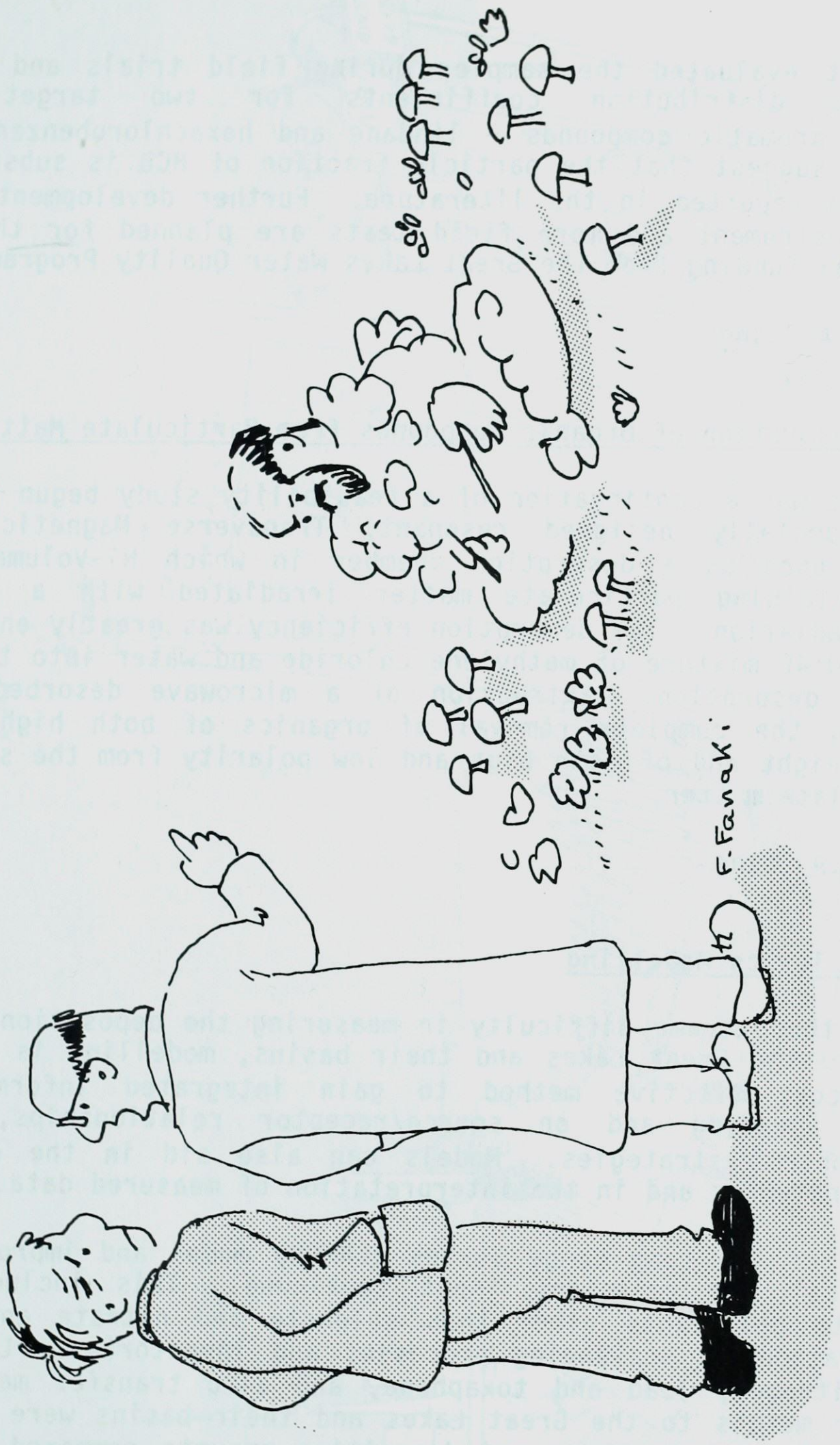
Toxic chemical fact sheets were prepared on PCBs, PAHs, pesticides, heavy metals and accidental releases. Briefing notes were prepared on lead, dioxins, pesticides, PCBs, monitoring of priority atmospheric pollutants and on the nuclear-winter follow-up seminar. The draft of the Air Quality Trends and Air Quality Impacts reports were reviewed.

Contact: E. Wilson

3.2.2 Biological monitors

Lichens and mosses have been used with success as biomonitoring agents for measuring airborne pollutants in both rural and urban areas of Canada. These plants have been used mostly to monitor around point and area sources but their use has now been extended to describe regional deposition patterns. Regional surveys of lichen element concentrations showed that only sulphur and lead had consistently higher concentrations in eastern Canada than in the Northwest Territories. Chromium, iron, mercury, nickel, titanium and vanadium levels in lichens from the two regions were generally the same except in the vicinity of local anthropogenic sources. Regional gradients within eastern Canada were evident for lichen sulphur concentrations with the highest concentrations in central Ontario and the lowest in Newfoundland. Regional gradients for lead were not as well defined. The regional deposition pattern shown by the lichen agreed with other indirect measurements of sulphur deposition. Lichen sulphur concentrations correlated well with measured wet sulphate deposition.

Contact: K.J. Puckett



This is our lichen expert.

3.2.3 Organic Gas/Particle Fractionating System

The Ontario Research Foundation had, during the previous year, developed a prototype diffusion denuder front end for the dichotomous sampler.

This project evaluated the sampler during field trials and obtained gas/particle distribution coefficients for two target toxic, chlorinated aromatic compounds - lindane and hexachlorobenzene (HCB). The results suggest that the particle fraction of HCB is substantially greater than reported in the literature. Further development of this versatile instrument and more field tests are planned for the future under partial funding from the Great Lakes Water Quality Program.

Contact: D.A. Lane

3.2.4 Microwave Desorption of Organic Compounds from Particulate Matter

This project was a continuation of a feasibility study begun two years ago. A specially designed resonant, Transverse Magnetic (TM_{010}) cavity was used as a desorption chamber in which Hi-Volume sampler filters containing particulate matter irradiated with a 2.45 GHz microwave radiation. The desorption efficiency was greatly enhanced by misting a 60:40 mixture of methylene chloride and water into the cavity during the desorption. Extraction of a microwave desorbed, filter demonstrated the complete removal of organics of both high and low molecular weight and of both high and low polarity from the surface of the particulate matter.

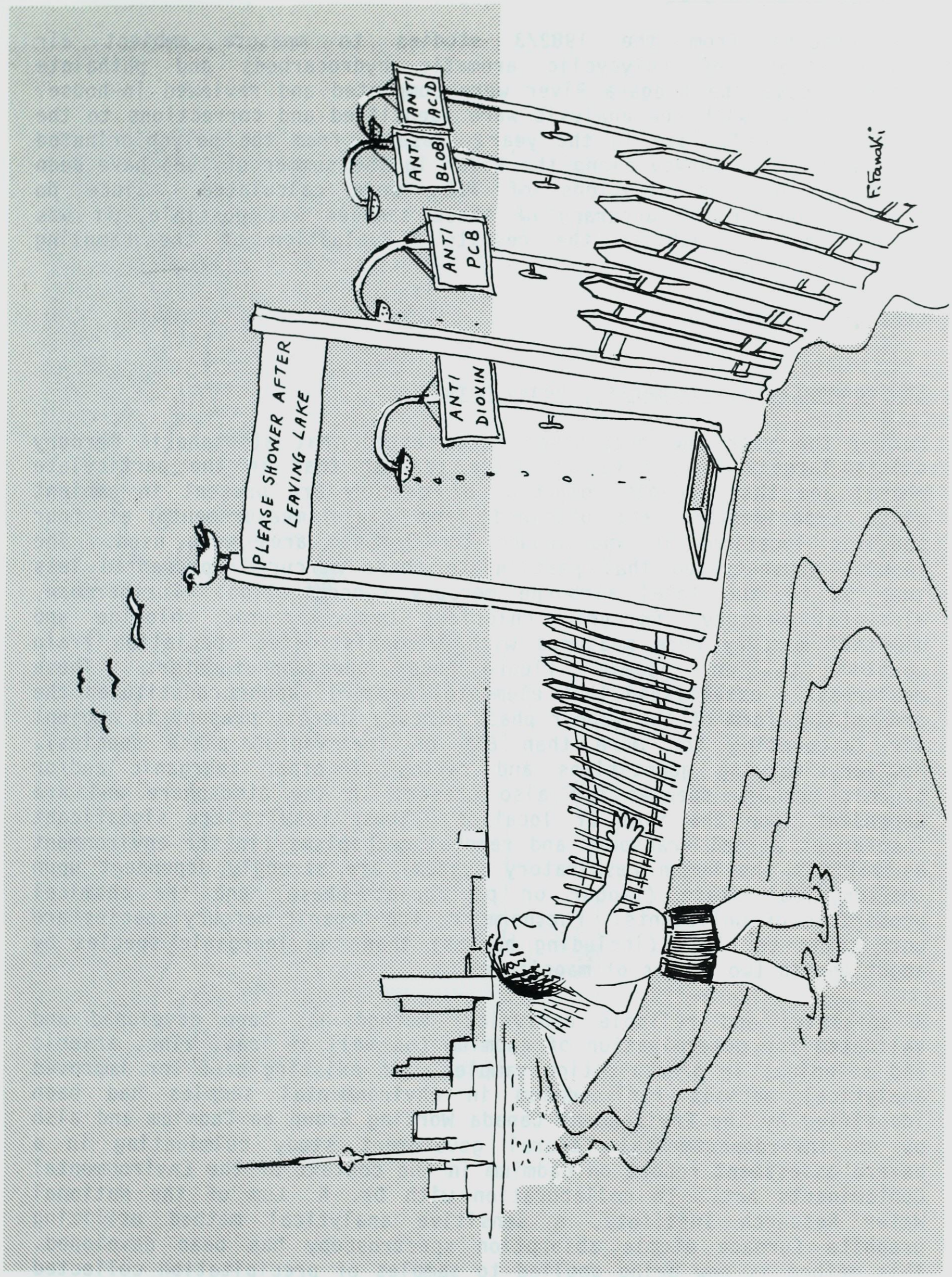
Contact: D.A. Lane

3.2.5 Atmospheric Toxics Modelling

Because of the extreme difficulty in measuring the deposition of toxic chemicals to the Great Lakes and their basins, modelling is currently the most cost-effective method to gain integrated information on atmospheric loading and on source/receptor relationships, and to evaluate control strategies. Models can also aid in the design of monitoring networks and in the interpretation of measured data.

Development of the Long Range Toxics (LRTOX) model and improvement in meteorological and emissions input continued. This included model expansion to pollutants other than sulphate and nitrate and revised parameterization of scavenging processes and inventories. Loading of sulphur, nitrogen, lead and toxaphene, and also transfer matrices of other toxic metals to the Great Lakes and their basins were computed. The predicted concentrations and deposition amounts compared favorably with measurements.

Contacts: E.C. Voldner, G. West


ANTI ACID
ANTI BLOB
ANTI PCB
ANTI DIOXIN
PLEASE SHOWER AFTER LEAVING LAKE
F. Fanaki

3.2.6 Niagara River Studies

The results from the 1982/3 studies to measure ambient air concentrations of polycyclic aromatic hydrocarbons and phthalate esters above the Niagara River were completed and reviewed in-house. Some problems with the analysis were identified and corrections to the final draft made late in the year. Results from the polychlorinated biphenyls (PCB) survey along the River in the summer of 1984 have been analysed and concentrations of PCBs were calculated. Since no confirmation on the accuracy of these samples was possible, it was decided not to publish the results. Evaluation of the sampling technique was made.

