A Brief History of Meteorological Services in Canada Part 1: 1839–1930

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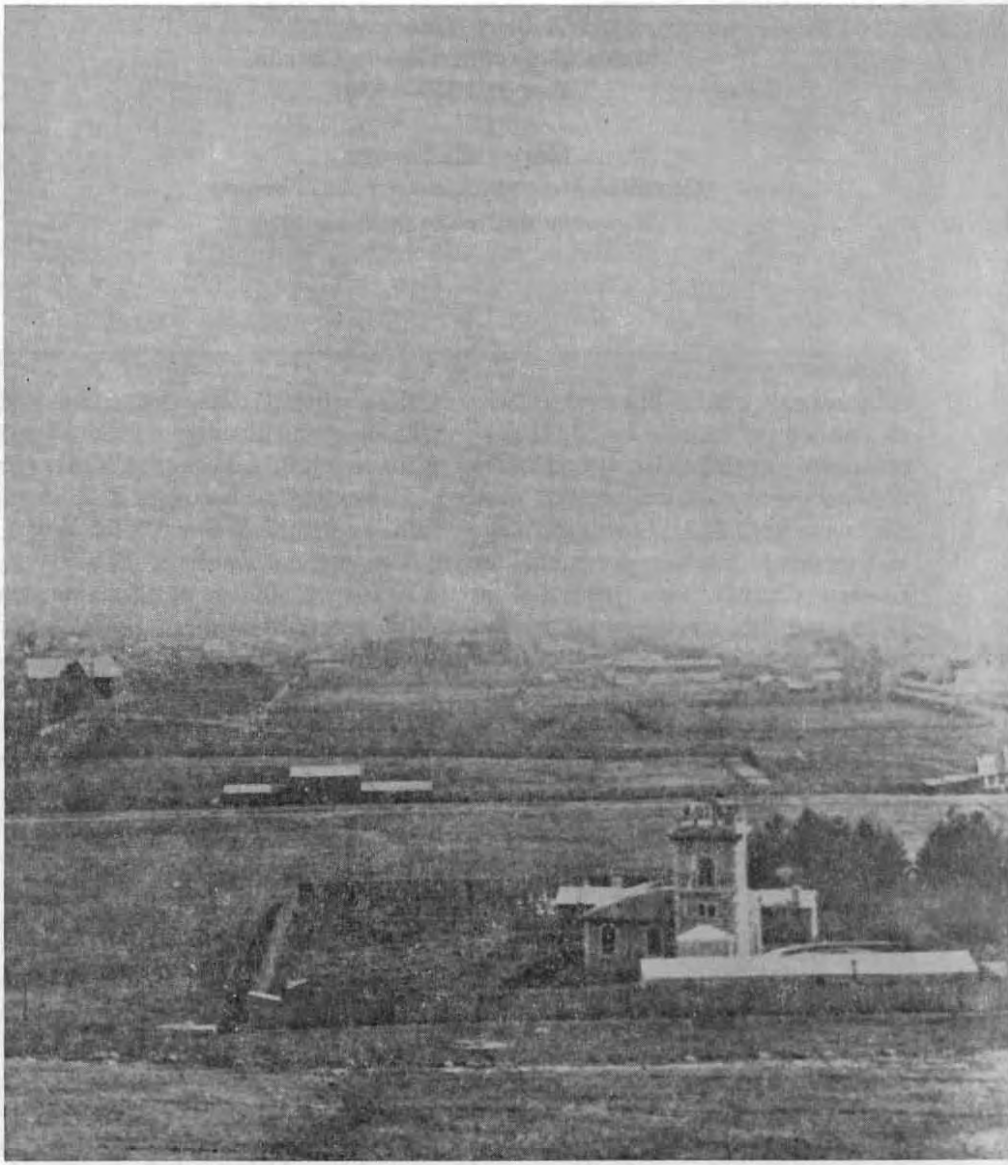
ABSTRACT
Although an official observatory was established in Toronto in 1839, governmental attempts to organize a national meteorological service were not begun until 1871. Storm warnings and general weather forecasts for Eastern Canada were instituted in 1876, and this service was extended across the West and throughout the settled portions of the country by the early years of the 20th century. Historical climatological data were published annually after 1871, but very little statistical data, delineating the climate of the country, were available prior to 1900. A beginning was made at expanding meteorological activities into the North before World War I, but it was not until the 1920's that a significant number of observing stations were located there. By 1930 the need for extensive aviation meteorological services was becoming apparent, but the economic depression prevented an expansion of both aviation and meteorological services.

