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ROBERT EDWARD MUNN

Interviewed by D.W. Phillips
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ORAL HISTORY PROJECT

An Interview with Dr. R.E. Munn

This is another in a series of personal interviews with outstanding figures in Canadian meteorology as part of the oral history project of the Canadian Meteorological Service. Today is September 28, 1983 and I have the privilege of interviewing Dr. Ted Munn at his office in the University of Toronto. The interviewer is David Phillips.

Ted Munn was born in Winnipeg in 1919 but received his early schooling in Ontario. He graduated from McMaster University in mathematics in 1941 and joined the Meteorological Service in the same year. He was stationed at Dunnville, Rivers, Dorval and Gander before receiving his M.A. in meteorology at the University of Toronto in 1945. He returned for three more years at Gander before moving to Halifax as a weather forecaster in 1948 where he remained until 1956. That year he became Project Manager for a special study of air pollution in the Detroit-Windsor area and soon began his PhD studies at the University of Michigan, which he received in 1962 for his thesis on the Vertical Diffusion in the Atmosphere. For several years Dr. Munn was head of the Micrometeorology Unit in the Research Division and Chief Scientist of the Air Quality Research Branch.

In 1977 he retired from government service and joined the University of Toronto as an associate of the Institute for Environmental Studies and as professor of Physics.

Dr. Munn has an international reputation in the field of micrometeorology and on the meteorological aspects of air pollution. He has also carried out many studies on the relationships between meteorology and the other environmental sciences. He has authored or edited a dozen books, one of which Descriptive Micrometeorology is in its 5th printing. In addition he has authored nearly 200 papers on various aspects of his research, many of which have appeared in numerous scientific journals. He is the founding editor of Boundary Layer Meteorology.

Dr. Munn has received considerable recognition as a scientist. He has been active in many world organizations including the World Meteorological Organization, International Association of Meteorology and Atmospheric Physics, the International Joint Com mission, and the Scientific Committee on Problems of the Environ ment. During 1970 he was visiting scientist at the Institute of Meteorology at the University of Stockholm. In 1972 he was honoured by the American Meteorological Society with an award for his outstanding contribution to the advancement of applied meterology and in the same year he received the Patterson Medal for distinguished service to meteorology in Canada. He is the recipient of the President's Prize of the Canadian Meteorological and Oceanographic Society on three occasions.

DWP: **Dr. Munn that is a short biographical sketch. Are there any errors you wish to correct or any information you wish to add at this time.**

REM: First of all where did you get all that information. Well, it seems to be reasonably correct. There's an impression that back in the 1940's I left Gander to come back to the University of Toronto for a Masters degree in meteorology, but actually all that happened was that I and a number of other people took an examination in Hugh Bindon's office in Gander in Differential Equations and Statistics and the University then gave us a Masters degree.

DWP: **My first question is one I have asked everyone, how did you find your way into meteorology?**

REM: Well, purely by accident. I had finished my first degree at McMaster University and I was going to do graduate work in mathematics at the University of Chicago. McMaster has always had close links with Chicago. But the war came along and my professor in mathematics, Professor Findley, suggested I come to Toronto and see what graduate studies were related to the war-time effort. I went into the Physics Department first to talk to them and they sent me over to see John Patterson and Andrew Thomson. At that point I had never heard of meteorology as a profession or as a discipline at all.

DWP: **You were stationed at Dunnville and Rivers as a Dependent Forecaster. What did that mean?**

REM: Well simply that I and others interpreted the forecast that came from the main forecast offices in Malton and Winnipeg. But I had no authority to make my own forecast.

DWP: **Do you think that the war helped the advancement of meteorology as a science?**

REM: Oh yes, it certainly did. The training program of the Canadian Meteorological Service was tremendous.

DWP: **Not only in Canada but in the world?**

REM: I suppose so, yes.

DWP: **Between the years 1943 and 1956 you were an operational forecaster at Gander and Halifax. Was there an opportunity at that time to do project work, conduct research and write papers while forecasting?**

REM: Well not at Gander although some of us took a few minutes to collect our thoughts. In Halifax I would credit Rube Hornstein with really starting my career in the research area. He somehow found the time in the shift schedule for people to have one day a month, at least, free of forecast duties to involve themselves in special local studies. He always felt that people had to refresh their minds. I made good use of this and actually got more than my share of time because Carl Mushkat found those days without day to day forecast responsibilities rather boring. He used to give me his days as well as my own, so I really got two sometimes three days a month for special projects.

DWP: Was it a mistake to have stayed in operational meteorology for as long as you did?

REM: Well, I don't think so, no. I would probably have been too immature to benefit from a doctoral program earlier in my career. I took science and life rather lightly anyway, so I probably wasn't ready for it.

DWP: Did you find your routine at the weather office boring?

REM: No, not at all.

DWP: You were about 40 years old when you enrolled in the University of Michigan in 1957 to work on your doctorate. Why did you wait so long before going to graduate school?

REM: First of all I had a family and four children and also I didn't have the financial resources. The opportunity arose when I won the position in Windsor. At that time I'd won three competitions - two of them were in Headquarters.

Harold Baynton, who had been in Windsor before me and had left for Ann Arbor because he could not get educational leave, persuaded me that that was what I should do. He indirectly had a great effect on my life.

DWP: Did the Meteorological Service encourage you or dissuade you from doing your PhD?

REM: I won the competition so I was sent to Windsor to write a final report on the Windsor-Detroit transboundary air pollution flow. I knew really nothing about the field at the time, it was just a complete mystery, but I had at the back of my mind when I went to Windsor that I would perhaps follow Harold to Ann Arbor, which was about 50 miles away. It was suggested that I take some educational leave but I got a flat refusal from Andrew Thomson at first. Then

I suggested that I would do it without any bookkeeping problems for the AES, that I would simply continue to work in Windsor but go to Ann Arbor three mornings a week. Andy wasn't too happy about that but there was Harold's precedent; he had resigned because he had been refused educational leave.

I sort of left the suggestion with Headquarters that I'd probably be going in a few months when the fall semester started and at that moment there was a happy phone call from Toronto and all was well. However, Andrew Thomson and Don McIntyre both told me that it would be a kind of a waste of time to do a doctorate in air pollution because there was no future for air pollution in the Canadian Meteorological Service.