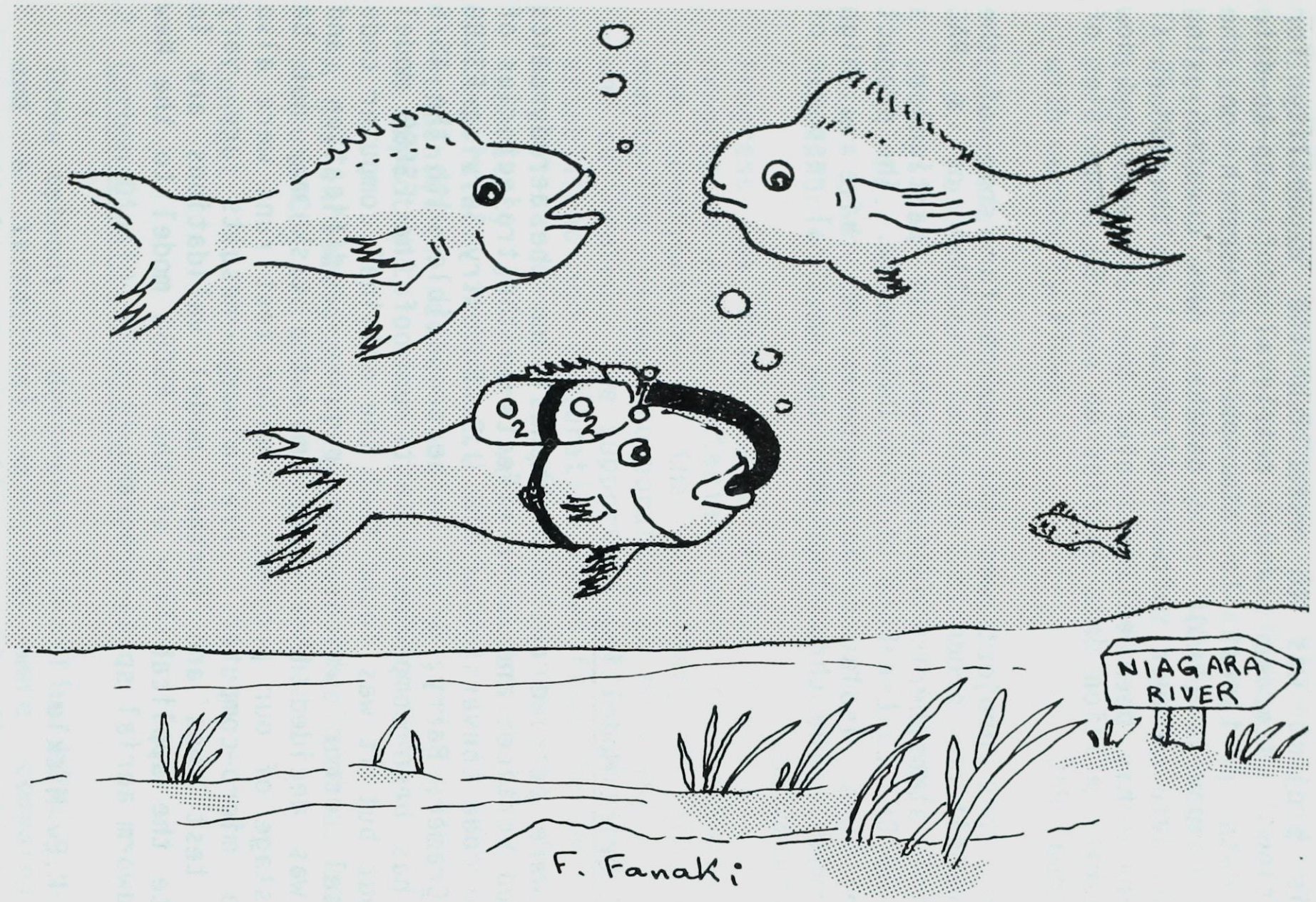
Contacts: R. Hoff

3.2.7 Environmental Measurements: Heavy Metals

During the year the hypotheses were tested that atmospheric mercury exists largely in the vapour phase (rather than in the particulate phase) and that organic compounds of mercury are present in ambient air. Experimental data obtained from field measurements at four specific locations in and around the Toronto area were used. The results demonstrated that particulate phase mercury represented less than 5% of the total airborne mercury concentration. Furthermore, elemental mercury, mercuric chloride, methylmercuric chloride and dimethyl mercury were measured with a sophisticated speciation train coupled to an atomic fluorescence spectrophotometer. These measurements established that elemental mercury vapour constituted the predominant form of the vapour phase mercury species present in ambient air (accounting for more than 85% of the vapour phase species). However, varying quantitites and ratios of other inorganic and/or organic mercury species are also present in the atmosphere and are dependent upon the type of location. These results are significant insofar as aerial transport and removal mechanisms (in the environment as well as the human respiratory system) are strongly dependent upon the physical state (vapour or particulate-phase) and the chemical properties of pollutants. Furthermore, the organic mercury species are more toxic to biota (including humans) than the inorganic species by about one to two orders of magnitude.

A sensitive and reliable analytical method has been developed and validated for determination of cadmium (as well as lead, zinc, arsenic and selenium) in precipitation samples. An existing need for improved analytical methods for cadmium in environmental samples had been identified by the Environment Canada Working Group on Cadmium and also by an interdepartmental federal government study culminating in a hazard assessment report on cadmium in the context of the Environmental Contaminants Act. In collaboration with Dr. K. Lum of the National Water Research Institute, a sensitive analytical method utilizing graphite furnace atomic absorption spectroscopy has been developed. This method is now being applied to samples of precipitation collected at selected stations within the AES CAPMoN network to provide data on the spatial and temporal variability of heavy metal concentrations in rain and snow in Eastern Canada.

Contact: W.H. Schroeder



He is on his way to visit his uncle in Lake Ontario.

3.2.8 PAH Studies

The physical, chemical and biological properties of any given toxic substance are of paramount importance in determining its environmental behaviour and its toxicological characteristics.

The object of this project was to establish the capability for efficient acquisition, storage and retrieval of up-to-date scientific-numeric data pertinent to atmospheric research on the Polycyclic Aromatic Compounds (PAC). The database was created using the SCI-MATE personal data manager software (from ISI) on the IBM PC-XT computer. The database has been enlarged over the last year and now contains about a quarter million data entries on over 50 properties of more than 950 individual PAC.

A second aspect of this project was the search for some of the photochemical decomposition products of the reaction of a PAC (Benzo(a)pyrene) with atmospheric oxidants, and, in particular, a product synthesized by Dr. E. Lee-Ruff of York University. The product (seco-Benzo(a)pyrene) was isolated but appears to have a high photochemical reactivity. The chromatographic and spectral response of the compound were determined.

Contact: D.A. Lane

3.2.9 Pesticide Off-Target Drift Modelling

Literature surveys were carried out with emphasis on the aerodynamics of wing-tip generated vortices and their effects on the trajectories of spray droplets. The code conversion of the U.S. Forestry Service FSCBG (Forestry Service, Cramer, Barry, Grim) to be compatible with the AS/6 mainframe computer has been completed. Test runs of the FSCBG model were also carried out but it was found that the original computer code contained a logical error which may require modification and verification. It was decided that such an extra task may not be warranted at this stage of our project. Similar test runs were also carried out on a micro-computer. Preliminary results are very promising. Detail test runs and further model validations are in progress to evaluate the applicability of the FSCBG model to the New Brunswick spruce budworm aerial spray program.

Contacts: A.K. Lo, R.E. Mickle

3.3 CLIMATE CHANGE

3.3.1 Carbon Dioxide Monitoring Program

Weekly CO_2 flask sampling continued at Alert, Sable Island and Cape St. James with the flasks being analyzed in the laboratory at the Institute of Ocean Sciences in Victoria. Analyses of previous data from Alert, Sable Island and Mould Bay to identify regional sources of carbon show that low concentrations of CO_2 at Sable Island were associated with northerly or south-easterly trajectories while high concentrations were correlated with westerly or south-westerly trajectories. Low values of CO_2 at Alert were usually associated with S-SW airflows while high concentrations were generally associated with northerly flows.

Cooperative flask sampling programs were initiated at Alert with Dr. C.D. Keeling of Scripps Institute of Oceanography and the NOAA Geophysical Monitoring for Climate Change laboratory for CO_2, and with Dr. Rasmussen of the University of Oregon for hydrocarbons. Future plans include cooperative sampling with the National Centre for Atmospheric Research at Boulder and with the Japanese.

Progress was made toward establishing a continuous CO_2 monitoring program at Alert. Materials were transported to Alert in preparation for construction of the laboratory in the summer of 1986. The monitoring system incorporating an NDIR analyzer was assembled, tested and calibrated. The supporting calibration laboratory at Downsview was established and calibration gases from the WMO reference laboratory at Scripps acquired. A 50-metre tower at the site of the future laboratory at Alert was instrumented at 5 levels with wind and temperature instruments and at 1 level with humidity sensors. A condensation nuclei counter was also installed. Continuous monitoring is expected to commence in September 1986.

A gas chromatographic system was developed as an alternative method to measure CO_2 and also to measure methane.

Contact: N. Trivett

3.3.2 Carbon Dioxide Flux Studies

Three methods of determining the flux of CO_2 between the atmospheric and a terrestrial ecosystem were compared. These were the energy-balance Bowen-ratio approach, the eddy-correlation method and a trajectory simulation diffusion model. The third method requires relatively simple measurements, compared to the first two, and would facilitate estimating CO_2 fluxes over large areas.

Contact: N. Trivett

3.3.3 Arctic Gas and Aerosol Sampling Program (AGASP)

An Arctic Haze Study workshop was held at Eaton Hall, Seneca College on June 4/5 to discuss the experimental data collected during the March 85 experiment. This experiment was to test the hypothesis that material is transported into the Arctic in layers which may be different than those coupled to the surface. The project paper was outlined with some sections drafted during the workshop. Our participation in the International AGASP Experiment in 1986 was discussed and an experimental program was outlined.

The final AGASP II planning meeting for the major field experiment in the eastern Arctic (March 26 to April 18, 1986) was held in Boulder, Colorado in September, 1985. There will be at least 4 flights with the NOAA P-3 aircraft over our ground station at Alert. The University of Washington aircraft (Radke) will also overfly Alert. Dr. Bottenheim will install the PAN equipment on the P-3 and will fly both the western and eastern Arctic portions of AGASP II for a total of 6 weeks in the field. The National Research Council will provide a Twin Otter to obtain vertical profiles of aerosol number concentrations at Alert.