1 Introduction

One hundred years ago the first step in establishing a national meteorological service was taken by the Government of Canada when the sum of $5,000 was appropriated to the Minister of Marine and Fisheries to financially support the organizing of a system for the taking of weather observations. No appreciable meteorological services had been provided prior to that time despite the founding of the first official observatory in Canada at Toronto in 1839. The story of meteorological services, as distinct from meteorological research, is the subject of this series of articles. Hence this account will not be a complete history of the Canadian Meteorological Service, but the story of its development and organization must be central to a history of the services it has provided.

2 The Toronto Observatory

It is interesting to note that official or government-sponsored meteorology began in Canada as the result of international rather than national or domestic influences, and that the prime purpose for establishing the Toronto Observatory was the need for terrestrial magnetism data rather than for meteorologi-

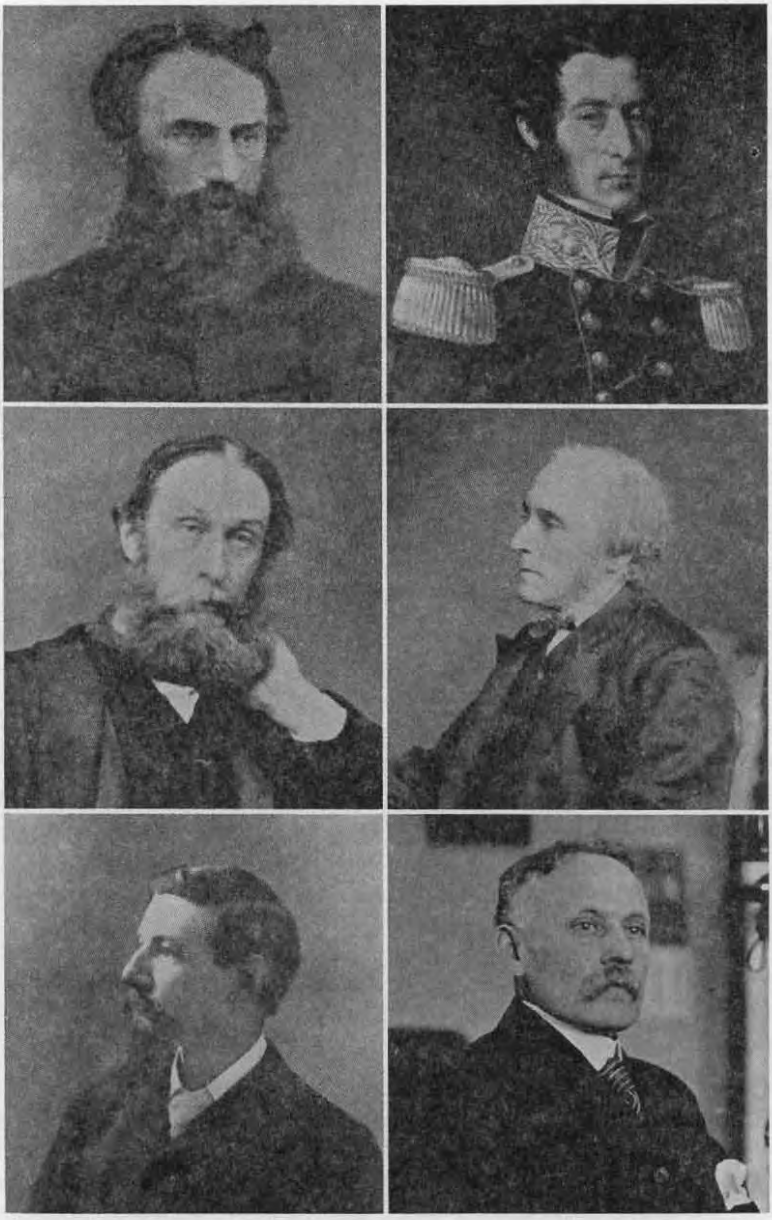


View of the magnetic and meteorological observatory from the main tower of the University of Toronto, 1859. *Photo: courtesy of Metropolitan Toronto Central Library*