DWP: **Was your first exposure to this field of air pollution in Halifax or did you come to Windsor knowing very little about micrometerology?**

REM: I came to Windsor knowing nothing about micrometeorology and not very much time to learn because I arrived in August and the final report was due the following May. I had to pick up the pieces that Harold Baynton had left, there was a lot of data, numbers, and pollution concentration values around which nobody had really looked at. Added to that was the problem that the officer in charge of the laboratories was a phony. This was one of the reasons why Harold had left because the person had claimed to have had a PhD and it turned out he was only a high school graduate and was running a laboratory knowing nothing about it. Harold had been crossing swords with him. The other people from Health and Welfare couldn't very well expose him because he was their supervisor. It left them with a difficult position so Harold resigned and exposed him and they checked his record.

There was a great mass of data around there and I was expected to write a final report with a colleague in Cincinnati who was doing the American side of the report. It was a very difficult winter for me.

DWP: **Where did Harold Baynton go?**

REM: He went to Ann Arbor and started a doctoral programme. The attraction was that Wendell Hewson and Gerald Gill were both there and at that time, they were the North American experts on air pollution. As you know, Wendell was a long-time member of the Canadian Meteorological Service and he did the Trail studies.

DWP: **Why are the Trail studies so well remembered - because they were was the first, because of the geopolitical nature or was it just a good piece of research?**

REM: All of those reasons. I guess it's a good piece of research because it exposed a phenomenon called the Hewson fumigation; it's still called that. It relates to the fact that a chimney plume goes along at night above a ground-base radiation inversion. There is no sign of it and there are no high-level concentrations at ground level. About an hour after sunrise, the surface convection builds-up and eventually reaches the plume level and then the concentrations rise all the way downwind.

At first in Trail there were high values found at certain hours. The chemists thought that this was due to a leak and that the emission had gone up unexpectedly which the plant officer didn't realize. But Hewson showed in fact that it was due to this break-up of the morning inversion or the so-called Hewson fumigation.

DWP: **After you finished your report in Windsor that fall and winter, what then was your task?**

REM: The International Joint Commission's Technical Advisory Board got a draft report together the following March-April for a meeting in Washington, which I attended, but it was three years before it got into final form because there was so much integration that had to take place.

DWP: **Did the project deal with ship pollution?**

REM: Well, that turned out to be a major concern. There were technicians in Windsor and in Detroit looking at ship's smoke as it moved up and down the river and following it with what was known as a Ringelman Chart which gave the colour of smoke and the degree of blackness. If there was a violation, the Ringelman number was too high and the ship operator was informed. There were annual statistics collected for seven or eight years on the number of ships going by in the Detroit River and on the Ringelman Number frequency distribution.

There were all kinds of violations. Some of the older ships would go by at night or weekends when they knew that there were no technicians there. In other cases they would put a white chemical into the stack so that white smoke would come out just as they went past the observing points. Lots of things like that went on.

DWP: **Were your findings confidential, controversial or accusatory?**

REM: No, I don't think so. They certainly weren't confidential. There was a final report published and distributed widely. The public hearing process didn't take place in those days but if anybody wanted a copy they could have it.

The political action to be taken following that was not what one might expect. The two governments interpreted the terms of reference to mean mostly ship smoke and eventually, in order to get any action on the steel mills in Detroit and some of the power stations, it was necessary to have a new reference in the 1960's. It expanded to include both Windsor-Detroit and St. Clair River-Sarnia-Port Huron. So it was not until 1966 that all the land base sources were brought into this programme. But there were some political reasons for this, i.e., the conflicts between Michigan and Washington and between Ontario and Ottawa made political action in the 50's pretty difficult.

DWP: **In the '60's your were head of the Micrometeorology Unit. Was air pollution the main thrust of your research and that of the scientistists working for you during that period?**

REM: Well it was one of the main thrusts, not the only one. We developed quite a competent field team and we had a meteorological tower which would travel. We did one study at the NRC Montreal Road site, we did field studies in Douglas Point, in fact one could say we did an environmental impact assessment for Douglas Point and for Whiteshell, Manitoba. We did other investigations, for example, we did a study of a watershed in Alberta for Don Storr at Marmot Creek. I did an estimate of the evapotranspiration from that basin and in another case we looked at a Queen Elizabeth telescope site in the Rocky Mountains for the Canadian National Committee for Astronomy. We were doing a wide spectrum; whatever business came along we would take it.

DWP: **Were you responsible for starting the Tower Bulletin publication?**

REM: Yes. At that time I was given the official title of Meteorological Service Consultant to the Department of Health and Welfare and to Atomic Energy. Both agencies were interested in getting information on the lapse rate distribution near the ground. Health and Welfare seemed to have an unlimited amount of money they could give to the provinces. If a province asked for money to put up a tower, Ottawa would give them a health grant, so there was a network of towers set up that way. In addition Atomic Energy of Canada had funds for this sort of thing. It seemed natural, once we got the thing going, to publish the data in some form.

DWP: **Was there ever any consideration given to passing the network over to Basic Weather and publishing responsibilities over to Climatology or was it considered Research's programme?**

REM: Well, we discussed it from time to time with Don Archibald but he didn't seem to be particularly interested as I recall. I can appreciate their point of view. We hadn't thought out the siting criteria and all the steps that WMO and that Basic Weather take. If there was a tower in the middle of a city or we found a site, even though it was unrepresentative in terms of a meteorological analysis, we would still accept it as a fall back position.

DWP: In 1973 Canada established six stations to take turbidity observations and precipitation sampling as part of our contribution to WMO's Global Air Pollution Monitoring Network. Why was the selection of suitable sites for the AES baseline network difficult?

REM: In 1973, I had been in on the process of setting air quality criteria in Geneva. In fact, I was the one who organized the WMO Background Monitoring System, it was entirely at my initiative. It was pretty hard to persuade the people back home that this was a good idea. There was a lot of resistance to this because it required resources.

This may be off the subject a little bit but it seems to be the normal situation in Canada, speaking not only for myself but for a lot of other people, to get programmes approved internationally and then to use that as a lever to get something going at home, which was what you wanted in the first place. I've seen this time and time again at various departments of government.

DWP: What memories do you have of your sabbatical in Sweden in 1970?