Contact: N. Trivett

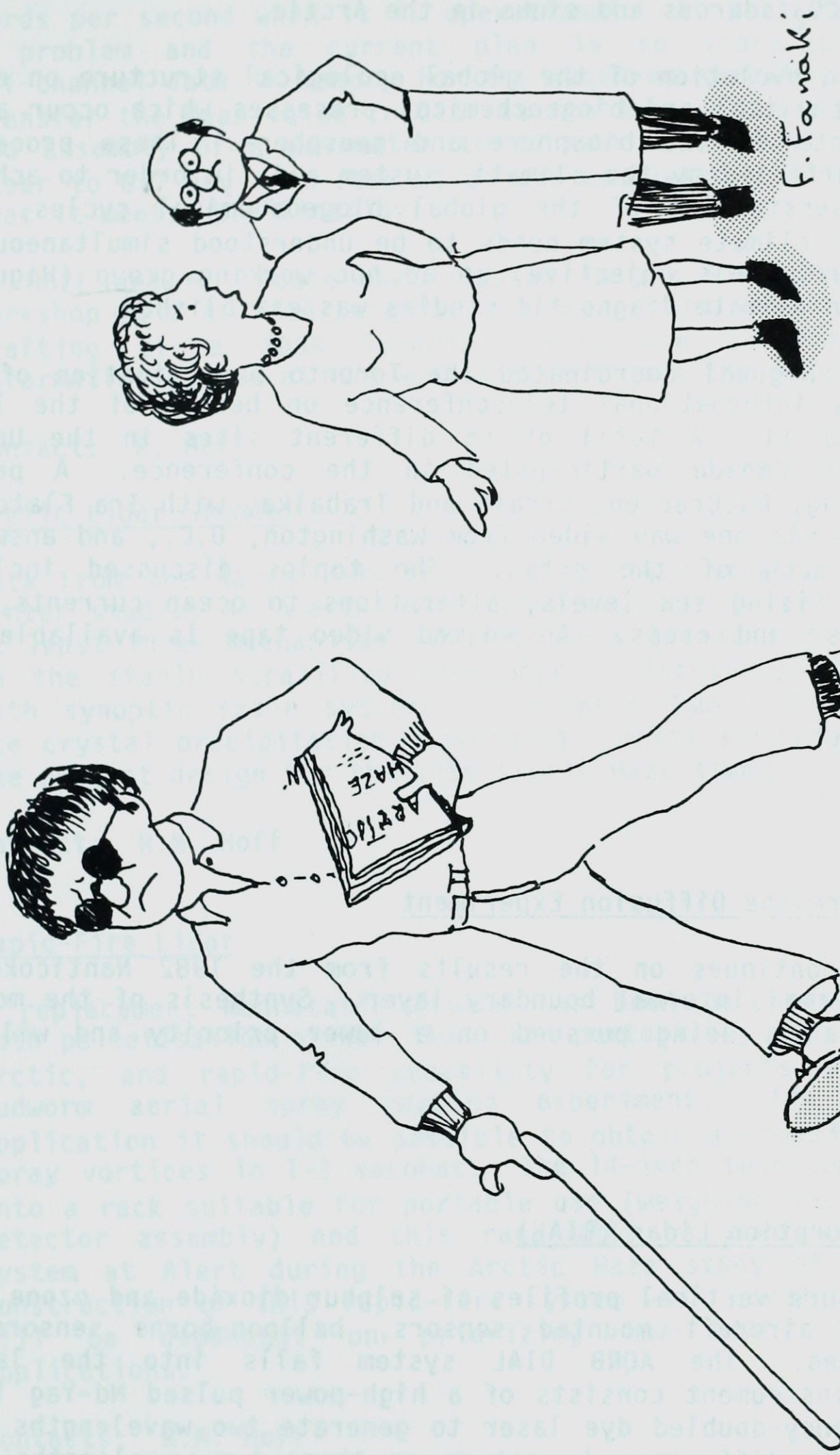
3.3.4 Biogeochemical Cycle Research

A technical meeting to address problems in modelling of the global biogeochemical cycle of carbon was held in November, 1985. The meeting concluded with the formation of a Canadian modelling group that would exchange information, co-ordinate research activities, and initiate and maintain co-operative research programs. The participants felt that the Canadian effort should focus on the increased understanding and on the development, improvement and testing of various parameterization schemes of the biological activities in carbon cycle models.

The meeting recommended that biogeochemical cycle research in AES should proceed along two fronts:

(1) An investigation of the role of the marine biosphere in the global carbon budget is required. The Institute of Ocean Sciences has been analyzing observational data on biological activities in the oceans, with emphasis on representing the role of biological pumping mechanisms in transporting carbon from the surface to the deep oceans. AES will participate by incorporating these mechanisms into a one-dimensional model of the global carbon cycle to assess quantitatively their importance.

(2) As the global carbon cycle cannot be entirely understood in isolation, the biochemical connections need to be investigated and their influence on the stability of the whole biogeochemical cycles system determined.



He is not blind, he's just practising for his trip to Alert to study Arctic Haze.

To address scientific problems and issues peculiar to the Arctic, the Arctic Research Modelling (ARM) Working Group was established to exchange ideas, to cooperate on research activities and to increase the level of understanding of Arctic haze and the climatic impact of the distribution of CO_2 sources and sinks in the Arctic.

The existence and evolution of the global ecological structure on earth depends on the physical and biogeochemical processes which occur among various components of the biosphere and geosphere. These processes affect and are affected by the climatic system and, in order to achieve satisfactory understanding of the global biogeochemical cycles, the behaviour of the climate system needs to be understood simultaneously. To progress towards this objective, an ad hoc working group (Higuchi, Knox, Shabbar) on climate diagnostic studies was established.

Drs. Phillips & Higuchi coordinated the Toronto participation of 200 people in a CO_2 international teleconference on behalf of the local chapter of Sigma Xi. A total of 55 different sites in the United States and 2 in Canada participated in the conference. A panel, consisting of Fung, MacCracken, Strain and Trabalka, with Ira Flatow as moderator, spoke via one way video from Washington, D.C., and answered questions from each of the sites. The topics discussed included climate change, rising sea levels, alterations to ocean currents, and effects on forest and crops. An edited video tape is available for viewing.

Contact: K. Higuchi

3.4 CORE RESEARCH

3.4.1 Nanticoke II Shoreline Diffusion Experiment

Follow-up work continues on the results from the 1982 Nanticoke II study of the thermal internal boundary layer. Synthesis of the mobile air quality data is being pursued on a lower priority and will be completed in 1986.

Contact: R. Hoff

3.4.2 Differential Absorption Lidar (DIAL)

In order to measure vertical profiles of sulphur dioxide and ozone, one can either use aircraft mounted sensors, balloon-borne sensors or remote techniques. The AQRB DIAL system falls into the latter category. The instrument consists of a high-power pulsed Nd-Yag laser pumping a frequency-doubled dye laser to generate two wavelengths near 300 nm. From the difference in return on these two wavelengths, the concentration of SO_2 or O_3 as a function of distance from the lidar can be determined.

During 1985, construction on the 400 mm diameter Cassegrain telescope for the DIAL detector assembly was completed. Work has been completed on the high speed interfaces between the Biomation 8100 and the PDP 11/34. The DIAL system will acquire data at a rate of 5000 12-bit words per second when it is operational. At that rate storage becomes a problem and the current plan is to store the on-channel and off-channel data in memory for the required sampling period and then to transfer the mean value to disk at the end of the period. Construction and assembly of a wavemeter to monitor the output wavelengths of the laser to 0.1 Angstrom resolution was completed and initial tests showed that it meets specifications.

R. Hoff and F. Froude participated in the First DIAL Data Collection workshop held at NASA Langley in November and also were involved in the drafting of a NASA Technical Reference on the DIAL technique. Information gained at the workshop confirmed the final DIAL design.

Contact: R. Hoff

3.4.3 Arctic Lidar Studies

Data from the March 1985 Arctic Haze lidar study and from the 1984/85 winter studies at Alert have been analysed. These studies showed that at least three mechanisms exist to move Arctic Haze aerosol vertically in the stably stratified atmosphere: isentropic movement associated with synoptic scale systems, subsidence due to foehn-type winds, and ice crystal precipitation scavenging. These results influenced some of the project design for the 1986 Arctic Haze study.

Contact: R.M. Hoff

3.4.4 Rapid-Fire Lidar

A replacement monostatic source has been purchased which will allow both palletisation of the lidar for portability (28 lbs) for use in the Arctic, and rapid-fire capability for projects such as the spruce budworm aerial spray mapping experiment. In the budworm spray application it should be possible to obtain a cross-section of aircraft spray vortices in 1-2 seconds. The 14-inch telescope was incorporated into a rack suitable for portable use (weighing less than 70 lbs. with detector assembly) and this rack will be used with the Ruby laser system at Alert during the Arctic Haze study of March-April, 1986. Construction of this rapid-fire system will continue into 1986-87 and will be dependent on priorizing the DIAL, Arctic and Toxics applications.

Contacts: R.M. Hoff

3.4.5 NASA Polar Stratospheric Cloud Project

Dr. Hoff and Mr. Froude cooperated with NASA Langley with Mr. Froude providing meteorological support on the NASA P-3 aircraft in the January 1986 Polar Stratospheric Cloud project. AES contributed extra meteorological support at Alert, special archiving of the upper air data, and meteorological communications support through Thule/Alert links.

Contacts: R.M. Hoff

3.4.6 Flow Over Complex Terrain

The objective of this research is to understand how the wind flow is altered by horizontal variations in elevation and surface roughness. This work has applications in studies of wind energy potential, wind effects on structures and air pollution. The variable-roughness version of the MS3DJH model has been applied to Sable Island as part of our contribution to Canadian Atlantic Storm Program (CASP). The MS3DJH is a linearized model which computes wind flow over variable terrain features. Contract work on preparing standard FORTRAN-77 code and a user's guide has been completed.

A new "Mixed Spectral Finite Difference" (MSFD) model has been developed. The MSFD model offers the same advantages as MS3DJH - high resolution at fairly low computing cost - and also incorporates higher-order turbulence closure enabling better simulation of turbulence. Comparisons between the model and Askervein '83 data showed good agreement.

A new method of obtaining gridded surface roughness fields from land-use maps has been developed and successfully applied to Sable Island.

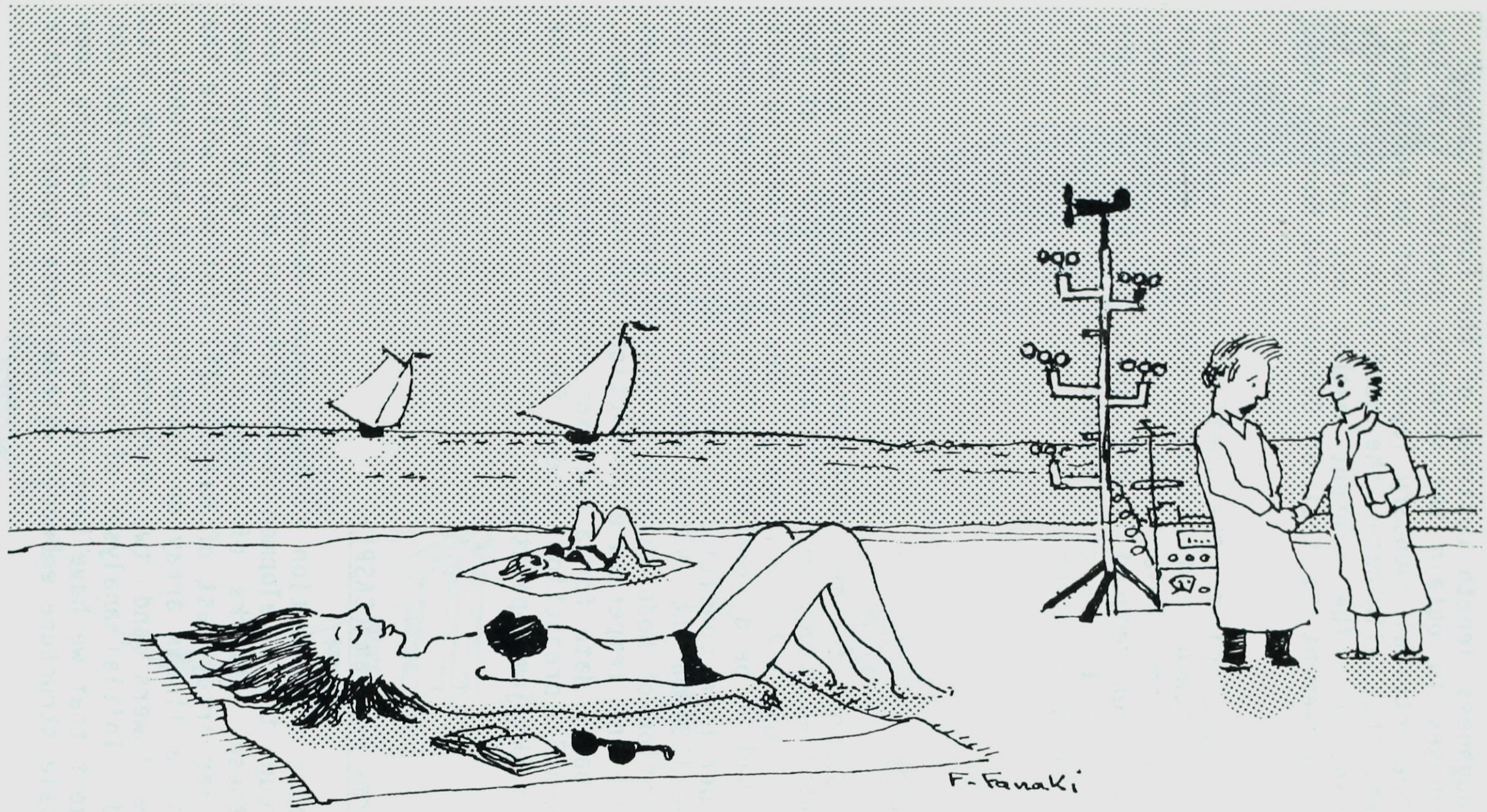
Computer code for Taylor and Lee's (1984) method of estimating wind speeds in complex terrain has been written, tested, applied and transferred to the AES Climate Centre.

Contact: J.L. Walmsley.

3.4.7 Askervein and Kettles Hill Projects

Although there were no field studies associated with these projects during FY85/86, work has continued on the analysis and interpretation of the data from the experiments which were conducted to measure the detailed structure of boundary-layer flow over low hills. Detailed comparisons have been made between field measurements, wind tunnel model simulations and numerical computations. The major achievement has been a substantially improved understanding of the flow modifications caused by low hills and other topography.