cal information and forecasts. Scientific weather forecasting, of course, was unknown in 1839, but it did seem that world-wide observations of magnetism would reveal a useful understanding of that subject. During the 1830's, Baron Alexander von Humboldt, the noted German scientist, appealed to the British Government to establish observatories at several locations throughout the Empire, and in 1838 a decision was made to locate one observatory in Canada. On Christmas Day, 1839, the first official meteorological observations were taken at Toronto, Upper Canada, under the supervision of Lieutenant C. J. B. Riddell (Patterson, 1940; Thiessen, 1940, 1941a, 1941b, 1942a, 1942b).

Scientific meteorological observations had been made in Canada prior to 1839, but it is unlikely that the resulting data had ever been put to much practical use. Fragmentary meteorological reports were prepared and published by European explorers in the North American Arctic during the late 16th and 17th centuries, and in the 18th century, meteorological registers were compiled by military personnel at such locations as Fort Prince of Wales and Fort York on Hudson Bay, and at Quebec. When obtainable, these data were doubtless of value to others planning expeditions and forays into a generally unknown country. Early in the 19th century, in the settled part of the colonies, individuals such as Messrs. Kelly and Watt at Quebec and the Reverend Dade at Toronto, were compiling observations which were used and quoted by those who spoke and wrote on such subjects as the encouragement of emigration from Europe and the effect of clearing and cultivation on climate in Canada.

As intimated above, magnetic observations were of prime importance during the early years of the Observatory. In fact, during 1843–44, Lieutenant Riddell's replacement, Captain J. H. (later General Sir Henry) Lefroy, travelled to Hudson Bay and the Mackenzie River valley in northern Canada to observe magnetic phenomena, leaving the new Observatory in the care of his assistant. However, Captain Lefroy and his superior in England, Colonel (later General) Edward Sabine, were enthusiastic scientists and made sure that the observed meteorological data were properly reduced and published. In 1853 Sabine, incidentally, prepared and read before the Royal Society in London the first scientific paper based on meteorological data from the Toronto Observatory (Sabine, 1853). Also in 1853, responsibility for and control of the Observatory passed from the British (Army) Ordnance Department to the Province of Canada. Financially supported by the Legislative Council, the University of Toronto took responsibility for general control and management of the Observatory. Professor Cherriman was provisional director from 1853 to 1855, during which time a stone building, enclosing the original log observatory, was constructed on King's College Road, University of Toronto Campus. In August 1855, G. T. Kingston, Head of the Naval College in Quebec, was appointed Professor of Meteorology at the University and replaced Cherriman as director of the Observatory.



Successive Directors of the Canadian Meteorological Service, from left to right: Lt. C.J.B. Riddell, R.A., 1839–1841, Capt. J.H. Lefroy, R.A., 1841–1853, Prof. J.B. Cherriman, 1853–1855, Prof. G.T. Kingston, 1855–1880, C. Carpmael, F.R.S.C., 1880–1894, Sir Frederic Stupart, F.R.S.C., 1894–1929

3 Prospects for a national system

During the dozen years before Confederation, responsibilities of the Toronto Observatory were limited to the local meteorological and magnetic observations, but the Director began to play an increasingly important role in meteorological activities throughout the British North American colonies. A Montreal scientist, Dr. Charles Smallwood, M.D. (Marshall and Bignell, 1969), established his own observatory at St. Martin's, Canada East, and amateur meteorologists at such places as Quebec, Hamilton and Stratford, began to take weather observations. In 1858, Dr. Egerton Ryerson, Superintendent of Education in Canada West, was successful in arranging for observations to be taken at senior county grammar schools in the province. The program lasted for nearly twenty years, and during this period the historical climatological record began at several Ontario cities and towns. Early scientific publications, such as the *Canadian Journal* (Toronto) and the *Canadian Naturalist and Geologist* (Montreal), carried articles on meteorology as well as tables of climatological data from the official observatory and private observing stations. However, as Professor Kingston was to note in an official report, prior to the autumn of 1869 there were few meteorological observers in the Dominion, there was no true description of the climatology of the country, and the existing agencies were inadequate to remedy the situation. Needless to say, few, if any, meteorological services were being provided.