REM: Well, it was a very exciting period for me. I went to Stockholm in 1970 to help them with there acid rain problem; they needed an outside consultant whom the government might believe. It was kind of amusing because acid rain hadn't come along in Canada at that time.

I had been working on meteorology on the small scale - diffusion from chimney plumes to down wind distances 30 or 40 kilometers at most - and I came into this Institute in Stockholm, which was looking at air pollution on the global scale and the long range transport scale. They didn't know anything about the small scale but with people like Bert Bolin they knew all about the large scale, like global balances of sulphur and nitrogen. So we helped each other. For the first time, I looked at this larger scale; in fact Bolin and I wrote a review paper on long range transport of air pollution which brought in all scales, all the way from micro to global. I think we got something like 2,200 requests for reprints of that review paper, which was in Atmospheric Environment; it was sort of the basic paper that's still referenced in the long range transport field.

It was my first exposure to acid rain. I'd never heard of it before except a little bit on the WMO when I was on a Working Group when Erickson from Stockholm and the Soviet Union's, Mrs. Selezneva were arguing about whether wet deposition buckets should be closed or open during periods when it wasn't raining. This argument raged forth for 2 or 3 days and of course I wasn't grasping the significance of all this. Now of course, we have all these automatic systems that are around the world. But this was back in the 60s.

DWP: **Was it difficult getting AES approval to go to Sweden?**

REM: No, not at all. I give full marks to Warren Godson, he must have realized that these two fields were going to become connected. Of course, he'd known Bert Bolin for a long time and I think he thought that AES was going to get as much out of this deal as Stockholm was.

DWP: **What kind of administrative or financial arrangments were made? Were you away on leave of absence, with the University paying your salary?**

REM: Well, as in the Windsor case, it turned out that the simplest financial arrangement was for AES not to change my pay at all. I went over on full pay and then the University of Stockholm gave me some money for an apartment in Stockholm.

DWP: **Your paper with Rodhe on the chemical composition of monthly precipitation samples also received considerable worldwide attention. In that paper you show strong correlations between chloride and sulphur depositions and the frequency of rain-bearing winds in the southwest to northwest sector. Was it clear to you where this pollution was coming from, and if it was, why wasn't the pollution source named in the paper?**

REM: Oh well, the pollution comes from all over the place: the U.K., the Ruhr Valley, Poland, from all sorts of places. What we tried to do was to normalize out the effects of meteorology to see what the trend in wet deposition was. There had been a rise in the acidity of lakes in Sweden that the Swedish agriculturalist Svante Odén had been talking about and we wanted to know whether this was due to a short-term departure in climate or whether it was due to an increase in emmissions.

It turned out that most of it could be explained by the fact that there were more rain-bearing winds from pollution source regions in the 60's than in the 50's. In the 50's most of the rain-bearing storms or a large fraction of them were associated with cold lows over the Baltic and the air coming into Sweden was from Northern Siberia and was relatively clean.

DWP: Did you say that Rodhe was going to be the next Rossby?

REM: I think so, yes, sure.

DWP: Are you and Rodhe still collaborating?

REM: Oh yes, he and I are just finishing a book, WMO Training Manual on Air Pollution and Air Chemistry. He's now Chairman of the Department of Meteorology. That was another reason why I went to Stockholm because the Swedes had this young PhD student, Henning Rodhe that nobody understood what he was doing and so the idea was that I'd go along and tell Bert Bolin whether what Henning was doing was right or not, because he was into some of the small scale turbulent diffusion work. It turned out that he was way ahead of me; he knew far more than I did. I was having trouble keeping up with him, chasing him. No, he's good.

DWP: In 1971 you became Chief Scientist of the Air Quality Research Branch. Was this position created for you to free you from the burden of government paper work so that you could put all your energies on science?

REM: Well, I don't know. You had better ask Warren Godson. Again he was very good to me through the years, and I give him full marks.

My problem around the Meteorological Service was Don McIntrye, who wanted to have his staff in administratively tidy systems. In fact when I came from the University of Michigan, I spent the first couple of years writing terms of reference for the Meteorological Service in air pollution and I kept sending him in drafts and he kept finding something wrong with them. Finally a draft eventually went up and became a Treasury Board Minute, which to me was sort of a surprising way to go, but at that time McTaggart-Cowan thought, since in meteorology we were getting into all these applied fields, it would be nice to have a whole series of Treasury Board Minutes. Mine was to be the first in air pollution meteorology and then we would put these all together and we would have a package of programmes. It was sort of almost the equivalent of a Meteorological Act for Canada. We did get the Treasury Board Minute in air pollution meteorology but I don't think we got much farther than that.

DWP: Was Don McIntrye fond of administrative details such as Variance Reports, Budget Reviews, and man-year's allotments.

REM: Oh yes, yes.

DWP: **What were some of the highlights of your research activities during your period as Chief Scientist? That title has a laisse-faire sound to it. Did you have a support staff? Were you on your own to do what you wanted? Were you accountable only to Godson? How much freedom did you have?**

REM: Well, I had lots of freedom. Godson felt that the record spoke for itself. As long as people were producing, as long as there were papers being published and as long as we were stimulating research in AES and across Canada, then let it be.

Myself and one or two others were going into the universities and persuading them that what they were doing was actually meteorology which they hadn't realized. We would take every opportunity where someone who had some problem he was working on to try and show him how, by reformulating his questions a little bit he could improve the quality of his research.

DWP: **Was it any different doing research in the Department of Transport as compared with that in the Department of Environment?**

REM: Well, it's hard to separate that question from the move. We moved into the new AES building about that time. Prior to that we had been a rather small group in Spadina Road. Nobody else in the Meteorological Service really knew very much about what we were doing, except we had good relations with Jim Bruce and Lloyd Richards in Climatology. But I felt that, as soon as we got out to Downsview, everyone was too close. Even in Spadina Road, we were a fair distance away from Research Headquarters. Don McIntrye was up on Davenport Road, so we were a long way from there, nobody bothered us very much. But, as soon as we got to 4905 Dufferin Street, everyone was too close, they could call meetings easier.

DWP: **Were you involved in the Canadian research associated with the Global Atmospheric Research Program and GARP's Atlantic Tropical Experiment (GATE) efforts?**

REM: Only to a minor extent, I participated in SMIC, this meeting in Stockholm in 1971 which led to GARP. In fact, I wrote about 20% of the book on Man's Impact on Climate. I was the only boundary layer and air pollution person at the meeting. It was a book that was written in three weeks. That was quite a lot of fun.

