A Short History of Meteorology at McGill

by R.R. Rogers

Although the Department of Meteorology was established in 1959, the history of meteorology at McGill actually had its start a century earlier. It was in 1856 that Charles Smallwood, M.D., from the University of London, received an honorary LL.D. from McGill and an appointment (also honorary) as Professor of Meteorology. This was just a year after George Templeman Kingston had been appointed Professor of Meteorology at the University of Toronto, the first such appointment on the continent. With a residence and medical practice in St. Martin, Quebec (now downtown Laval), Dr. Smallwood in 1841 had added to his establishment a small wooden building to house observing equipment and apparatus "for the purpose of Meteorology." An enthusiastic observer and student of the weather, he took regular readings several times a day of the temperature, pressure, and precipitation amounts, and kept notes on the temperatures of springs and rivers, the flowering dates of plants and trees, and the time of appearance of animals, birds, fish, and insects. In 1863 he moved the equipment from St. Martin to a small stone building on the McGill grounds. The McGill Observatory was thus established and continued without interruption until 1992, when the responsibility for downtown Montreal weather observations was taken over by Environment Canada.

Smallwood died ten years after his move to McGill and was succeeded as Observatory Director by Clement Henry McLeod, who had just graduated in McGill's first class in engineering. The next year, in 1874, McGill became a "chief station" in the new observing network of the Canadian Meteorological Service, connected directly by telegraph to the central forecast office, reporting observations every three hours. One of McLeod's specialties, as a civil engineer, was surveying. Accordingly, his first achievement at the Observatory was to establish its exact longitude. By determining the longitude relative to Harvard College, and later relative to Greenwich, he was able to improve slightly the figures for the whole North American continent. With McLeod as superintendent, McGill Observatory became the principal time-keeping observatory in Canada in addition to its weather observing duties. In the late 1920s, the Dominion Observatory in Ottawa took over the task of being the country's time keeper, but for another forty years the railways continued to operate on McGill Observatory time.

During his half-century as Director, McLeod worked on meteorological problems in collaboration with some of McGill's most eminent physicists. He and H.L. Callendar studied the variation of soil temperature with depth. With H.T. Barnes he measured the temperature difference between the Observatory and the top of Mount Royal, finding that changes at the Observatory were often anticipated by those on the mountain, before the ideas of fronts and airmasses had been conceived. After McLeod's death in 1917, Barnes continued with research on the physics of ice for another two decades and became a world authority in this field.

It was World War II that led to a resurgence of activity in meteorology at McGill. Wartime needs had stimulated great advances in weather observing and forecasting. Afterwards there was a world-wide flowering of meteorological research, in which McGill would play an important part. Two new faculty members arrived just after the war who set the course for McGill meteorology for years to come.

Stewart Marshall, from Queen's University and the Cavendish Laboratories, had been among the first to observe precipitation by radar in the war years. From 1943 he headed Project Stormy Weather of the Canadian Army Operational Research Group, the purpose of which was to make sense of the "weather" echoes. In 1945 he joined the Department of Physics, transplanting Stormy Weather research from the National Research Council to McGill and initiating the unbroken history of radar meteorology at McGill. Marshall's first graduate students were Walter Palmer, who had been with him in Ottawa, Kenrick Gunn, and Walter Hitschfeld.

In 1946, George Kimble, Chairman of Geography, attracted to McGill Kenneth Hare, an Englishman with wartime experience as a meteorologist with the RAF. Kimble, himself an Englishman, had arrived only a year earlier as McGill's first Professor of Geography, and had served in the war in the British Naval Meteorological Service. Hare began a research program focused on the synoptic meteorology and climatology of polar regions. One of his first graduate students was Svenn Orvig, a Norwegian who had flown for Ferry Command. The program grew, and the Department of Geography awarded several graduate degrees essentially in meteorology. In

1954, Hare arranged to have transferred to McGill from UCLA a research project in polar meteorology supported by the U.S. Air Force Cambridge Research Laboratories (AFCRL), thereby forming the Arctic Meteorology Research Group. Coming with the project was Arthur Belmont, who had been a key participant at UCLA.