Abroad, an embryonic meteorological world was stirring as scientists began to realize the possibility of employing the new electric telegraph to collect data from which storms might be predicted. In the United States, where the systematic collection of climatological data had been ordered as early as 1814 by the Army Surgeon General, the Smithsonian Institution in 1849 organized a small telegraphic network "to solve the problem of American storms" (Hughes, 1970). By the early 1850's, daily weather maps, which contained data from a few Canadian and about three dozen American stations, were being displayed in Washington. Finally, after Cleveland Abbe had inaugurated a private weather reporting and warning service at Cincinnati, the United States Congress early in 1870 established a national weather service and made the Army Signal Service responsible for its operation.

4 Organizing the service

Perhaps inspired by developments in the United States, Professor Kingston had begun to correspond with the Honourable Peter Mitchell, Minister of Marine and Fisheries in the new Canadian Government, in an attempt to impress upon him the advantages and value to the country of a network of stations to observe the weather and of a system to issue storm warnings. Early in 1871, Professor Kingston was advised by the Deputy Minister ... *that the sum of $5,000 has been placed in the estimates for meteorological observations with a view of ultimately establishing storm signals* ...[1], and by an Order in Coun-

[1]Letter dated March 24, 1871, to Prof. Kingston from Wm. Smith, Deputy Minister of Marine.

cil, dated May 1, 1871, the proposal was approved by the Government. This act effectively established a national meteorological service in Canada, and Professor Kingston was authorized to proceed with its organization.

A century later, the amount of money appropriated to organize a service seems quite inadequate, but it must be noted that the government was already supporting the Magnetic and Meteorological Observatory at Toronto, and observatories at Quebec (Capt. Ashe), and Saint John, N.B. (G. Hutchinson), where time services were furnished to shipping. In addition, the observatories at Queen's College in Kingston, and McGill College in Montreal received allowances. Also by 1871 there were scores of Marine Department lighthouses, several of which Professor Kingston considered for use as observation stations, although the lack of communications at many of these isolated locations made them unsuitable for climatological, let alone telegraphic, reporting stations. Starting late in 1869, and continuing during 1870, Professor Kingston had corresponded extensively with all those whom he knew were interested in meteorology. He received much valuable assistance from the railroad and steamship companies, and in their regions, Mr. F. Allison of Nova Scotia and the Reverend Père Bonneau of Quebec were helpful.

5 The first forecasts

Because of the lack of trained scientists and money, and because Professor Kingston believed that the organization should be developed gradually, the new Canadian Service during the first few years of its existence did not prepare any weather forecasts, but on occasion relayed storm warnings from the U.S. Signal Service to other Canadian centres, usually lake and sea ports. A storm warning was defined as ... *a publication of an opinion to the effect that shortly after a time specified or implied, a storm will probably occur in some portion of a certain region within a radius of 100 miles of the port warned.*[2] In 1874, there were 35 of these storm warning stations in eastern Canada, and on 56 individual days during that year storm warnings were dispatched to the proper towns. With increased resources, however, additional staff were hired and trained, more observed data were imported from the United States, and on October 1, 1876, the first Canadian prepared *probs* were issued for Ontario. An indication of the Service's instant success was the following resolution passed in Toronto: *The Marine Exchange cannot close its meetings for 1876 without putting on record its appreciation of the services rendered by the Meteorological Department during the past season in accurately forecasting the weather.*[3]

During these early years two types of forecasts were issued – the cautionary storm signals or storm warnings described above, and the daily probabilities. By 1879 the daily probabilities were telegraphed to 125 places from Ontario eastward to Prince Edward Island at 10 a.m. daily, were posted in the local