Contact: P.A. Taylor



Congratulations! You have picked the right spot to study "Flow over Complex Terrain."

3.4.8 Aerodynamic characteristics of a forest canopy.

Using horizontal mean wind measurements in and above the canopy, an expression has been derived that shows the zero-plan displacement being independent of the roughness length upstream of the forest canopy. The present study proposes to obtain the velocity gradient from the measured wind within the internal boundary layer so that an additional equation can be derived that eliminates the need of a simultaneously measured friction velocity. The present method not only is an alternate but is an improvement to that of DeBruin and Moore (1984, hereafter DB&M).

The present method was applied to the Thetford Forest experimental data. Results not only showed good agreement with that of DB&M but also greatly simplified the calculation procedures. The three governing equations have been reduced to one single equation involving the zero-plane displacement as the only dependent. This equation is independent of the Von Karman constant.

Contact: Dr. A.K. Lo

3.4.9 Canada Olympic Park Study

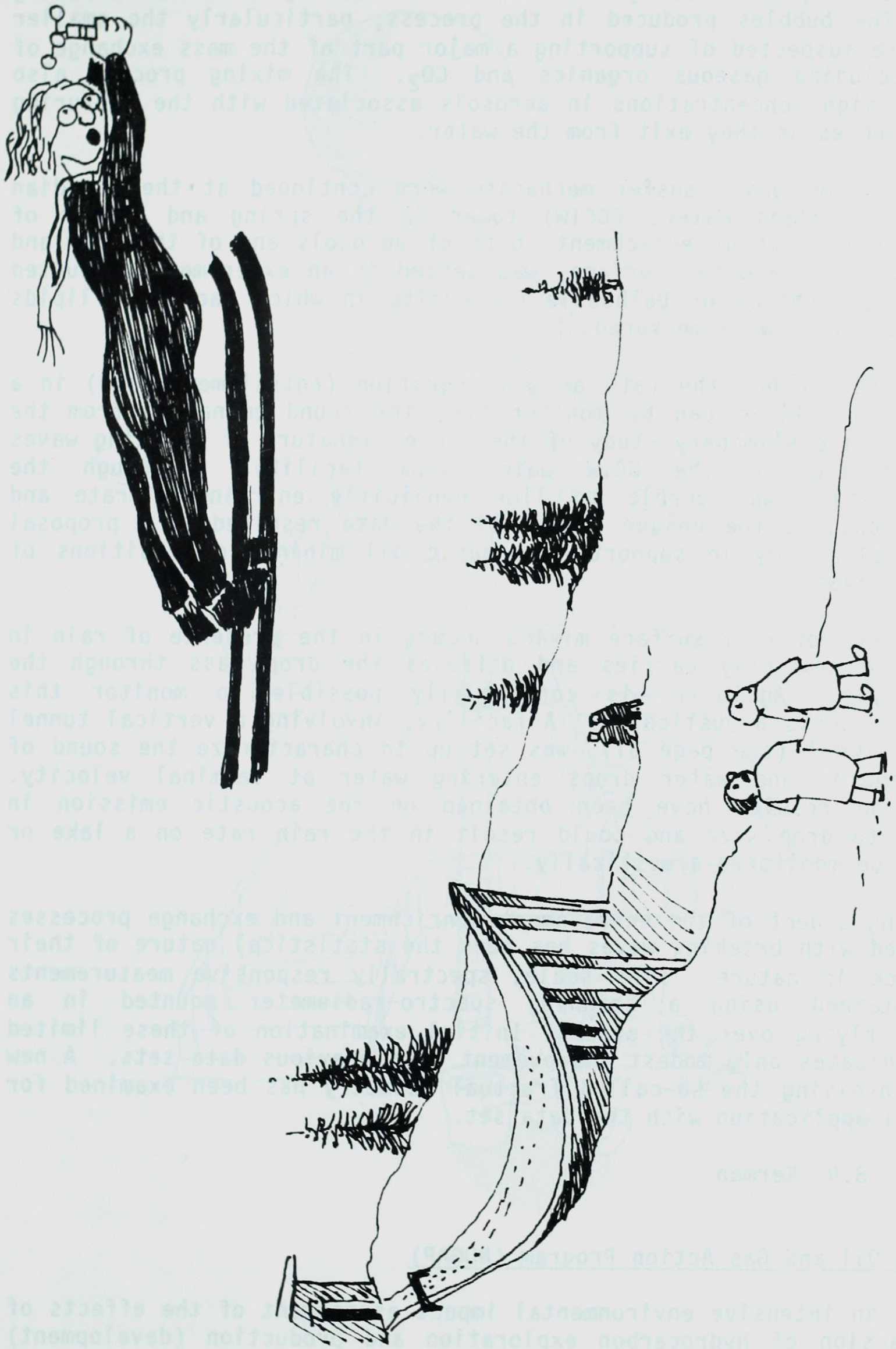
As a part of the AES support for the 1988 Winter Olympics, the Branch has continued the detailed study of winds and temperatures at the Canada Olympic Park Ski Jump site in Calgary. Due to engineering work at the site, 5 towers had to be dismantled in July and redeployed under extremely adverse temperature conditions, late in November. Data are now available from the 1984/85 and 1985/86 winters and will be used as a basis for the application of Model Output Statistics (MOS) techniques for site specific wind and temperature predictions during the games. This will provide the basic data for a decision on the necessity for a very short-term, gust-lull prediction scheme for winds to ensure the safety of skiers during ski jump operation.

Contact: P.A. Taylor

3.4.10 Canadian Atlantic Storms Program (CASP)

The Branch made a major contribution to the January-March 1986 field component of CASP through the development and deployment of two Surface Mesonets. One of these networks of surface weather stations was deployed in a triangular array east of Halifax (17 stations) while the other, was deployed in a linear array on Sable Island (9 stations). Two 26-metre profile towers and two Airsonde stations were also deployed and operated. Initial analyses of the data were carried out in the field and suggest that we have been successful in observing some of the surface mesoscale structure embedded within these synoptic scale storms.

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



Peter likes to take in-situ measurements.

3.4.11 Wind-Driven Entrainment and Enrichment at the Air-Sea Interface

The exchange of gases between the atmosphere and the oceans and lakes is considerably assisted by the violent overturning action of breaking waves. The bubbles produced in the process, particularly the smaller sizes, are suspected of supporting a major part of the mass exchange of gases including gaseous organics and CO_2. The mixing process also leads to high concentrations in aerosols associated with the rupturing of the bubbles as they exit from the water.

Studies of the gas transfer mechanism were continued at the Canadian Centre for Inland Waters (CCIW) tower in the spring and summer of 1985. The concept of enrichment, both of aerosols and of the foam and microlayer at the water surface, was tested in an experiment conducted with Dr. B. Johnson of Dalhousie University in which bacteria, lipids and trace metals were measured.

To evaluate whether the rate of gas ingestion (entrainment rate) in a breaking wave field can be monitored by the sound emanating from the whitecaps, a preliminary study of the audio signature of breaking waves was conducted in the CCIW water tank facility. Although the instrumentation was unable to link explicitly entrainment rate and sound intensity, the unique nature of the data resulted in a proposal for a field study in support of oceanic oil mining in conditions of breaking waves.

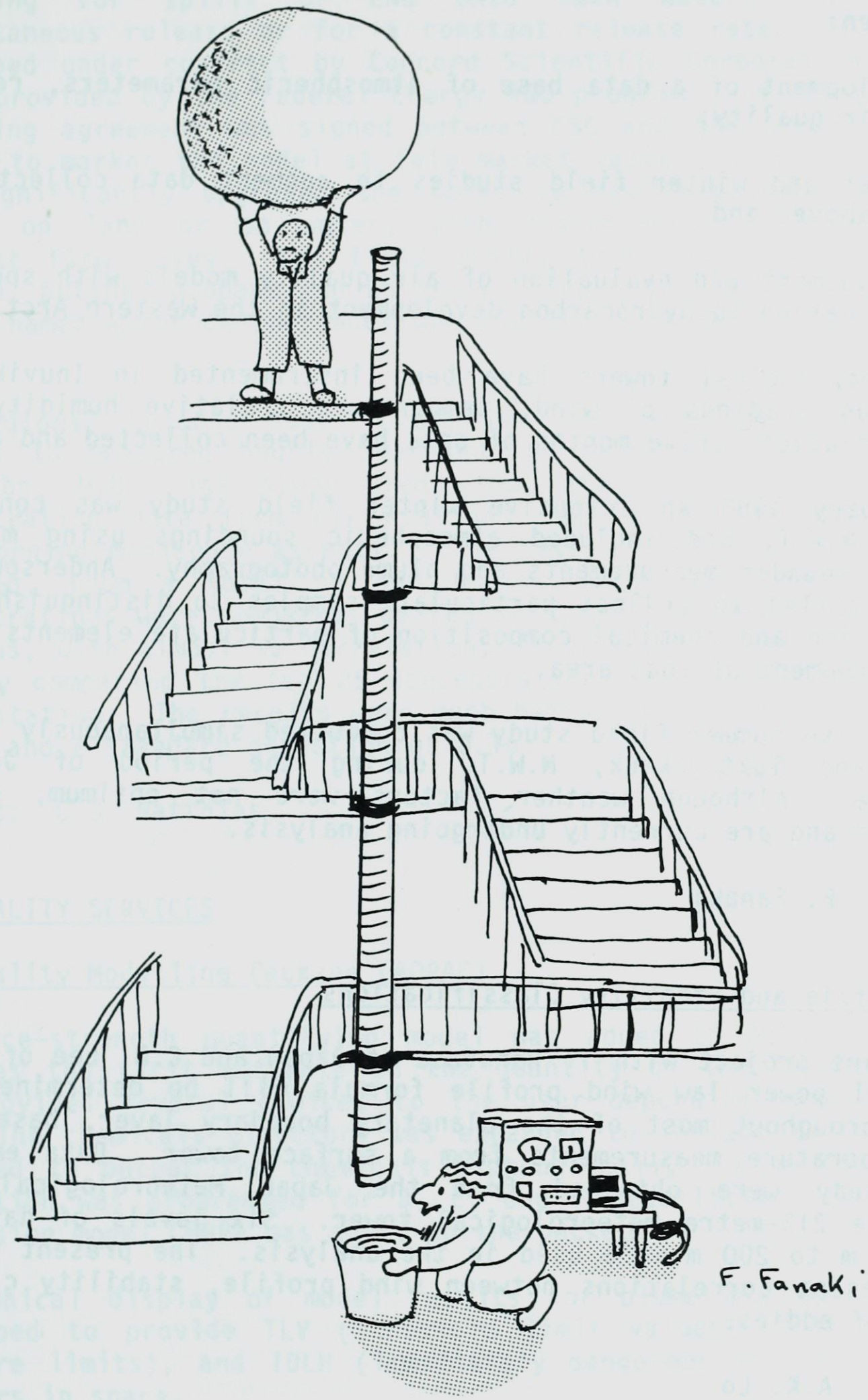
Another form of near-surface mixing occurs in the presence of rain in which a vortex ring carries and diffuses the drop mass through the upper layer. Again it is conceptually possible to monitor this exchange process acoustically. A facility, involving a vertical tunnel in a stairwell (see page 31), was set up to characterize the sound of solid spheres and water drops entering water at terminal velocity. Interesting results have been obtained on the acoustic emission in relation to drop size and could result in the rain rate on a lake or ocean to be monitored acoustically.

An ongoing aspect of the entrainment, enrichment and exchange processes associated with breaking waves has been the statistical nature of their occurrence in nature. Fine scale, spectrally responsive measurements were obtained using a scanning spectro-radiometer mounted in an aircraft flying over the ocean. Initial examination of these limited cases indicates only modest improvement over previous data sets. A new method involving the so-called fractual geometry has been examined for potential application with the data set.

Contact: B.R. Kerman

3.4.12 Northern Oil and Gas Action Program (NOGAP)

NOGAP is an intensive environmental impact assessment of the effects of the expansion of hydrocarbon exploration and production (development) in the Beaufort Sea/Mackenzie Delta area.



Bryan, do you want me to drop it now?