By 1959 the research and teaching activities of the Stormy Weather Group and the Arctic Meteorology Group, both enjoying financial support from American and Canadian sources, had grown to such an extent that the University approved the formation of a Department of Meteorology. Geography had already offered an M.Sc. in Meteorology on a "restricted basis," and the University had agreed in 1955 to offer on the same basis a Ph.D. in Meteorology for students working under Hare in Geography or Marshall in Physics, with Hare serving as "chairman" for administrative purposes. Arthur Belmont received his degree by this arrangement in 1956, with Dr. Hare as supervisor, and was thus McGill's first Ph.D. graduate in Meteorology. The following year Richard H. Douglas was awarded a Ph.D. in Meteorology under Dr. Marshall.

At the time the Department was established, the Stormy Weather Group consisted of Marshall, Hitschfeld, Gunn, and Douglas. Tom East and Walter Palmer, active members of the group in the early 50s, had left McGill, while M.P. Langleben and P.R. Wallace had by then moved away from atmospheric science but remained in the McGill Physics Department. E.J. Stansbury of Physics was just changing his research interests from the Eaton Electronics Laboratory to the Stormy Weather Group. The Arctic Meteorology Group consisted of Hare, Orvig, and Byron Boville, Belmont having left McGill.

In the Stormy Weather Group, research highlights up to 1960 included the work by Marshall and Palmer on raindrop size distributions; that of Gunn and Hitschfeld on droplet growth by coalescence; the research with Milton Kerker of Clarkson College and David Atlas of AFCRL on scattering and depolarization by non-spherical particles; Langleben's studies of the sizes and fall speeds of snowflakes; Gunn and East's calculations of the influence of precipitation on microwave propagation; the work by Marshall, Hitschfeld, Wallace, and Ph.D. student Arnett Dennis on radar signal fluctuations; the work with another student, Caroline Rigby, on precipitation development; Douglas's study of snow generating cells and later his initiation of the Alberta Hail Project; laboratory studies on freezing nucleation by Stansbury; and a continuous series of technical innovations to improve radar as a meteorological instrument. This remarkable research record easily made McGill a leader in radar meteorology. The only close competition was from the Weather Radar Project of the MIT Meteorology Department, also established at the end of World War II.

Accomplishments in the Arctic Meteorology Group to 1960 included Hare's monumental study of the climatology of the Canadian Subarctic, early work on airmass modification over open water by F.E. Burbidge, micrometeorological studies related to glaciers by Orvig, Mariano Estoque's work on Arctic circulation, and Boville's analysis of the dynamics of the circumpolar vortex. For the five years up to 1956 Orvig had served as Assistant Director, and then Director, of the Montreal-based Arctic Institute of North America. The series of Stanstead Seminars, launched by Hare in 1955, continues to the present.

Charter members of the Department of Meteorology were Marshall, Hitschfeld, and Douglas from Physics, and Hare, Orvig, and Boville from Geography. Marshall and Hitschfeld held joint appointments in Physics, Hare in Geography. Marshall was appointed Chairman in 1960. From the beginning there were good relations between the Department and the Canadian Meteorological Service (now called the Atmospheric Environment Service). While they were graduate students at McGill, Boville and Douglas had been on leave from the Meteorological Service. They were mature students with broad experience in operational meteorology and applied research. With the blessing of the Meteorological Service, they remained to join the faculty of the new Department. The Superintendent of Atmospheric Research in the Meteorological Service, Dr. Warren Godson, often came to McGill in the late 50s and early 60s to advise and collaborate with the Arctic Meteorology Group.

In a letter of February 1960 to McGill Principal F.V. Cyril James, Dr. Patrick D. McTaggart-Cowan, Director of the Meteorological Service (later to become Executive Director of the Science Council of Canada), wrote:

> *"I would like to assure you that I am personally delighted that McGill University is establishing a Department of Meteorology and I know the Department will*

make a valuable contribution in the field through the years, as in fact it has already through the efforts of Professor Hare and Professor Marshall."

To this nice expression of support, he added:

"Quite apart from my personal interest, the Meteorological Service has perhaps a very real and selfish interest . . . in that the teaching conducted by the McGill Department of Meteorology will produce well-trained graduates which we hope will help to reduce the very great shortage of meteorologists in Canada with which we have been contending since the end of the war."