[2]*Fourth Report of the Meteorological Office*, December 1874, p. 5.
[3]*Sixth Annual Report of the Meteorological Service*, December 1876, p. xii.

telegraph and post offices, and were published in the evening editions of the various papers in eastern Canada. The work of a meteorologist, in preparing these forecasts at the Central Office in Toronto during the first decade of the Service's existence, would not seem strange to any meteorologist recruited during World War II: ... *the information received is entered on a map of the continent prepared specially for the purpose. The map is then examined by the officer whose duty it is to make out the probabilities and issue warnings when required. In order to do this satisfactorily, it is necessary not only that he should know such laws as have already been established relative to the movement of the various kinds of atmospheric disturbances, but he must also be familiar with a long series of previous weather charts so that he may be able to supplement the conclusions drawn from theory by a practical knowledge of what has followed similar conditions on previous occasions and thus tell at a glance what conditions are likely to prevail during the 24 hours following ...*[4]

Appreciation of the dual value of weather observations and the recognition of the value of climatic data and information, as well as weather forecasts, were apparent in the early days of the Service:

Although the weather predictions are immediately founded on the reports received by telegraph ...

... the returns of these observations are of great value in dispelling the erroneous notions regarding the climate of certain districts, and in aiding farmers and others interested in agriculture to select the crops most suited to the climate, while they furnish intending settlers with data to aid them in choosing localities adapted for general purposes.[5]

Few, if any, applied meteorological studies were undertaken and none was published, but by the volume of correspondence handled through the Central Office it is apparent that at least some information and advice were supplied to the public during these years. Since publication of the Annual Report, which contained considerable historical climatological data, was often considerably delayed, the Service instituted the preparation and publication of the *Monthly Weather Review* in 1877 which contained condensed statistics and information and was available a week or so after the close of every month.

6 Expansion of service

Upon Professor Kingston's retirement in 1880, Mr. C. Carpmael became the new Director, and a period of expansion for the new Service began. During the early 1880's the Canadian Pacific Railway and its telegraphic lines were pushed across Western Canada allowing the establishment of telegraphic weather reporting stations and many climatological and precipitation reporting stations. In Eastern Canada during the summer of 1881 the Service began

[4]*Eighth Annual Report of the Meteorological Service*, December 1878, p. 418.
[5]*Ibid.*, p. 422.

to issue forecasts at midnight so that these might be published in the morning newspapers and also be displayed at telegraph stations as soon as they were opened each morning.

Another innovation of the early 1880's was the dissemination of weather predictions by means of display discs attached to railway cars. The signal word to be displayed was telegraphed each day at about 1 a.m. to the railway agents who would change the signs on cars each morning in an attempt to provide a reliable weather prediction service for the farming community along the lines of the railway. However, through neglect, the local train hands did not always keep the signal discs up-to-date, and this arrangement had to be dropped after a decade or so.

The processing and publishing of climatological data during the early years of the Service presented problems not unlike those experienced today. Checking data was a tedious chore, hardly as glamorous as participating in the preparation of weather forecasts, and when manuscripts were ready there remained the administrative task of finding funds to publish. Official historical data publications had been issued for each year from 1872 to 1890 when lack of both staff and funds forced a postponement which has resulted in a gap in the series of data publications from 1891 to 1895. In 1892, however, the Director was primarily concerned with the possibility of preparing statistical climatological data, that is, the reduced and summarized data based on an accumulated twenty years of data, to form an authoritative government publication on the climate of Canada. Despite special appeals for additional funds to carry out this work, the project did not get underway until well after the turn of the century: the *Climate of British Columbia* and the *Climate of the Prairie Provinces* were published in 1915 and 1920, respectively; the *Climate of Ontario* was prepared but never published; and it is uncertain whether or not the manuscripts for Quebec and the Atlantic Provinces were ever completed.

An Annual Report of the early 1890's mentions that forecasts of the weather were, as usual, asked for by many persons whose avocations were affected by changes in the weather – shippers, brewers, fishmongers, fruiterers and proprietors of skating rinks. In 1886, the Superintendent was able to claim that whenever a storm of any magnitude occurred, due warning was given to shipping. Also at this time railroad companies asked for and received special forecasts of winter snowstorms and thaws. Co-operation with the Canada Department of Agriculture began in 1889 when personnel at four new experimental farms began to observe and report the weather.