The overall objective of Project C.19 (Beaufort Sea Air Quality) is the assessment of the environmental impact of air pollutant emissions associated with the increased activity of hydrocarbon development in this area. To meet this objective, the following projects were undertaken:

(1) development of a data base of atmospheric parameters, related to air quality;

(2) summer and winter field studies to augment data collected in (1) above; and

(3) development and evaluation of air quality models with specific application to hydrocarbon development in the Western Arctic.

Two meteorological towers have been instrumented in Inuvik to give continuous readings of wind, temperature, relative humidity and net solar radiation. Five months of data have been collected and analyzed.

In February 1985 an intensive winter field study was conducted in Inuvik, N.W.T. and included atmospheric soundings using minisondes, acoustic sounder measurements and plume photography. Anderson samplers were installed to collect particulate samples to distinguish the size distribution and chemical composition of particulate elements common to the environment of that area.

An intensive summer field study was conducted simultaneously in Inuvik, N.W.T. and Tuktoyaktuk, N.W.T. during the period of July 13-25 inclusive. Although weather factors were not optimum, data were collected and are currently undergoing analysis.

Contact: F. Fanaki

3.4.13 Wind Profile and Stability Classifications

In a joint project with T. Hanafusa of Japan and C.B. Lee of Korea, an empirical power law wind profile formula will be determined that is valid throughout most of the planetary boundary layer, based on wind and temperature measurements from a surface tower. Data employed in this study were obtained from the Japan Meteorological Research Institute 213-metre meteorological tower. Six levels of data ranging from 10 m to 200 m were used in the analysis. The present study will also present correlations between wind profile, stability classes and shapes of eddies.

Contact: A.K. Lo

3.4.14 Gaussian and Heavy Gas Modelling

As of April 1, 1985, the LNG (liquidified natural gas) spill model was operating for spills of LNG onto open water, for either an instantaneous release or for a constant release rate. The model was developed under contract by Concord Scientific Corporation (CSC) with funds provided by the Federal Energy R&D program. In the past year, a licensing agreement was signed between CSC and the Crown, giving CSC rights to market the model at fair market value. During the year, CSC has significantly upgraded the model to handle bounded or unbounded spills on land or on water, with instantaneous, time-varying, or constant flow rates. The fluid spills that have been modelled are methane, butane, propane and chlorine. The model is now referred to as COBRA, named after Colenbrander who did the original development of the model.

The Regional Episode Model (REM) was evaluated by comparing model results to measured hourly averaged SO_2 concentrations in and around St. John, N.B. The study used wind data from six local stations, concentration data from six stations, and mixing heights determined from morning minisonde ascents. Five days of data in each season were selected, from a total of 480 hours. When modelled and measured concentrations were compared, paired in space and time, the scatter was enormous, with almost no correlation. A very brief additional test was made by comparing the top 25 concentrations, not paired in time, at a given station. The results were much better, with a fractional bias of -0.01, and a standard deviation of 0.16.

Contact: C.S. Matthias.

3.5 AIR QUALITY SERVICES

3.5.1 Air Quality Modelling Package (AQPAC)

A source-strength quantifying model was added to AQPAC. This model provides the first estimate on the quantity of the chemical released and provides several choices to the user depending upon the type of leak. The chemicals directory was expanded to include 34 chemicals and modified to output the chemicals alphabetically. A mixed layer depth estimation was programmed for D, E, and F stabilities. The heavy gas dispersion model COBRA was added to the package.

A graphical display of model results for plume and puff models was developed to provide TLV (threshold limit values), STEL (short term exposure limits), and IDLH (immediately dangerous to life and health) contours in space.

Barry Atkinson (AES Central Region) bullet-proofed, restructured and made bilingual the plume model of version-3 to improve usability. All regions have received this version.

Contact: S.M. Daggupaty

3.5.2 Model Evaluation

The EPRI-Kincaid field experimental data base, consisting of about 280 cases of continuous releases of SF6 tracer was used to evaluate AQPAC models. Model concentrations were calculated and compared with observed results. Pattern analysis of modelled concentrations and observed concentrations for about 30 selected cases is complete. The general area of maximum concentration between observed and modelled concentration for these cases seems to be reasonable. Further analysis of results under different stability stratifications leads to this tentative conclusion. Generally, the model over-predicts the maximum concentration under all stability classes. Under C and D stability classes, the agreement between observed and modelled concentrations is relatively better (far less than a factor of 2). There are not enough cases of E and F stability classes for analysis and further statistical tests and analysis are required.

Experiments were carried out with the mesoscale forecast trajectory model. The constant velocity algorithm was replaced with the constant acceleration algorithm for the computations of trajectories. The model is still deficient in simulating mesoscale features.

Contact: S.M. Daggupaty.

3.5.3 Environmental Emergencies

A task force to recommend an all-weather sounding system for response to environmental emergencies was formed. The most important parameters for use in the models were determined. Several sounding systems were reviewed and the Beukers system was determined to be the most appropriate at the present time.

3.5.4 Environmental Impact Assessment (EIA)

A user guide has been prepared for the UNAMAP dispersion models on the AS/6 computer and these have been distributed to the regional offices.

The COBRA model was made available for use in an environmental impact assessment involving the shipping of butane on the St. Lawrence River. COBRA calculates the location of the toxic or flammable boundary of a heavy gas cloud as it drifts downwind.

Two EIA's describing a proposed Ocelot Ammonia plant in British Columbia were reviewed. Model calculations were done in support of the local AES and EPS offices and for BC Environment.

Contact: C.S. Matthias

Quick! Send me to the cleaners. I have a spot on my jacket.

(Editor's note: Environmental Emergency?)

3.5.5 Beukers Upper Air Sounding

The Beukers upper air navaid system which was purchased in Jan/85 was used to support the AGASP March/85 study at Alert and the NOGAP summer study at Inuvik, N.W.T. The Omega navaid buffer was used in Alert while both the Loran and the Omega buffers was used successfully in Inuvik. Two weeks were spent releasing test flights at MRS Woodbridge in May/85 and again in Jan/86. The soundings were used to evaluate and modify the system by replacing the IBM-PC with a COMPAQ Plus to make it more portable. Further software revisions and development is expected to enhance the systems wind reporting capabilities.

Technical Team: F. Froude, J. Kovalick, R. van Amerom

4. WEATHER SERVICES REGIONAL AIR QUALITY REPORT

4.1 Long Range Transportation of Air Pollutants (LRTAP)

4.1.1 The Pacific Region collected precipitation samples for approximately 30 events from their 13-station South Coast B.C. network and will evaluate these data to ascertain the effect of the closing of a major emitter in southern Washington State.

Contact: R.R. McLaren

Under contract ($16,513.00), Cirrus Resource Consultants Ltd. completed a study on the background sulphate concentrations in precipitation along the B.C. Coast.

Contact: Don Faulkner

4.1.2 The Western Region was involved in continued operation of the Northwest Territories precipitation event sampling network.

Bruce Thomson co-chaired with Randy Angle (Alberta Environment) a Task Force on Mesoscale Monitoring and Modelling. Over 100 models, that are appropriate for Western Canada, were evaluated. A report was submitted to the Western LRTAP Technical Committee (WLTC) and, as a result, a contract was let to Concord Scientific to implement statistical Long Range Transport (LRT) models on the AES computer (AS/6).

The Cray computer was used to evaluate the AES LRT model with respect to the model's performance over high terrain. A sulphur deposition modelling study was completed using 1982 scenario data.

Western Region drafted an acid rain fact sheet which was reviewed by WLTC and submitted to the Communications Directorate for publishing. Bruce Thomson participated in a meeting of Western Governor's Association on LRTAP matters (Denver, Colorado).

Contact: Bruce Thomson

4.1.3 The Central Region has completed calculations on precipitation chemistry data in Manitoba and Saskatchewan. This information will be given to Bruce Thomson (Western Region) who is preparing a report that analyzes and evaluates precipitation data in Western Canada. Central Region has also provided comments to Western Region on a draft report on LRT modelling in Western Canada. Data have been collected in Regina to compare the hydrometeorology of the CANSAP and CAPMoN collectors. An interim report has been written.

Contact: Ron Hopkinson

Five-day back trajectories for 1984 were calculated for the province of Manitoba for their five precipitation monitoring sites. The procedure reported in AQRB-85-006-T was used.

Contact: Bob Tortorelli

4.1.4 Ontario Region conducted a case study of the extreme deposition episodes at Chalk River (Ontario) in 1982. The objectives were to determine the meteorological conditions for high deposition episodes and to analyze the relationships between the source and the receptor. The case study used an extreme wet deposition episode where the deposition values of $SO_4^{=}$, NO_3^{-} and H+ were largest. Backward air trajectories were computed and the synoptic weather conditions were analyzed. The Region is preparing an internal report describing the methodology and the results.

Contact: Dr. S. Bhartendu

4.1.5 Quebec Region analyzed the data from the provincial precipitation chemistry network. It was found that the spatial representativeness of the mean monthly pH was not well correlated. There was a stronger correlation for the spatial representativeness of precipitation depth. The Region continues to prepare and distribute the monthly bulletin indicating the pH and the associated trajectories in the pH monitoring network.

Contact: Richard Laurence

4.1.6 Atlantic Region prepared and distributed a report that evaluated the precipitation chemistry networks in the Atlantic Region. This report recommended changes to siting and procedures that could be instituted to improve the networks. A summary was presented to the annual meeting of the Atlantic Region LRTAP Monitoring and Effects Working Group.

The Region prepared an annotated bibliography of published and unpublished literature that is relevant to acid precipitation studies in the region. A brief report on the pH of rain and snow events for 16 months beginning January, 1984, at Kejimkujik was prepared.

Billie Taylor represented the AES Atlantic Region on the Atmospheric Sciences Subgroup of RMCC and attended the International Symposium on Acidic Precipitation (Muskoka, Ontario).

Contact: Billie Taylor

4.2 Toxic Chemicals

4.2.1 The Atlantic Region installed equipment and trained provincial staff to collect meteorological data for the Nova Scotia spruce budworm spraying program.

B. Taylor represented AES on the Atlantic Region Pesticides Advisory Committee (ARPAC) and on the Regional Toxics Chemicals Committee (RTCC). J. Dublin represented AES on the Environmental Monitoring of Forest Control Operations Committee (EMOFICO).

Contact: Billie Taylor

4.2.2 Representatives from the Central Region attended the regional Toxic Chemicals Management Workshops, the public hearings on toxic waste management in Manitoba and a seminar on toxic wastes in Manitoba.

Lectures, handouts and exam questions were provided to the provincial licensing courses for Forest Spraying Applicators, Rights of Way Applicators and Aerial Applicators.

Contact: Barrie Atkinson

4.2.3 The Pacific Region completed the analysis of PAH measurements made in Greater Vancouver in 1984/85 and wrote an internal report on the results.

Contact: Don Faulkner

4.3 Oxidants

4.3.1 Don Faulkner (Pacific Region) presented a conference paper on oxidant modelling in the Vancouver area.

4.4 Environmental Emergency Preparedness and Response

4.4.1 The Atlantic Region gave briefings on weather conditions after an explosion at the Imperial Oil refinery in Dartmouth on July 13,1985. There were concerns that there would be a release of toxic gases but, actually, only a minute amount was released.

The Region responded to an environmental emergency near Yarmouth (Nova Scotia) in October, 1985, by providing weather information and dispersion calculations (AQPAC). The emergency involved a 5-ton transport truck carrying drums of sodium cyanide pellets but, fortunately, no spillage occurred.

Contact: R. Nelis or W. S. Appleby

4.4.2 The Quebec Region has acquired from EPS information packages that give tips on the problems of chemical spills. To improve operating conditions in cases of environmental emergencies, the Region is considering dedicating an area in the office solely for this function. The Region participated in the 3rd annual Technical Seminar on Chemical Spills.

The PUFF module of AQPAC is being evaluated. The Region has prepared an internal bulletin called Info-AQPAC. An introductory course on the use of AQPAC has been given to new meteorologists in the Quebec Region.

Contact: Richard Laurence

4.4.3 When a small amount of dimethyl benzene was accidently spilled in a rail yard at Sault Ste. Marie, Ontario Region used AQPAC to model the dispersion of the evaporating substance.