DWP: **Well, you have used that technique at other times. I refer to the meeting at Victoria Harbour in 1973 when a group of 30 specialists met for a week to prepare a book called <u>Environmental Impact Assessment: Principles and Procedures.</u>**

REM: Everyone came there as an expert. They were specialists in all fields. They had a little problem relating to each other in some cases and some of them would never forgive me for putting them up there in 30 below weather in February. Two or three of the Africans thought they were going to Victoria, British Columbia.

DWP: You mention SMIC and the Victoria Harbour Workshop. Are there other examples of workshops that produced a book right away?

REM: Yes, I have been on the sidelines of writing a number of books. There was another one - a WMO one on climate sometime in the '70's. There was one on simulation modelling that I co-chaired, which led to a book.

The modern view now is that its a little bit too much to expect people to write a book in three weeks without some previous preparation. The way people are doing this now is to have background papers prepared for discussion. In fact I've just edited a book on Risk Management in Canada, in which we went through that process. We had a three-day meeting to discuss the Table of Contents of the book, then we got people to write draft chapters, and then we went to a longer workshop to discuss the chapters. I pulled the whole thing together into a single book at the end.

DWP: Were you involved in the United Nations Conference on Human Environment held in Stockholm in June 1972?

REM: No.

DWP: Were you involved in any of the work that led up to that Conference?

REM: Well, I was involved in preparing for the conference in two ways; a Swedish case study was submitted to that conference and I was in on the beginning of that study but I left before it was completed. In Canada, I was on several task forces that Environment Canada set up.

One was chaired by Maxwell Cohen on the Law of the Sea, in which I went to a number of meetings, including a very nice meeting down in St. Andrews, New Brunswick where we ate lobster for a week. I really didn't have very much to contribute to that, but I found it interesting and very broadening. I was on another task force on monitoring, I think. There were 2 or 3 workshops that I attended, one in Quebec in which the Canadian position was being prepared.

DWP: In 1977 you embarked on a new career when you joined the University of Toronto as an associate of the Institute for Environmental Studies and Professor of Physics. What circumstances led to this change of career? Were you dissatisfied with AES or was it just time for a change?

REM: No, I was quite happy out there. The thing that happened was that I had been doing work for the United Nations Environment Program, which was the agency that was set up after the U.N. Stockholm Conference, and they commissioned a consultancy report on the design of a global monitoring system and I had written the book called SCOPE 3 which was the basis for the global system GEMS.

To develop it even further, the Rockefeller Foundation organized a meeting in Bellagio, Italy to discuss network design and global problems. I presented a paper there on the historical perspective on how the world ozone network had got started and the acid rain network had got started in Scandinavia. Well, Ken Hare who was Director of this Institute was at that meeting and so were Ralph Richardson and other Rockefeller Foundation people. I had known them earlier through the Monitoring Centre at Chelsea College. Anyway, sitting over coffee, the Rockefeller people thought I should be spending more time on global monitoring design problems and less time on some of the other things I was doing with the Canadian Meteorological Service, so they offered to fund a position at the University of Toronto. It was sort of a fate accompli right there, all I had to do was fill out a piece of paper. The Rockefeller Foundation came along with the money. Anyway I didn't really retire, I just had a mid-term correction.

DWP: Do you still maintain contact with AES?

REM: Yes, I was on their Science Subvention Committee in August. I'm going out to give a lecture for Doug Whelpdale's acid rain monitoring workshop in October and I'm going to organize a workshop for AES in November on the problem of how to detect trends from acid rain chemistry data.

DWP: You've been associated with so many successful workshops. What are the necessary ingredients for ensuring a productive workshop?

REM: Well, you've got to have sufficient funds and enough independence so that you can do what you think is best. You don't want too big a committee running these things or you never get very far. And then you have to make sure that you get 2 or 3 key people and let the word out that Mr. X or Mr. Y is coming. The other people want to come because it gives them a chance to see him.

We had a small workshop at Trinity in June on international science and we got one person lined up, and let some other people know that he was coming. Because they never have a chance to talk to him, this was their opportunity. We had people wanting to come from around the world just because they knew that Mr. X was coming.

DWP: **Do you have any more freedom here at the Institute for doing research than you did at AES? Is it a different atmosphere for conducting research?**

REM: No, I had just as much freedom at AES as I have here. In both cases, there is paper work to do in the administration, there is really not much difference. Also, I'm a little more available in the downtown area. I have people coming to see me, simply because they're visitors from overseas and it's too far out to AES so they'll drop in to see me.

Also, I operate what you might call a storefront activity for AES. There are lots of graduate students and professors who are doing research that involves meteorology in one way or another. There is a meteorology group over in Physics, but they are not in forest meteorology, agrometeorology and applied meteorology, so either they send them over to me or else these people find out about me. As a result I'm constantly re-directing people out to AES to the right person where they can get the information they need and in helping them re-define their problems.

DWP: **What is your association with Chelsea College?**

REM: Well, Tom Malone and I more or less founded the place. It became a SCOPE Centre. Over the years it's had a good deal of funding from the United Nations and still has. On the SCOPE side, there's been a feeling that, once the Centres get off the ground, they should be allowed to grow on their own; otherwise resources of SCOPE would be tied up with Centres all around the world, even though few people thought we should be a network of Centres. There is a Centre for carbon in Hamburg and a Centre for sulphur in the Soviet Union but the general view is that these should become independent. About two years ago the SCOPE Monitoring Centre in Chelsea College severed its ties from SCOPE but we still have good relations and I'm on a informal Advisory Committee to the Centre. In fact I was over there a couple of weeks ago.

DWP: **You have certainly done a lot of work for the United Nations family of agencies. You've been involved with the World Health Organization, UNEP and WMO. I guess the one group that you're best known for is the subcomponent of GEMS, BAPMoN, the background air pollution monitoring network. In your work with GEMS, was there considerable pressure to overcome intense political and personal persuasions to adopt a specific instrument, network or program?**

REM: No, I wouldn't say that. The pressure always has been that the so-called environmentalists or the activists, particularly in the United States, thought that the network should develop more quickly than it actually could. However, the design criteria were not yet in place. In the FAO, for example, the world forest inventories are produced every two years or so without anyone agreeing

on the definition of a forest and so that the data on changes in world forest cover are pretty well useless for carbon dioxide studies unless you know the idiosyncrasies of each member state. It's a long process producing network design criteria.