As an increasing amount of weather information was being received from Western Canada it was possible to begin issuing forecasts for Manitoba on August 26, 1899, and in July 1903 this service was extended to that part of the Northwest Territories that is now southern Saskatchewan and Alberta. In an Annual Report the Director pointed out that the increased demand for forecasts of the weather was an indication of the reliance placed in them by

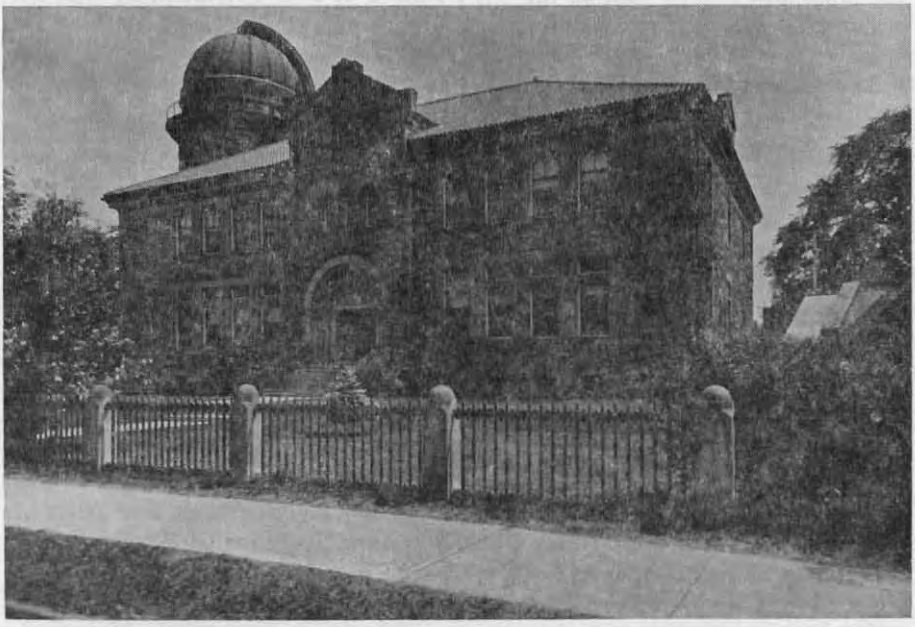
the public. City dwellers as well as farmers were beginning to ask for more services. For example, in his 1894 report, C. H. McLeod, the Superintendent of the McGill College Observatory in Montreal, pointed out the need for a local forecast office in Montreal. In these early years the Service was the only "scientific institution" in the Department of Marine and Fisheries, and because of this became involved in new scientific activities such as seismology and tidal and hydrographic surveys as well as maintaining the magnetic and astronomical observational work, the provision of time services, etc. Important as these activities were, the Meteorological Service's involvement in them must have detracted considerably from the provision of meteorological services.

In October 1894, upon the death of Professor Carpmael, R. F. (later Sir Frederic) Stupart became Director. Stupart, in 1872, at the age of 15, had been one of the first to join the Service as a map draughtsman after Kingston had been authorized to organize a national service. The *Monthly Weather Map* – a narrative and tabular description of the previous month's weather – was instituted in 1894, and during the following year staff at the Central Office in Toronto also began to prepare and mimeograph a daily weather map for distribution. Until this time all weather forecasting for Canada had been carried out in Toronto, but with the expansion of the observing network into the West and North, staff at the chief station in British Columbia, Victoria, began to forecast the weather for the southern part of that province.