Now, 37 years later, the shortage over, McGill has awarded more than two-hundred B.Sc. degrees, close to 270 M.Sc. degrees, and an even hundred Ph.D. degrees in Meteorology. Nearly half of the graduates have taken positions with the Meteorological Service. In fact, a list of McGill Ph.D. graduates who have stayed in Canada is almost a "Who's Who" of leading scientists and administrators in the Atmospheric Environment Service.

Graduate and undergraduate curricula in Meteorology were introduced as soon as the Department was established. At the undergraduate level the plan was to have a program strong in physics and mathematics, including sufficient meteorology for professional employment or for postgraduate study in meteorology at any university. The graduate program was designed to accommodate students from physics or applied mathematics with little prior exposure to meteorology, because at that time there were no other undergraduate meteorology programs in Canada. Although this approach imposed a relatively heavy course load on graduate students, the M.Sc. program was nevertheless strongly oriented toward research, including a second year devoted to thesis research. With some adjustments, the original plan has served the Department well over the intervening years.

Although the research programs already had considerable momentum on their own, the formation of the Department led to an expansion of activity. More students were attracted to meteorology than previously and many were better prepared for research, through courses designed specifically for the subject rather than traditional physics or geography. At least half of the M.Sc. students through the decade of the 60s and a few years beyond were AES meteorologists on academic leave with financial support provided by their employer. It is clear in retrospect that the graduate teaching program, as it took shape in the early years, was strengthened by the regular presence of a significant proportion of students with experience in operational meteorology. They could readily see the connection between theory and the practical problems of weather forecasting. Moreover, because they did not require financial support from the Department, the research income which otherwise would have been needed to support students was free to use for research associates and postdoctoral fellows.

By the mid-60s there were two distinct areas of activity within the Stormy Weather Group. Some staff members and students did research centered on radar and laboratory studies in Montreal; others were affiliated with the Alberta Hail Project. The Montreal-based research was still supported by contracts with AFCRL, but an increasing fraction came from Canadian sources, primarily NRC and the AES. In 1967, AFCRL presented Dr. Marshall with a brand-new radar having outstanding potential for meteorological work. A laboratory on the campus of Macdonald College was built to accommodate the radar and had its formal opening in 1968, just in time for the 13th Conference on Radar Meteorology of the American Meteorological Society, held at McGill in August of that year.

The Alberta Hail Project was a unique example of what can be achieved through creative management and friendly collaboration: the Alberta Research Council provided staff and facilities for the field program; the National Research Council built the radar at the field site in Penhold, Alberta; the AES provided meteorologists and observers; McGill was responsible for scientific direction, with financial support through a contract with AES. Major advances were made in understanding atmospheric processes associated with hail production and in perfecting new observing techniques. A theory of hailstorms and hail development was introduced by Hitschfeld and Douglas, and later elaborated by Ph.D. students Marianne English and Alex Chisholm. A novel way to analyse the airflow around storms was developed by Norman Thyer and Gerd Ragette.

Two other Ph.D. students, Brian Barge and Robert Humphries, were first to use the new NRC radar for meteorological studies, and with Glen McCormick and Archie Hendry of NRC pioneered the techniques of polarization-diversity measurements. On the theoretical side, Ramesh Srivastava in the early 60s analyzed the relation between cloud dynamics and precipitation development in a one-dimensional, time-varying numerical model, initiating what was to become a major area of cloud physics. His work at McGill was the starting point for a continuous progression of research through Ian Harris, Takao Takeda, J.T. Steiner, and now M.K. Yau and his students. Innovative laboratory work on freezing nucleation was carried out by Dr. Stansbury and Gabor Vali, providing insight on hail formation from a microphysical perspective. Their techniques, developed further and applied elsewhere, led quite unexpectedly to the discovery of biogenic ice nuclei and the possibility of reducing frost damage to plants through biological controls.