DWP: **You were a speaker at the World Climate Conference. Do you have any thoughts or recollections about that particular conference?**

REM: Well, I have a complaint to start with and I think Ken Hare and a lot of other people share it. And that is that the World Climate Conference Proceedings didn't get the recognition that they should have. WMO has always insisted on publishing information itself but it has a poor track record of distributing these things. It's a super volume but it's not getting into the universities. Each Member state gets two copies and so if you look at the universities across Canada I think you'd find very few copies of the Proceedings of the World Climate Conference.

Aside from that, I thought the conference went very well. I was disappointed at first that the applied side was being let down. The basic science on the effects of CO_2 on climate, the effects of particulates and the various climate processes were really well covered. Some of the review papers on the effects of climate on health, on fisheries, and things like that were pretty trivial in some cases.

It sort of came together the last day in a paper that Bob Kates produced on his own. Because he was unhappy with the way things were going, he announced that he was going to give a paper, even though he wasn't on the programme. He wrote his paper, the last one of the Conference, over a weekend and I think he arranged to present it, even though he hadn't had any advance notification. There were some of us who encouraged him to do this. And this I think put the essential climate impact problem into focus.

DWP: **Which of the many conferences, workshops, seminars that you have participated in has been the most successful, or the most significant in your mind, in terms of the impact it had on science, on the Service or on yourself?**

REM: Well I don't know, I suppose the one that set the pattern and the one that established a basic framework for future studies in the WMO was the SMIC meeting in Sweden. It was run by a man named Carol Wilson who really did a super job.

We were isolated for three weeks and were expected to write a book. This was the first time this had ever been tried. They had tremendous support staff so that if one wanted a reference it could be flown in from Germany or somewhere the next day.

It was funded by the Massachusetts Institute of Technology and hosted by the Royal Swedish Academy of Sciences. I guess MIT must have got the money from somewhere else. It was published in eight weeks. Some of the leaders in the field were Postdocs at the meeting, helping out with the donkey work. One of them was Steve Schneider. He was a young fellow who wasn't doing anything else just sitting there talking to people.

DWP: **For many years you were Assistant Secretary of IAMAP. What is IAMAP?**

REM: Well, IAMAP is the International Association of Meteorology and Atmospheric Physics. It represents the non-governmental side of meteorology in the world and is part of the International Council of Scientific Unions. It plays its role with WMO in organizing joint programmes such as GARP, IGY and a whole lot of other programmes.

DWP: **What were your responsibilities as assistant secretary to IAMAP?**

REM: Well, the challenge for me was that I had an opportunity to come face to face with the leaders of world meteorology. There was some paperwork, but it was always interesting and entertaining. I got to know both Obukov and Monin in the Soviet Union through this mechanism. While conferences were going on, Warren and I shared making sure that everything was running smoothly. What to do when some speakers whose papers had been accepted, didn't show up? How do you re-organize a programme? You had a lot of people at a fairly senior level of meteorology, I don't mean on the bureaucratic side but on the scientific side, coming to depend on you and before you know it, you're having lunch with them and getting to discuss science.

DWP: **You've been a member of the Executive Committee of SCOPE. What is SCOPE? Are you still editor-in-chief of publications?**

REM: Yes, I'm editor-in-chief. I'm an ex officio on the Executive Committee.

SCOPE arose a little before the time of the Stockholm Conference when people were realizing that there were a lot of global problems that couldn't be dealt with by a single discipline. ICSU decided first of all to get an Advisory Committee together, a so-called ad hoc committee to advise them on what they should do about the environment as an integral activity. Again I think, Warren Godson had something to do with it. There were six of us on this ad-hoc committee that met for a couple of years and produced a draft blueprint for an organization called SCOPE.

AT first SCOPE was "Special Committee on Problems of the Environment" and "special" meant that it just had a limited life to the next general assembly of ICSU, but then a year later, we got to be called a scientific committee on problems of the environment, which meant that we could hold our own general assemblies and raise our own money from research councils and academies of science around the world. We've been going ever since. We spent our ten years of existence in undertaking synthesis of various fields. We never hold scientific symposia but we do decide on an area that needs looking at from an inter-disciplanary point of view. One that's just starting now, for example, is intergrated pest management, which requires input from social scientists as well as from the biologists and the chemists. We'll bring all of the people together in about three years time and produce a book on the subject.

DWP: **Does the book publishing side of SCOPE hold its own?**

REM: Yes, we make money.

DWP: **You were active in the Professional Institute and the Canadian Air Services Association for several years.**

REM: No, I was never active in the Professional Institute, I was active in the Public Service Alliance. In fact I'm an honorary life member of the Alliance.

In the early days, again it was Rube Hornstein and his influence, there was a meteorological union so called and it consisted of a branch in Toronto run by Fred Patterson and another branch in Halifax run by Rube Hornstein. The predecessor to the Public Service Alliance, which was the Civil Service Federation of Canada, was holding a convention in Quebec City in 1955. Fred Patterson decided that it was Halifax's turn to send a person, so Rube decided that I should go. So I went off to this meeting, the first time I'd been to one of these great meetings where you needed Bourinot Rules of Order and where the postal employees were voting as a block and all the rest. It was really great fun.

While I was there, there were people twisting my arm. You see, the whole Department of Transport was not unionized, was not organized. It wasn't a union in that sense but there was a federation of organizations with voluntary dues and so on. They were just about to get the check-off. There were a lot of people coming to see me, including one of the Public Service Commissioners who wanted somebody he could deal with in the Department of Transport. There was nobody representing the employees. Nearly all of the other civil service departments at that time had staff associations but the Department of Transport didn't. I just happened to be the only one there from Department of Transport, so I was getting it both from

the other staff associations and also from the Public Service Commission. I ended up trying to organize, with Rube Hornstein's support, a national union in the Department of Transport.

McTaggart-Cowan was behind this too as a matter of fact. He thought this was a great idea but he didn't want all of Transport in that, it was a little bit much. I didn't even know where the people were but we called ourselves the Canadian Air Services Association. We brought in air traffic control, the Met Service, the marine people and, I think, some radio operators. Before you knew it, we had a union and we had a convention in Toronto.