The Region provided support to a Gulf Canada water surface spill exercise in May, 1985. The motion of the spill material on Lake Ontario was tracked and the model outputs, including those from SLICK, were verified.

A Quick Reference Guide to AQPAC was prepared and used as a basis for a series of AQPAC training seminars. The Region gave these seminars to Ontario Weather Centre meteorologists and Toronto Weather Office supervisors.

Peter Chen attended a one-day course on "Practical Planning for Toxic Gas Releases" by Trinity Consultants at which course notes were provided. A report on the course has been prepared. The 3rd Technical Seminar on Chemical Spills was attended by Peter Chen. Proceedings were provided and the Region has prepared a report.

Contact: Peter Chen

4.4.4 In early December, the Central Region's emergency procedures were tested due to a railway derailment in western Manitoba involving cars carrying butane. Although no spill occurred, the Region decided to use this incident as an exercise. The exercise revealed some confusion and shortcomings. A revision to the Regional Environmental Emergency Response Plan is being prepared.

Central Region participated in an agricultural emergency exercise held by the Manitoba and Federal Departments of Agriculture. The exercise considered that the disease virus could be borne through the atmosphere. Trajectories, dispersion estimates, and actual and forecasted weather were provided to the exercise in real-time. The Region also provided comments on the exercise.

The Region worked with the Branch to make AQPAC bulletproof, bilingual and user-friendly. Version 3 programs (A3PAC, A3AID and A3IFM) are complete and documented. Now it is not necessary to load all programs into memory in order to run the package. In the event of an actual emergency, the programs can be run with a higher priority. Work continues on the documentation of A3CPS and the use of weather data from specials as well as from hourly data. The Hazard Research Group (University of Manitoba) has received a contract ($250k) from DND to develop a package similar to AQPAC. This Group has visited the Region to see a demonstration of AQPAC and to discuss its features. A poster session presentation on AQPAC was made at the Operational Meteorological Workshop in Winnipeg.

A presentation was made to the Statistical Association of Manitoba on the statistical models used in dispersion work, and on the estimation of the statistical parameters used in them.

Contact: Barrie Atkinson

4.4.5 The Western Region responded to an oil spill from Esso's Minuk artifical island in the Beaufort Sea. The SLICK model was implemented and used during the Minuk episode in support of the COGLA mandate. A report was prepared and distributed. The Western Region Emergency Response Plans have been updated for Alberta and for the Arctic.

Contact: Bruce Thomson

4.4.6 A rail car filled with liquified sulphur dioxide overturned near Williams Lake in November, 1985. Fortunately, the tank did not rupture but, at the request of EPS, the Pacific Region provided advice on the dispersion of the gas in this potential emergency.

The updated versions of AQPAC were installed on the regional mini-computer.

Contact: Don Faulkner

4.5 Environmental Assessment and Review Process (EARP)

4.5.1 Pacific Region (SSD) served on the Regional Screening and Co-ordinating Committee (RSCC) and on three Task Forces. The Region reviewed the preliminary assessments of two projects in which air quality or the dispersion of toxic or flammable gas was a concern.

4.5.2 The Western Region continued their participation in AWAC, RSCC and 5 sub-committees. The significant projects were the review of Polargas and the follow-up to the Beaufort Panel report that included the coordination and implementation of NOGAP projects.

4.5.3 Three of Central Region's staff were active on the RSCC and its sub-committees. Ron Hopkinson was chairman of the "South of 60° Mining" sub-committee and prepared their annual report. Regional procedures for EARP screening were developed and implemented.

The Region reviewed the AES EARP Guidelines and the Initial Assessment Guide to the Federal EARP.

The Region reviewed the following EIS's:

- Husky Heavy Oil Upgrader (Lloydminister)
- Newgrade Heavy Oil Upgrader (Regina)
- Risk Assessment for Accidental Release of Toxic Chemicals (Regina Rail Relocation Office)
- Waterbury Lake (Cigar Lake) Environmental Baseline Studies Report
- Husky Aberfeldy Steamflood Project (oil recovery)
- Limestone Generating Station Discussion Papers (in lieu of EIS)

4.5.4 The Ontario Region was active on the OSCC and its sub-committees. They initiated jointly with EPS (Ontario Region) the Port Hope Meteorological Study. This follow-up activity is to validate meteorological data used as a basis for EIS and site approval for ERL uranium refinery expansion at Port Hope. The data collected from the observational program (late 1983 - March, 1986) have been routinely checked and archived. Basic analyses were performed and an interim report was prepared. The final report will be prepared in 1986/87.

The Region reviewed the following documents:

- EPS Technical Guide (Screening of Marine Development in Ontario)
- Moosonee Airport Improvement (IEE)
- Derived Release Limits Verification Study, ERL, Blind River
- Great Lakes Connecting Channels and Harbours, draft EIS
- CHINTEX Model Documentation (Revised Volume 1)
- Welcome and Port Granby Decommissioning Engineering Feasibility Studies and Environmental Pathways Analysis: Report #5
- Consumer's Gas LNG Storage Report: Site Selection and Environmental Assessment
  - Phase 1 (Initial Site Screening)
  - Phase 2 (Preferred Site Selection Summary)
  - Exhibit 6/Schedule 2 (Preferred Site Selection)
- City of Belleville Ice Management Plan: Environmental Assessment
  - Phase 1 (Ice Control Structures)
- Collingwood Airport Expansion (IEE)
- Carlton Waste Management Master Plan (Regional Municipality of Ottawa)

- Toronto Transit Commission Harbourfront LRT
- CN Railway Lands (Precinct "A") Environmental Report
- Kincardine Airport Expansion
- Ontario Waste Management Corporation - Phase 4A Site Selection Documents (3)
- Timber Management or Crown Lands in Ontario

4.5.5 The Chief of Scientific Services (Quebec Region) chaired a sub-committee on risk analysis and environmental consequences of a project to import bulk liquified butane. This evaluation was based on the TERMPOL procedures of the Canadian Coast Guard.

The EARP regional directives for AES projects in the Quebec Region are being revised.

Contact: Richard Laurence

4.5.6 The Atlantic Region made a significant contribution in support of the Hibernia Development Project. The Region attended public meetings, the Working Group meetings to prepare the Panel presentations and the Working Group meetings with the Project Environmental Assessment Panel. The Development Project EIS was reviewed and the AES comments were rolled up by the Region. The Region prepared the AES portion of Environment Canada's review of the Hibernia Environmental Assessment Panel Project. The draft of Environment Canada's position paper on the project and their submission to the Hibernia Offshore Panel were reviewed by the Region.

The Region reviewed the following documents:

- COGLA's Technical Evaluation of Environmental Issues on Georges Bank
- Coleson Cove Coal Conversion (EIS)
- New Brunswick - Prince Edward Island link (proposal)
- Mobil Venture Development Project: Meteorological and Oceanographic Criteria Study
- B.P. Resources Ltd. East Coast Contigency Plan (Volumes I, II and III)

The Region prepared a briefing paper on AES services to the offshore industry and a submission on RSCC Terms of Reference and FEARO guidelines for the Environmental Assessment and Review Process (EARP). The Region developed and implemented regional guidelines to ensure that regional projects, programs and activities are screened under EARP.

Contacts: J.O. Bursey (Bedford, N.S.) or
S. Porter (St. John's, Newfoundland)

4.6 Air Quality Services

The Regional Scientific Services Divisions provided support for various activities. Some of these activities are summarized here.

4.6.1 The Quebec Region evaluated for Fisheries and Oceans a submission for a study on the air quality at the port of Sept Isles.

4.6.2 Staff of the Ontario Region attended the "Canada-Ontario Agreement (COA)" meetings, the annual ARD/WSD meeting on Air Quality Services and the International Symposium on Acidic Precipitation (Muskoka, Ontario).

4.6.3 The Central Region attended the APCA/CPANS (Canadian Prairies and Northern Section) Technical Workshops in Winnipeg and Regina.

4.6.4 The Western Region, in conjunction with Whitehorse Weather Centre and this Branch, continued evaluation of the woodsmoke problem in Whitehorse. The Region participated in the panel that evaluated the response to the 1982 Lodgepole Blowout and the resultant ERCB recommendations. B. Thomson implemented a mixing height model on the HP1000.

4.6.5 The Pacific Region provide consultation on air parcel trajectories for acid rain research and on hourly data for input to dispersion models.

4.6.6 The Atlantic Region provided advice and technical assistance to the New Brunswick government for their sulphate deposition study around Saint John, N.B. A joint project with Nova Scotia Environment, EPS and Texaco was initiated to investigate modelling of atmospheric discharges from local Halifax industries.

4.7 Publications

4.7.1 Journal Publications

McBean, G.A. and S. Nikleva, 1986: "Composition of Snow in Pacific Coastal Mountains." Atmospheric Environment (accepted for publication).

Taylor, B.L., 1984: "Acid Rain and Snow at Kejimkujik, Nova Scotia." Chinook, 6, 79.

4.7.2 Internal Reports

Cirrus Resource Consultants Ltd., 1986: "Background Concentrations of Sulphate in Precipitation along the B.C. Coast." Report PAES 86-1.

Fanaki, F. and B.L. Taylor, 1986: "A Field Study of Plume Dispersion from Tufts Cove Power Generating Station in Nova Scotia."

Faulkner, D.A., 1985: "Atmospheric Concentrations of Polycyclic Aromatic Hydrocarbons (PAH) in Greater Vancouver." Report PAES 85-1.

McLaren, R.R., 1985: "Lower Mainland and South Coast B.C. Precipitation Chemistry Data." Report PAES 85-2.

Taylor, B.L., 1985: "Atlantic Provinces Precipitation Chemistry Evaluation Project." Report MAES 3-85.

Taylor, B.L. (ed.), 1985: "Report of the Fall 1985 Workshop of the Atlantic Region LRTAP Monitoring and Effects Working Group."

Taylor, B.L., (ed.), 1986: "An Annotated Bibliography of Documentation Relevant to Acid Precipitation in Atlantic Canada."

4.7.3 Conference Papers

Faulkner, D.A., 1985: "A Case Study of Elevated Oxidant Levels near Vancouver, B.C." 1985 Joint Annual Meeting of Canadian Prairie and Northern Section, and Pacific Northwest International Section of Air Pollution Control Association, 13-15 November, Calgary, Alberta.

Faulkner, D.A., 1986: "Acid Rain in British Columbia". Environmetrics Seminars sponsored by the Department of Statistics, University of British Columbia, 13 February, Vancouver, B.C.

5. PUBLICATIONS

5.1 Journal Publications

Anlauf, K., J. Bottenheim, K. Brice, P. Fellin, H.A. Wiebe, H. Schiff, G. Mackay, R. Braman and R. Gilbert, 1985: "Measurements of Atmospheric Aerosols and Photochemical Products at a Rural Site in SW Ontario." Atmos. Environ., 19, 1859-1870.

Barrie, L.A. and R.M. Hoff, 1985: "Five Years of Air Chemistry Observations in the Canadian Arctic." Atmos. Environ., 19, 1995-2010.

Barrie, L.A., D. Fisher and R.M. Koerner, 1985: "Twentieth Century Trends in Arctic Air Pollution revealed by Conductivity and Acidity Observations in Snow and Ice in the Canadian Arctic." Atmos. Envir., 19, 2055-2063.

Barrie, L.A., D.A. Fisher, R.M. Koerner and D.M. Whelpdale (Assoc. Eds.)., 1985: Proceedings of the Symposium on Snow and Ice Chemistry and the Atmosphere, Annals of Glaciology, 7, Peterborough, 19-24 August 1984, 215 pp.

Barrie, L.A., 1985: "Atmospheric Particles: Their Physical and Chemical Characteristics and Deposition Processes relevant to the Chemical Composition of Glaciers." Annals of Glaciology, 7, 100-108.

Barrie, L.A., 1985: "Features of the Atmospheric Cycle of Aerosol Trace Elements and Sulphur Dioxide revealed by Baseline Observations in Canada." J. Atmos. Chem., 3, 139-152.

Crutzen, P.J., D. Kley, L.A. Barrie and D.M. Whelpdale, 1985: "The Cycling of Sulphur and Nitrogen in the Remote Atmosphere." Chapter 10 in The Biogeochemical Cycling of Sulphur and Nitrogen in the Remote Atmosphere (eds. J.N. Galloway, R.J. Charlson, M.O. Andreae and H. Rodhe), NATO Advanced Study Institute Series, Reidel, Dordrecht, 203-212.