By the time the Department had formed, the Arctic Meteorology Group had two branches, one concerned with physical climatology, the other with large-scale dynamics. Eberhart Vowinckel, who arrived in 1960, worked first as a research associate with Dr. Orvig and later became a regular faculty member. His specialty was the energy exchange between vegetated surfaces (particularly forests) and the atmosphere, which complemented similar work of Orvig for snow and ice surfaces. Their close collaboration produced a number of now classic papers on energy budget climatology, originally over polar surfaces but gradually extending to any kind of earth surface. Their Arctic research culminated in the book Climates of the Polar Regions, edited by Orvig and including a large part co-authored by Vowinckel and Orvig.

Peter Summers was among the first to study quantitatively the meteorological aspects of urban air pollution. In his Ph.D. thesis of 1964, the then-novel concept of the "urban heat island" was used to explain pollution phenomena in Montréal. After devoting more than a decade to research in hail and cloud physics, Dr. Summers returned to pollution studies and was for many years a leader in acid rain research in the Air Quality Branch of the AES.

The research in dynamic meteorology in the early 60s was directed by B.W. Boville. His students worked on computer modeling of atmospheric flows and on observational studies of large-scale energetics and dynamics. Highlights of the early years are without doubt the contributions made in the development of spectral models. André Robert's Ph.D. thesis, for example, was the first global, primitive equation, spectral model of the atmosphere to be published. Further contributions to this rapidly-expanding field grew from the work of Philip Merilees as a Ph.D. student and later a faculty member. One of his students, Roger Daley, has become a leader in spectral modeling.

The decades of the 70s and 80s saw the Department through periods of growth and retrenchment, but throughout this time there was a steady output of research in physical and dynamic meteorology, and continuing rejuvenation by new generations of graduate students. With the foundation provided by the Stormy Weather Group and long experience in storm studies from the Alberta Hail Project, the Department was well prepared to contribute to the expanding field of mesoscale meteorology. Unbroken progress continued in large-scale dynamics, and the work in atmospheric radiation initiated by Dr. Hitschfeld was continuing in the new context of climate effects and pollution studies. A signal event of the mid-80s was the formation of a new Climate Research Group. Acting on an opportunity provided by the AES, the Department was successful in obtaining two new faculty positions through the Industrial Research Chair program of NSERC. This event marked the beginning of a period of expansion in which the scope of research activities widened to include oceanography, satellite meteorology, and a broader range of geophysical fluid dynamics than ever before. The expansion enabled strengthening of two long-established areas of research, synoptic meteorology and radar meteorology, by bringing in new faculty members who have added to McGill's record of achievement in these fields, and by acquiring advanced research facilities for atmospheric remote sensing. In 1992, the name of the Department was changed to Atmospheric and Oceanic Sciences to reflect the breadth of the teaching and research activities.

At present, the Department has never been more vigorous, by measures of vitality such as faculty size, graduate student enrollment, research income, and quantity and quality of publications. But McGill, like most universities, is facing a budget crisis, which places a strain on all academic units. Pressures are mounting to change our ways of teaching and doing research, and it is safe to predict that the next few years will see some significant modifications in the

academic programs of the Department. Yet it is also safe to forecast that atmospheric science will continue to be a strength of McGill University, which has one of the longest histories of research in meteorology of any North American university.

About the author: R.R. Rogers is professor of meteorology and past chairman of the Department of Meteorology (now Atmospheric and Oceanic Sciences) at McGill University. He studied meteorology at the University of Texas, Massachusetts Institute of Technology, and New York University. He worked in the Applied Physics Department of Cornell Aeronautical Laboratory in Buffalo, New York, before moving to Canada and joining the McGill Stormy Weather Group in 1966. He teaches courses in physical meteorology and does research in atmospheric remote sensing. With M.K. Yau he wrote a widely used textbook in cloud physics.

À propos de l'auteur: R.R. Rogers est professeur de météorologie et ancien président du département de météorologie (maintenant Sciences atmosphériques et océaniques) de l'Université McGill. Il a étudié la météorologie à l'Université du Texas, au Massuchusetts Institute of Technology et à l'Université de New York. Il a travaillé dans le département de la physique appliquée du laboratoire aéronautique de Cornell, Buffalo, New York, avant de venir au Canada en 1966 pour se joindre au groupe "Stormy Weather" de McGill. Il enseigne la météorologie physique et fait de la recherche sur la télédétection dans l'atmosphère. Il a écrit avec M.K. Yau un livre bien connu sur la physique des nuages.