DWP: **Were professional, technical and clerical staff included?**

REM: Everybody! I then got into trouble later on with the Professional Institute because they didn't want to have anything to do with the other staff associations except on the National Joint Council. Eventually, it turned out that I could no longer even belong to the Public Service Alliance because they made the rule that if you were a professional you had to belong to the PI. I still get all the monthly magazines from the Public Service Alliance.

DWP: **In 1955 you wrote in the Forecaster that the PI should restrict itself to professional problems and not address injustices or grievances affecting all civil servants. What did you have in mind then?**

REM: Well, in looking back on it maybe it was pie in the sky but I thought there were quite a few issues at that time that applied across the board to everybody, not just professionals but to everybody and that we should all work together in trying to resolve some of these questions; things like superannuation, permanency, holidays, sick leave all the rest.

DWP: **Did you ever hold office in the Professional Institute?**

REM: I don't think they'd have let me. There was a man named Barnes in Ottawa who thought I was a traitor, scapegoat, and everything else. At that time I was signing up meteorologists across Canada.

DWP: **You've had a long active association with the Canadian Meteorological and Oceanographic Society. You've been a Councilor and President. In 1964 you chaired a committee charged with the responsibility of planning a change from the Canadian Branch to an independent Canadian Meteorological Society. Was there much opposition to its move back then?**

REM: Well, there was a lot of opposition from me. That was a very difficult situation. Somebody had proposed me as the incoming President of the Canadian Branch. I'd been told by the outgoing President Barney Boville that it was an honorary office - a nice thing to do, and to have on your record. The annual Congress was in Halifax. The first thing that happened after I'd been elected was that there was a motion from the McGill people that we separate from the Royal Meteorological Service. This was news to me. I didn't realize it was in the wind or I never would have taken the presidency. I'm always a strong supporter of the Brits, so I had my problems that winter, Brewer was the vice-president; the two of us weren't very keen on this at all.

At the end of the year, although it cost the society some money, I didn't feel that we should do it behind anybody's back, so I invited the president of the Royal Meteorological Society to come to our next Congress. I thought that maybe he could talk these McGill people out of it. They were the one's that wanted to separate. I couldn't see any reason for forming our own society. I am not quite sure who the President of the RSM was; I think it was Penman (Robinson??) who came over. He and Brewer knew each other, they agreed that it was probably a good thing to do.

DWP: Do you think that the Society has been effective in advancing the science of meteorology?

REM: Oh very, very much so. Yes.

DWP: Were you in favour of the name change from CMS to CMOS?

REM: Oh very much in favour, I'm always one for integrating the sciences. The larger the groupings the better. For example, you can't really discuss climate without bringing the oceanographers into it.

DWP: What does it mean to be a fellow of AMS, AAAS and RMS? Is it anything more than paying your dues? Is it an honour that these organizations bestow upon members?

REM: Well, in the case of the Royal Meteorological Society a fellow is simply anybody who pays his dues, so it's nothing special at all. In fact, you wouldn't even have to be a meteorologist, and looking back at the Royal Meteorological Society in the last century, there were a number of medical doctors and people with private means who were President of the Society. It's a non-professional organization.

But in the case of the AAAS and the American Meteorological Society, there is a small committee that every year recommends from 5 to 15 people to become fellows. You still have to pay your annual membership fees. It's just something you put on your CV and the university takes it fairly seriously.

DWP: **You've been a recipient of many prizes: the CMS President's prize on three occasions, the Patterson Medal, and the AMS Award. Is there any particular award or honour that you value more than any others?**

REM: Obviously, the Patterson Medal.

DWP: **Do you have any memories of Patterson? Did you two have conversations?**

REM: Well, the conversation I remember most was my first day, when I went into the Physics Department at U of T. They sent me over to 315 Bloor because they thought that there were some opportunities for employment. I was ushered into his office where he told me that meteorology was a very good career and after I had gone to university and got a degree then they'd be glad to have me. He thought I was a high school graduate at the time. I must have looked very young.

DWP: **Although it's in the field of air pollution meteorology that you've had you're most important successes, you've made significant contributions in such related fields as engineering, geography, land-use planning, and environmental science.**

How would you describe yourself?

REM: It depends who I'm talking to and who I want to impress at the moment. I'm known around here as an environmental scientist. I can work in eight or nine areas; most of the time, there's not much meteorological involvement. I do things like environmental impact assessments, risk managment and various studies. Right now I'm coordinating an activity on resource accounting for Statistics Canada - developing a framework for a national account system for renewable resources. I'm interested in doing different things everyday of the week.

DWP: **I think one of your greatest strengths is your ability to synthesize so many different sources into a readable, easily understood summary. How do you view survey papers? Do you think that they are even more valuable now, expecially since scientists are faced with such an enormous explosion of information?**

REM: Yes, I think so, and in particular I think there is a need for a historical perspective. As editor of a journal, I find that people are really not aware of the connections between work that was done in the '50's with that being done now. They are not really reinventing the wheel but they're not exploiting the old information. I don't intend to do this myself, but I think it would be useful if people sat down and wrote a review of say, the development of forest meteorology or agricultural meteorology over the last 30 years, so that they could see the ideas that had been

tried, see the ones that had worked and the ones that had failed. How early ideas had been dropped, then came back and were put into focus. The new student is hit with such a large body of information.

I've just been reviewing the latest edition of Frank Pasquil's book on turbulent diffusion for the WMO Bulletin. This is the third edition and now the reference list has grown longer and longer and nothing has been dropped. A lot of the early material is not that relevant. I don't think it's a bad idea to write a second or third edition of a book. But at the same time, there's a need for these review articles.

DWP: **In 1971 you suggested that the Meteorological Service should send a few promising meteorologists to schools of economics for a degree. As far as I know, we don't have any sociologists or lawyers in the Meteorological Service. Is this still a suggestion that you would make today?**

REM: Yes, that's a great mistake. There's something wrong with the way science is organized in this country. It's impossible even at the universities to get funding for climate impact studies which somehow falls between NSERC and the Social Science Research Council.