Davidson, C.I., S. Santhanam, R.C. Fortmann and M.P. Olson, 1985: "Atmospheric Transport and Deposition of Trace Elements onto the Greenland Ice Sheet." Atmos. Environ., 19, 2065-2081.

Grace, B., T.J. Gillespie and K.J. Puckett, 1985: "Uptake of Gaseous Sulphur Dioxide by the Lichen Cladina rangiferina." Can. J. Bot., 63, 797-805.

Grace, B., T.J. Gillespie and K.J. Puckett, 1985: "Sulphur Dioxide Threshold Concentration Values for Cladina rangiferina in the Mackenzie Valley, NWT." Can. J. Bot., 63, 806-812.

Higuchi, K. and S.M. Daggupaty, 1985: "On variability of atmospheric CO_2 at Station Alert." Atmos. Environ., 19, 2039-2044.

Hoff, R.M. and L.A. Barrie, 1986: "Air Chemistry Observations in the Canadian Arctic." Water Sciences and Technology,

Hoff, R.M. and A.J. Gallant, 1985: "The Use of an Available SO_2 Tracer during the 1983 CAPTEX Experiment." Atmos. Environ., 19, 1573-1575.

Isaac, G., W. Leaitch, J.W. Strapp and K. Anlauf, 1985: "Summer Aerosol Profiles over Algonquin Park, Canada." Atmos. Environ., 20, 157-172.

Lo, A.K., 1986: "On the Boundary-layer Flow over a Canadian Archipelago Polynya." Boundary Layer Meteor., 35, 53-71.

Miller, J.M., D.M. Whelpdale, H. Rodhe, L.A. Barrie, I.S.A. Isaksen and F.B. Smith, 1985: Working Group Report. Chapter 7 in The Biogeochemical Cycling of Sulphur and Nitrogen in the Remote Atmosphere (Eds. J.N. Galloway, R.J. Charlson, M.O. Andreae and H. Rodhe), NATO Advanced Study Institute Series, Reidel, Dordrecht, 127-139.

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Schroeder, W.H., R.A. Jackson, 1985: "An Instrumental Analytical Technique for Speciation of Atmospheric Mercury." Intern. J. Environ. Anal. Chem., 22, 1-18.

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Stensland, G.J., D.M. Whelpdale and G.O. Oehlert, 1986: "Precipitation Chemistry." Chapter 5 in Acid Deposition: Long-Term Trends, National Academy Press, Washington, 128-199.

Sturges, W.T. and R.M. Harrison, 1985: "Bromine: Lead Ratios in Airborne Particles from Urban and Rural Sites." Atmos. Environ., 20, 577-588.

Sturges, W.T., R.M. Harrison and R. Dams, 1985: "Development of a Technique for the Determination of Lead and Bromine in Atmospheric Particles by X-ray Fluorescence." Atmos. Environ., 19, 1495-1502.

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Taylor, P.A., J.L. Walmsley and J.R Salmon, 1985: "Guidelines and Models for Estimating Wind Speeds at WECS Sites in Complex Terrain." Proceedings of INTERSOL '85 Conference, Montreal. Internat. Solar Energy Soc.

Walmsley, J.L. and A.D. Howard, 1985: "Application of a Boundary-layer Model to Flow over an Eolian Dune." J. Geophys. Res., 90, 10631-10640.

Walmsley, J.L., P.A. Taylor and J.R. Salmon, 1985: "Boundary-layer Studies of Winds Over Islands with Applications to Surface Wind Data from Grindstone Island (Iles-de-la-Madeleine) and Sable Island." Proc. Internat. Workshop on Offshore Winds and Icing, Halifax, Nova Scotia, Oct. 7-11, 1985, eds. T.A. Agnew and V.R. Swail, 165-174.

Young, J.W.S. and R.W. Shaw, 1986: "A Proposed Strategy for Reducing Sulphate Deposition in North America - I. Methodology for Minimizing Sulphur Removal." Atmos. Environ., 20, 189-199.

Zakshek, E.M., K.E. Percy and K.J. Puckett, 1985: "Deposition Patterns of Lead, Sulphur and other Elements in Eastern Canada as Monitored by the Lichen, Cladina rangiferina." International Conference on Heavy Metals in the Environment (Edited by T.D. Lekkas), CEP Consultants Ltd., Edinburgh, U.K., II, 578-581.

5.2 Internal Reports

AQRB: Air Quality and Inter-Environmental Research Branch Annual Report 1984-85, AES Report AQRB-85-M-002, April 1985

ARQM: Operator's Instruction Manual - Precipitation, April 1985.

ARQM: Site Operations Reference Manual - Precipitation, April 1985.

ARQM: CAPMoN Precipitation Sampling Instruments Operation and Maintenance Manual, April 1985.

ARQM: Inspector's Reference Manual - Precipitation, April 1985.

Bottenheim, J., K. Brice, D. MacTavish and H.A. Wiebe, 1985: "Data Summary of 1984 Summer Experiments at AES Headquarters, Downsview." AES Report AQRB-85-007-T.

Fanaki, F., B. Martin and J. Markes, 1986(a): "NOGAP Arctic Meteorological Tower." NOGAP Report No. 1, C-19.

Fanaki, F., B. Martin and J. Markes, 1986(b): "Inuvik NOGAP Winter Field Study." NOGAP Report No. 2, C-19.

Hoff, R.M: "Project Overview of the 1982 Nanticoke II Shoreline Diffusion Experiment." AES Report AQRB-85-003-T.

Olson, M.P., A. Panigas, K.K. Oikawa, 1985: "A Users Guide to the Interactive Trajectory Computation and Plotting System (ITCAPS)." AES Report AQRB-85-006-T.

Salmon, J.R. and J.L. Walmsley, 1986: "User's Guide to the MS3DJH/3R Model." AES Report AQRB-86-I-2, 43pp.

Turner, H.E., 1985: "Environmental Risk Management: An introduction." AES Report AQRB-85-M-007, 15 pp.

Vet, R.J., W.B. Sukloff, M.E. Still and R. Gilbert, 1986: "CAPMoN Precipitation Chemistry Data Summary 1983-1984."

Wiebe, H.A., R.J. Vet, L.A. Barrie and K. Anlauf, 1985: "Canadian Air and Precipitation Monitoring Network (APN) Final Data Report December 1982-1983." AES Report AQRB-85-008-T.

5.3 Conference Papers and Presentations

Anlauf, K., J. Bottenheim, K. Brice and H.A. Wiebe: Comparison of Summer and Winter Measurements of Atmospheric Nitric Acid, PAN and Aerosol Nitrate. International Symposium on Acidic Precipitation, Muskoka, Canada, September 15-20, 1985.

Atkinson, G.B. and S.M. Daggupaty: Air Quality Package of Programs for Environmental Emergencies. Poster paper and hands-on demonstration of AQPAC at AES/CMOS Operational Meteorology Workshop, Winnipeg, February 4-6, 1986.

Bagg, D. and C.S. Matthias: Evaluation of a Multiple Source Regional Episode Model. 19th Annual CMOS Congress, Montreal, June 12-14, 1985.

Barrie, L.A.: Background Pollution in the Arctic Air Mass and its relevance to North American Acid Rain Studies. International Symposium on Acidic Precipitation, Muskoka, Canada, September 15-20, 1985.

Barrie, L.A. and A. Sirois: Wet and Dry Deposition of Sulphates and Nitrates in Eastern Canada (1979-1982). International Symposium on Acidic Precipitation, Muskoka, Canada, September 15-20, 1985.

Bottenheim, J., K. Anlauf and H.A Wiebe: Long-term Measurements of Atmospheric Peroxyacetylnitrate (PAN) at Rural Sites in Southern Ontario and Nova Scotia. 27th Rocky Mountain Conference, Denver, Colorado, July 14-18, 1985.

Bottenheim, J., K. Anlauf, K. Brice and H.A. Wiebe: The Effect of the Seasonal Variation of Solar Radiation on the Chemistry of Acid Rain. 12th International Conference on Photochemistry, Tokyo, Japan, August 1985.

Christie, A.D.: Evaluation of Comprehensive Acid Deposition Models - A Review. Keynote paper at 19th Annual CMOS Congress, Montreal, June 12-14, 1985.

Christie, A.D. et al.: Some Results from a Comprehensive Acid Deposition Model. International Symposium on Acidic Precipitation, Muskoka, Canada, September 15-20, 1985.

Daggupaty, S.M.: Operational Models for use in Response to Accidental Releases of Pollutants into the Atmosphere. Workshop on Real Time Computing of the Environmental Consequences of an Accidental Release to the Atmosphere from a Nuclear Installation, Luxembourg, September 17-20, 1985.

Fanaki, F.: Atmospheric Transport of Heavy Metals - A Review. Conference on Heavy Metals in the Environment, Athens, Greece, September 1985.

Fanaki, F., B. Martin and J. Markes: Arctic Air Quality Study in the Beaufort region. 14th Arctic Workshop, Bedford, N.S., November 1985.

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Fanaki, F., and B. Martin: NOGAP - Arctic Air Quality Study - C-19. Seminar at AES Western Region, 1985

Galloway, J.N., T.M. Church, A.H. Knap, D.M. Whelpdale and J.M. Miller: The Western Atlantic Ocean Experiment (WATOX): Advection, Deposition and Fate of Atmospheric Emissions from North America to the Western Atlantic. AGU Fall Meeting, San Francisco, December 1985 (Presented by J.N. Galloway).

Goodison, B.E., P.Y.T. Louie and J.R. Metcalfe, 1985: Field and Modelling Investigations of Snowmelt Acidic Shock Potential in South Central Ontario. International Symposium on Acidic Precipitation, Muskoka, Canada, September 15-20, 1985.

Hanafusa, T., C.B. Lee and A.K. Lo: Dependence of the Power Law Wind Profiles on Stabilities and Roughness Length. 1st International Conference on Atmospheric Sciences and Applications to Air Quality, Seoul, Korea, May 20-24, 1985.

Hoff, R.M.: Synopsis of Design of the AES SO_2-O_3 DIAL. 1st International DIAL Data Collection and Analysis Workshop (E. Browell ed), NASA Langley Research Centre, Hampton, VA., U.S.A., November 1985.

Hoff, R.M. and L.A. Barrie: Implications of Visibility Reductions by Man-made Aerosols. Annex to No. 14, WMO/TD #59, Environmental Pollution Monitoring and Research Program #31, WMO, Geneva, 1985.

Hoff, R.M. and L.A. Barrie: Air Chemistry Observations in the Canadian Arctic. Keynote paper at the International Conference on Arctic Water Pollution, Yellowknife, N.W.T., May 1985.

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Lane, D.A. and D.M.A. McCurvin: A Personal Computer Database for the Chemical, Physical and Thermodynamic Properties of Polycyclic Aromatic Hydrocarbons. 10th International Symposium on Polynuclear Aromatic Hydrocarbons, Battelle Laboratories, Columbus, Ohio, October 21-23, 1985.

Lane, D.A. and S.W.D. Jenkins: Quantitative Assessment of the Desorption of PAH from Particulate Matter in a Resonant Microwave Cavity. 10th International Symposium on Polynuclear Aromatic Hydrocarbons, Battelle Laboratories, Columbus, Ohio, October 21-23, 1985.

Matthias, C.S. and A.K. Lo: Application and Evaluation of the Fay and Rosenzweig Long Range Transport Model. 1st International Conference on Atmospheric Sciences and Applications to Air Quality, Seoul, Korea, May 20-24, 1985.

Munn, R.E., D.M. Whelpdale, G.W. Oehlert, P.W. Summers: The Detection of Sulfur Emissions Reductions using Wet Deposition Measurements. International Conference on Atmospheric Sciences and Applications to Air Quality, Seoul, Korea, May 20-24, 1985 (Presented by L.A. Barrie).

Ogram, G.L., S.C. Wright, S. Daggupaty and P.K. Misra: An Atmospheric Dispersion Modelling System for Nuclear Emergency Response. 6th Annual Conference of Canadian Nuclear Society, Ottawa, June 2-5, 1985.

Puckett, K.J.: Sulphur Deposition and Lichen Sulphur Levels in Eastern Canada. Industrial Ecology Group, British Ecological Society, Bristol, U.K., April 1-4, 1985

Summers, P.W.: Sourcing and Deposition of Acid Rain - A Review of Atmospheric Processes. Workshop on Acid Rain - The Current State of Knowledge, St. Mary's University, Halifax, N.S., April 30 - May 1, 1985.

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Summers, P.W.: Acid Deposition - An Overview of Atmospheric Processes. Briefing Presentation to the Acid Deposition Committee, Canadian Pulp and Paper Association, Ottawa, June 18, 1985.

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Summers, P.W.: Tracer Gas Motion over Distances of 1000km and Comparison with Long Range Transport Model Simulations. NATO/CCMS Workshop on Air Pollution Control Strategies and Impact Modelling, Lindau, FRG, October 2-4, 1985.

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Taylor, P.A., H.W. Teunissen and R. Johnson: The Askervein Experiments. BWEA Wind Energy Conference, Oxford, 1985.

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Vet, R.J.: Precipitation Chemistry and Wet Disposition Fields in Eastern Canada - Results of the Canadian Air and Precipitation Monitoring Network (CAPMoN) for 1983 and 1984. International Symposium on Acidic Precipitation, Muskoka, Canada, September 15-20, 1985.

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Voldner, E.C., L.A. Barrie, C.H. Chan, R.M. Hoff, E. Klappenbach and R.J. Vet: Atmospheric Component of the Great Lakes Surveillance Plan. Report to the Surveillance Work Group, Great Lakes Water Quality Board, IJC, August 1985.

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Voldner, E.C.: Atmospheric Deposition of Priority Chemicals - Monitoring and Research Needs. The IJC Workshop on Monitoring in Areas of Concern, Detroit, November 1985.

Voldner, E.C.: Atmospheric Deposition of Priority Chemicals - Monitoring and Research Needs. The Atmospheric Deposition Workshop, Minneapolis, MN, November 1985.

Whelpdale, D.M.: Long-range Transport and Acid Rain. Lecture to Chemical Engineering graduate course, U. of T., April 16, 1985.

Whelpdale, D.M.: The Transport of Acidic Species from North America. Invited seminar at Centre des Faibles Radioactivities, CNRS, Gif-sur-Yvette, France, May 15, 1985.

Whelpdale, D.M. (ed.): Annual Report 1984-85. University of Toronto, Institute for Environmental Studies, 1985, 88 pp.

Xiuren, H., C.L. Chakrabarti, W. Shaole and W.H. Schroeder: Direct Analysis of Solid Samples of Air Particulates by Graphite Probe Technique in Graphite Furnace Atomic Absorption Spectrometry. First Beijing Conference and Exhibition on Instrumental Analysis, Beijing, China, November 15-25, 1985.

Zakshek, E.M., K.J. Puckett and K.E. Percy: Lichen Sulphur Levels and Sulphur Deposition Patterns in Eastern Canada. International Symposium on Acidic Precipitation, Muskoka, Canada, September 15-20, 1985.

6. MAJOR CONTRACTS ($4,000 and over)

Beak Analytical Service $ 76,800	To load and unload CAPMoN filter packs
Concord Scientific $ 59,497	To load and unload CAPMoN filter packs
Concord Scientific $ 58,983	To develop monitoring methods based on the state-of-the-art gas chromatographic techniques
Concord Scientific $ 6,500	To automate the AES tungstic acid analyzer
Concord Scientific $ 4,000	To modify and test the AES tungstic acid ammonia analyzer
Environment New Brunswick $ 5,000	To determine the relative deposition of sulphur species from local and long-range regions and the fate of sulphur species emitted from local source region
Ernst, D. $ 23,426	To develop and implement AES continuous CO_2 monitoring system
Luxton, F. $ 31,000	To provide CAPMoN monitoring services at Kejimkujik National Park (Nova Scotia)
MEP Company $174,086	To provide technical services associated with the Eulerian Long Range Transport model
MEP Company $ 49,535	To provide technical services for the ABL model evaluation and Eulerian model data archiving
McCurvin, D.M.A. $ 6,930	To compile data on the properties of PAHs, and to perform chemical analyses of PAH photo-decomposition products in atmospheric particulate matter
Mitchell, R.E. $ 23,500	To analyze video scanner data for system problems
Nuclear Activation Services $ 4,725	To analyze Andersen Impactor filter paper from Inuvik
Nuclear Activation Services $ 4,625	To analyze Arctic aerosol filters using neutron activation analysis techniques

Ont. Min. of Environment $ 50,000	To provide computer services for the joint evaluation of the OME/AES Eulerian acid deposition model
Ont. Research Foundation $ 57,987	To conduct field evaluation of prototype gas/particle sampler and to determine the feasibility of adapting to the measurement of PCBs
Panigas, A. $ 13,650	To develop an interactive trajectory computation and plotting package
Panigas, A. $ 10,582	To resolve problems with the LRTOX model, to modify for acceptance of high resolution precipitation data and to run model scenarios
Polaris Computer Systems $ 15,700	To provide the necessary features in CDMS (Version 1) to process air quality data
Saini, B. $ 24,928	To provide data interpretation services for the Data Analysis, Integration and Synthesis (DAIS) project
Salmon, Dr. J. $ 47,800	To design, test and field utilize data acquisition and analysis procedures for CASP-I surface mesonets
Salmon, Dr. J. $ 9,360	To analyze wind and temperature data from the Canada Olympic Park, Calgary (Phase II)
SCS Consultants $ 25,000	To provide statistical analysis for the International Sulphur Deposition Modelling Experiment (ISDME)
Shannon, J.D. $ 4,750	To consult on the modification of the ASTRAP model and to provide advice on the structure of meteorological and emissions input and on model scenarios
Skelton, G.B. $ 18,261	To undertake a field study for the measurement of dry deposition to snow surfaces
Skelton, G.B. $ 17,480	To provide quality assurance/quality control services for the CAPMoN network
Skelton, G.B. $ 5,000	To provide hood gaskets for the CAPMoN precipitation collector

Unisearch Associates Inc. $ 35,000	To develop an aircraft mounted platform for measuring gaseous nitric acid and nitrogen dioxide in air
Unisearch Associates Inc. $ 4,000	To provide technical assistance on operation and calibration of the AES tunable diode laser system during 1985 field study and to provide analysis of the field study data
University of Guelph $ 9,080	To evaluate trajectory simulation model for estimating CO_2 fluxes at BAPMoN stations
University of Toronto $ 14,938	To collect cryptogamic plants and analyze for synthetic organic contaminants
York University $ 5,000	To install and operate chemical equipment for the Western Atlantic Ocean Experiment

7. UNSOLICITED PROPOSALS

CONTRACTOR	UP NO.	PROJECT TITLE
MEP Company $152,000	UP M-570	Development of procedures for modelling sub-grid processes in Eulerian Models.
Unisearch Associates, Inc. $250,000	UP-66	A tunable diode laser absorption spectro-meter for trace gas analysis from an aircraft.

8. SCIENCE SUBVENTIONS

APPLICANT/ INSTITUTION	SCIENTIFIC AUTHORITY	TITLE
BARIL, M. Université Laval $6,000.00	L.A. Barrie	Etude de faisabilité en vue de l'obtention de signatures des sources polluantes industrielles majeures au Canada central.
BUNCE, N.J. University of Guelph $10,000.00	D. Lane	Gas Phase Photochemistry of chlorinated Aromatic Compounds.
CAMPBELL, P.G.C. University of Quebec $10,000.00	W.H. Schroeder	Spéciation chimique de certains métaux présents dans les aérosols atmosphériques.
CHAKRABARTI, C.L. Carleton University $10,000.00	W.H. Schroeder	Development of a new analytical method for direct determination of heavy metals content in atmospheric particulates.
CHATT, A. Dalhousie University $9,000.00	P.W. Summers	Chemical Characterization of Acid Fog.
DRAKE, J. McMaster University $6,000.00	L.A. Barrie	Variation of sulphur, metal and halide content in precipitation within precipitation events and across Hamilton.
KEFFER, J.F. University of Toronto $6,000.00	Y. Chung	Digital Image Analysis of Meteorological Phenomena.

LEE-RUFF, E. York University $11,000.00	D. Lane	Mechanism of Oxidation and Product Characterization of Environmental Polynuclear Aromatic Hydrocarbons (PAH).
ORMROD, D.P. University of Guelph $11,000.00	M.L. Phillips	Effects of air pollutant mixtures on plants.
PICOT, J.J.C University of New Brunswick $10,000.00	J.D. Reid	Simulation of Forestry Aerial Spraying.
SCHIFF, H.I. York University $12,000.00	K. Anlauf	Measurements of NO_2 and PAN using a LUMINOX instrument.
STEYN, D.G. University of British Columbia $6,000.00	H.E. Turner	Sea Breeze Dynamics in the Lower Fraser Valley, B.C.
STUBLEY, G.D. University of Guelph $8,000.00	P.A. Taylor	Parameterization of Planetary Boundary Layer Structure.
WANGERSKY, P.J. Dalhousie University $7,000.00	B. Kerman	Bubble populations and transport of Toxic Materials

9. PERSONNEL

AIR QUALITY AND INTER-ENVIRONMENTAL RESEARCH BRANCH

			PHONE NO. (667-xxxx)	ROOM NO.
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	Clerk:	Mrs. M. Stasyshyn	4969	4S250
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	Senior Res. Scientists:	Dr. P.W. Summers	4796	4S190
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	*Co-ordinator:	Mrs. E.E. Wilson	4796	4S180
	PDF:	Dr. W. Fricke	4839	3S650A
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		Dr. H.A. Wiebe	4797	4S120
		Dr. D. Lane	4965	4S132
		Mrs. O. Hunt	4965	4S130
		Mr. D. MacTavish	4965	4S130
		Mr. S. Jenkins	4901	4S130
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		Dr. B.R. Kerman	4791	4S824
		Dr. A.K. Lo	4824	4S821
		Dr. J. Padro	4962	4S900
		Dr. P.A. Taylor	4824	4S823
		Dr. J.L. Walmsley	4780	4S816
		Mr. V.S. Derco	4791	4S822
	*	Mr. J. Deary	4680	4S640A
		Mr. L. Guise-Bagley	4680	4S640A
		Mr. N. Koshyk	4680	4S640A
		Mr. J. Arnold	4791	4S820
	**	Dr. H. Mengelkamp	4824	4S823
	PDF:	Dr. S. Karpik	4839	3S690A
	CO-OPS:	Mr. T. Pearce, Mr. J. Simpson		

* Term or assignment

** Visiting Scientist (GKSS Research Center)

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	Dr. S.M. Daggupaty	4980	4S841
	Mr. D. Bagg	4988	4S842

Carbon Dioxide/Climate Change

	Dr. K. Higuchi	4778	4S843
	Dr. N.B.A. Trivett	4954	4S831

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	Mr. A. Smith	4970	4S670
	Mr. A. Gaudenzi	4987	4S640B

QA and Data Management

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	Mr. R. Vet	4801	4S620
CO-OPS:	G. Uszkay, D. Worthy, A. Mowers, P. Girard		

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	Mr. J. Kovalick	4983	4S660
	Mr. J. Markes	4983	4S660
	Mr. S. Melnichuk	4941	4S650
PDF:	Dr. W. Sturges	4839	3S690A
*	R. Van Ameron	4786	-

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Special Studies Section

	Dr. D.M. Whelpdale	4903	4S340
	Dr. A. Sirois	4839	3S650A
CO-OP	S. Drake		

* Denotes term or assignment

10. ACKNOWLEDGEMENTS

To compile an annual report of a group's activities requires input from all component parts. My thanks must go to the persons from the divisions, the AES Regional offices and the Office of the Director who responded promptly to the call for information. Even though only some staff are mentioned by name, it must be remembered that the achievements of this Branch and the Regional offices are due to the effort and support of each and every member.

The annual report could not be produced without the effort of the Divisional secretaries (Doris Bardeau, Evonna Mathis, Pat Pearson, Judy Selmes-Brymer and Zsa Zsa Zarzycki) to transpose the scribblings of the project leaders into the type-written word. Special thanks must go to Zsa Zsa who merged all this input into a cohesive document that preceded this final product.

Malcolm E. Still

Type ... Type ... Type!