In principle, there's a mechanism in Ottawa for these two Councils to get together, but in practice it doesn't work. If you try and do cost effectiveness or cost benefit studies of climate variability or climate impact, NSERC won't fund you and the Social Science Council won't. Maybe the Canadian Climate Program can do something.

DWP: **You've authored more than 200 scientific papers and a dozen books.**

Do you remember the paper Early Greek Explanations of the Nile Floods?

REM: That again was Rube Hornstein's influence. Andrew Thomson sent a memo across the country to all the field offices saying that the Royal Meteorological Society was going to start a publication called Weather. It was to be a popular journal, and he hoped that Canadians would support it. Two years later he sent another memo to the OICs of the offices to say there were no Canadian contributions to Weather and to get cracking writing papers. Well, Rube's response to that second letter was to put a memo on the office file saying that the Halifax Weather Centre, or whatever it was called then, was to produce one paper every two months. He put down a roster of papers - Reed Dexter was due by March, Doug Holland by May and so on. When Rube told you to do something you did it. We all sat down and scratched our heads to try and think of ridiculous things to write on. I wrote this paper on early

Greek theories. It went through Headquarters at that time; you never sent anything on your own and they sent it along and it was accepted. That was kind of fun.

DWP: **Your paper on the Application of Air Pollution Climatology to Town Planning won for you the 1954 President's Prize of the Canadian Branch of the Royal Meteorological Society. Was that your first paper on applied meteorology?**

REM: I think so. It was about some of the Windsor-Detroit air pollution information. It was my first foray into air pollution. It was about the fact that if you wanted to minimize air pollution you should put industry, not on the upwind or the downwind side of a city, but in that part of the city which was related to episode meteorological conditions. In other words, meteorological episodes with southeast winds, even though they are light, then it would be better to put heavy industry on the northwest side of the city, even though the prevailing wind was west to northwest.

DWP: **One of my favorite Munn papers is the one you wrote in 1974 at the Symposium on Meteorological Challenges. It's title is Applied Meteorology and Environmental Utilization. In that paper, you say that, "the applied meteorologist is sometimes considered to be an entrepreneur by his colleagues". What did you mean by that?**

REM: I would say that two of the entrepreneurs of the Meteorological Service at that time were Jim Bruce and myself. We were out persuading people in other disciplines that they could do their job much better if they got some proper meteorology into it and convincing them that they could use our services. In most cases, it has always been true of climatological services, people phoning in wanting information. If you give them the information they are asking for, it's probably not what they need at all. If you can find out what their problem is, you can give them the right information and eventually, if you go about it the right way, you can end up providing a major service for flood control, or air pollution, or agriculture, or whatever.

DWP: **In that same paper you talked at length about the information explosion. Twelve years later the situation has probably gotten worse. You once said that scientists should devote a certain amount of time reading the literature.**

REM: You have to be a fast reader these days to keep up with the material. If anything causes civilization to collapse it will be the information explosion in the next century.

There are signs of new information transfer techniques such as computers and all these modern systems. Usually, I find that they don't work too well because things are filed in the wrong place. Maybe they were filed in the right place in 1980 but not in 1985. For instance, when the information was needed to do an assessment of acid rain in Canada, there was a basic set of papers but they weren't given an acid rain label in the '60's and early '70's. If you had done a computer search to find them, you probably would never have tracked them down to start with. I'm not completely sold on these information systems.

DWP: **For more than 13 years you have been editor of Boundary-Layer Meteorology. How did you get involved with Reidel Publishing Company in that venture?**

REM: Well, that came about through Dr. Schmidt who was the Chairman of the WMO Working Group on Air Pollution and Air Chemistry. I was a member of the group in the 1960's. He lived in the Netherlands and he had been talking to the Dutch publishing company, Reidel about the need for a journal in boundary-layer meteorology. They wrote to me and asked me if I would organize something. At that time, I thought there were too many journals but I offerred to send a letter out to a number of people around the world and see what they thought. Strangely enough, the response was all very positive except in Britain. The three British people I wrote to were very much opposed to a new journal but, in the rest of the world, they thought there was a need. There's such a wide spectrum of papers now. If you can only buy so many journals a year, you have to get more specialized.

DWP: **Have you or has the publisher encouraged the number of yearly issues to go from 4 to 12?**

REM: No. It's just the constant pressure of the number of manuscripts coming in that keeps increasing. I don't know where it will all lead.

DWP: **Your book Descriptive Micrometeorology is very popular. How did this book come about?**

REM: Well, I was asked to teach a course at the University of Toronto. It started out as a set of course notes and it developed from that into a book. It's very much out of date now and I'd like the publisher to take it off the market, but he never does. He keeps suggesting that I rewrite it. There is certainly a need for a new textbook. I'm appalled at some of the things that people are quoting, out of the book, which I know are wrong.

DWP: **How important was that book to your career? Did it open up a number of important avenues for you?**

REM: I don't know, you'd better ask some other people.

That group I had in the '60's at Spadina Road, for the first time brought an international reputation to Canada in that general area. Up until then, the two countries that were identified with micrometeorology were the Soviet Union and Australia. Prior to that it had been the U.K. but then it shifted and the Canadians came in, not only through our small group but through groups at Guelph, Waterloo and elsewhere.

DWP: **I've been told that you really don't care too much for administrative work.**

REM: That's right.

DWP: **However, in your position you must not escape it entirely. Do you have a particular routine that you follow for handling teaching, research and administration.**

REM: It depends what you mean by administration. Some so-called paperwork I enjoy; like I produce the Annual Report of the Institute and it's kind of a fun thing. It has pictures and informal poses, sort of like a college thing. There's some stuff like that that I enjoy. Getting myself at a meeting which is not related to my interest and I'm just there representing a larger group, like the Law of the Sea can be boring.

The Law of the Sea was Maxwell Cohen's Working Group that I was involved in. That turned out to be interesting, but sometimes you could get stuck into a situation like that and it's really, really boring. You can get trapped into it and there's no way you can get out of it. I guess writing a funding proposal can be pretty boring sometimes. You have to do that at the universities and at AES too.

DWP: **I think you always had a nose for the important new environmental issues. You're a pioneer in air pollution meteorology, in long-range transport, environmental impact assessment. What does it take, not only just to be abreast of what's happening but to be ahead of change?**

REM: Henry Regiar at this Institute is always talking about whether it's a good idea or not being ahead of the pack. It's frustrating in a sense that you can never get the support that you need. And as soon as the pack catches up with you, you might as well go into some other field.

We're always trying to figure out the problem of the next century. I produced a document for UNEP on the Environmental Prospects for the next century. I was a senior consultant to UNEP in 1981-82. UNEP produced two documents for the tenth anniversary of Stockholm. One of them was a ten year review of what had happened in the environment. It's about an 800 page book and I wrote the chapter on what had happened to the atmosphere; in most cases we just don't know what had happened.

Then the other thing they produced was a retrospective book on a series of environmental prospects coming up in the next century. The final document is largely the output of this Institute. We got a lot of flack from various people, but they didn't have very much to say. The tack we took was that the most important thing that would happen would be that there would be a lot of surprises. The main question that people should be looking at is how to prepare for surprises.

DWP: **You've had an important influence on the Canadian Meteorological Service not only though your research contributions but also by the encouragement you've given to others. Why do you think it's important for scientists to go and take their doctorate?**

REM: A doctorate is just a meal ticket, it's not in itself so important as spending a year in a research institute. Doing things that are foreign to what you've been doing is a very broadening experience, as long as you get involved in what they are doing. If you go somewhere and want to continue what you've been doing back home, it's a waste of time.

There is a certain fraction of Post Doctorates who come in and think their thesis is so important that they want to continue doing it for the next two years. They might as well go back home because they are not contributing. For me going to Stockholm and getting involved with what Henning Rodhe and Bert Bolin were doing was great fun. The same thing has happened to Doug Whelpdale and Leonard Barrie. I had quite an argument with the establishment to get both Whelpdale and Barrie overseas the first time. But that was the only way we were going develop competence in this area, there was no place they could go in Canada.

Lam Barrie got his doctorate with Georgii in Germany and I had to pull all the barrels on that one. Not with Warren, Warren was supportive, it was higher up. I'm not sure whether it was Don McIntrye or whether it was Reg Noble but there was some reluctance.

DWP: **Do you think that AES provides too much of a service at the expense of the private sector?**

REM: I don't really have any strong views one way or the other. I think there's enough work for everybody. It's nice to have a place where you can get climate data and some basic services.

The other area, of course, is the role of the consultants and the universities. We are always being asked to provide a consulting service, not only myself but everybody in this Institute. The engineering firms get a little bit upset because we're drawing away business from them. It's a continuing problem.

I've just had a request yesterday to put in a funding proposal for an environmental impact assessment for the urban development of downtown Toronto south of the railway tracks. They've just unveiled this thing two weeks ago. So I guess I'm going to do what you call a scoping job to tell them what I think the environmental issues are and what kind of approach should be taken to them. It includes not only the atmosphere but all kinds of different environments and social questions. I can see the consulting firms being very upset about this.

DWP: Do you think that AES should be more or less involved in direct research?

REM: I think they're playing an important role. I wouldn't want them to reduce their effort like is happening in the United States. I think there should be some new money for the universities in some of the applied fields. I think the idea of reducing the in-house research, such as is happening in Lands and Forests, is ridiculous. They're now talking about moving all of their research in the Ontario Ministry of Lands and Forests to the universities. It means that there will be nobody left back home to monitor what's going on.

DWP: Can you briefly tell me what your association has been and what your scientific opinion is of the following people: Bert Bolin.

REM: Oh he's a superstar. What is absolutely unique about him is that he can attend a seminar in field in which Bolin has no expertise, and Bolin will ask the key question at the end of the seminar which will either illuminate what the lecturer has been doing or dreadfully embarrass him. Just to have lunch with him, and sit back and listen to his latest ideas is great.

DWP: What about Chant?

REM: You must have read a book review of mine. Well I don't think much of him. I don't think he's had much impact around this university either except as a politician. Some of his predictions in the early seventies that the world oceans were going to die by the year 1980 and things like that were baloney.

DWP: What about Warren Godson?

REM: He may have his critics around AES, but as far as I am concerned he's really treated me well through the years. We worked well as a team on IAMAP - he was secretary and I was the assistant secretary. He brought me into the international arena. I have a feeling that he is a little bit too critical of second-rate people. I sometimes get embarassed by the way he criticises somebody in front of me. But as far as being a scientist, he's a good man.

DWP: What about Ken Hare?

REM: Oh again, he's a super scientist but on a different sphere. Whereas Bolin and Godson are what you call "hard" scientists, Ken Hare brings in the social sciences. He realizes the policy and management implications of science. I have a lot of time for him too. He's good.

DWP: What do you foresee as the primary challenge to AES from now until year 2000?

REM: It's a general question, which we look at in some detail in this Institute, of organizations getting out of step with the problems of the day. How do you re-organize? How do you maintain the flexibility so that you can deal with a new question that comes along, without disturbing the status quo? This whole problem of preparing for surprises. Should you have some people working on research that won't be useful for 20 years time, and building up a competence in some of these new areas that are coming along? An example is the whole area that John Reed is into with risk, e.g. the very unlikely possibility of an explosion of heavy gases.

DWP: What challenges remain for Ted Munn?

REM: Oh well lots of them. I'm going to a meeting in Boston the week after next to discuss a programme to support IIASA, the International Institute of Applied Systems Analysis. We were going to develop a North American programme to look at the resilience of the biosphere. The lead agency in Canada is going to be this Institute. The principal investigator is going to be Ted Munn so that's one thing I'm going to be doing.

I would like to spend a lot of time on the climate impact side. If I could get anybody to fund the social sciences side of climate impact, that's what I would like to do. I've been trying for five years now and I haven't had any success. I've got a big strategic grant into NSERC, but I don't think it's going to fly.

DWP: **Do you think that climate and climatic variability will one day become a major political issue?**

REM: Oh sure. It is now. As Federov of the Soviet Union said at a cocktail party at the World Climate Conference, there will never be another world war over ideology. The major concern that he sees is that there'll be a weather anomaly that may last two or three years and that one side, either the West or the East will treat it as an anomaly and the other side will treat it as the first sign of a change in climate. That will put such enormous pressure on resources, and taking some action on one side or the other that, it's a major cause for another world war - resource pressures rather than ideology.

DWP: **Well Dr. Munn, thank you for giving up your valuable time to permit me to interview you. For me it's been a most interesting two hours.**