7 The pre-war era

By early 1905 the Service had grown to employ 185 people, including 20 at the Central Office in Toronto. Most of the staff outside Toronto were employed on a part-time basis for either observing the weather or displaying storm signals. There were 374 observing stations, of which 34 telegraphed reports twice daily to Toronto. Forecasts were issued at 10:30 a.m. and p.m. The evening forecasts were published in nearly every morning journal in the Dominion, and in addition were posted at all telegraph offices. The morning forecasts were published in the afternoon papers and were posted at conspicuous places in shipping ports, while in many of the large cities of Canada a weather bulletin was duplicated and distributed to business houses and shippers of perishable goods. It is interesting to note that at this time, thirty years after the establishment of the Service, practically all the forecasting was done by the Director and his deputy, B. C. Webber, and although two assistants were employed, they were rarely allowed to issue the bulletins. Further, it was then the policy that the forecasters should inspect the outside stations in order to ... *have a perfect knowledge of the country, and also a complete change from the very trying work of issuing bulletins which were sure to be duly criticized by the public.*[6] In British Columbia regular daily forecasts were

[6] *Thirty-Fourth Annual Report of the Meteorological Service,* June 1905, p. 126.



TOP: The Toronto Observatory 1854–1907 and Headquarters of the Canadian Meteorological Service 1872–1907, situated 27 feet from Convocation Hall at the University of Toronto until 1908. *Photo: University of Toronto Archives, c. 1922*

BOTTOM: Headquarters of the Canadian Meteorological Service, 315 Bloor Street West, erected 1909. *Photo: University of Toronto Archives*

issued from Victoria by E. B. Reed and F. M. Denison with a gratifying degree of success – ... *notwithstanding the difficulties to be contended with in forecasting on the Pacific coast, the percentage of verification obtained is most creditable.*[7]

Early in this century the Central Office outgrew the original observatory building, and in September 1909 the staff moved into a newly built Meteorological Office at 315 Bloor Street West. Also during the first decade of the century three young men, who each was to leave his mark on Canadian meteorology, joined the Service. In 1901 F. O'Donnell was appointed to the staff as a clerk. He worked his way through the ranks and on retirement in 1946 had been head of the Forecast Section for a number of years. In 1907, an M.A. graduate, A. J. Connor, was employed as a part-time forecaster but primarily to undertake the special studies in climatology mentioned earlier. He soon became known as the Dominion Climatologist and was in charge of this branch of the science until his retirement in 1950. In 1910, John Patterson, M.A., a Canadian meteorologist who had been in the Indian Meteorological Service, joined the Service as a meteorological physicist, and the following year began to explore the upper atmosphere by means of balloons and kites. Patterson's scientific and administrative abilities quickly became evident and later in his career he was to lead the Service for nearly twenty years, including the difficult and expansive war years of the 1940's, until his retirement in 1946.

There was further expansion in each province during the early years of the century as chief meteorological stations were set up to which persons seeking information could either visit or write. By 1914, in addition to the Victoria Office, such offices were located at Edmonton and Moose Jaw in the West, and a local meteorological office had been established in Vancouver, while in the East the observatories at Montreal, Quebec, Saint John and Halifax continued to function as both observing stations and information centres. At the Central Office in 1914, a new branch of the Service was inaugurated for the study of agricultural meteorology in general and specifically to cooperate with the Dominion Experimental Farm system in field experiments on spring wheat in relation to weather. About this time an improved method of providing forecasts to the public was introduced by which the latest forecasts were delivered to the telephone exchanges in a large number of towns in Ontario so that subscribers on rural lines could obtain them by calling their local exchange. It was still felt, however, that forecasts could best reach the largest number of people by being published in newspapers, and since rural mail routes were becoming more numerous, increased attention was paid to the preparation of the 10 p.m. forecasts which appeared in all morning papers. Although meteorological activities were somewhat curtailed during the period of the first World War, a new office was established in the Winnipeg Grain Exchange in 1918 to provide climatological information and forecasts to those active in the grain trade.

[7] *Ibid.*, p. 129.

8 The Twenties

By the early 1920's the availability of weather forecasts in the daily newspapers was an accepted part of Canadian life. Forecasts were issued twice daily at 10 a.m. and 10 p.m., each for the ensuing 36 hours, based on data from about 36 Canadian, 5 Newfoundland, one Bermuda and 100 American stations. In addition to the availability of the forecasts in the press and at telegraph offices, the new government wireless stations had begun broadcasting forecasts for the benefit of shipping on the Great Lakes and along the Atlantic coast.

In July 1929, Sir Frederic Stupart retired and was replaced as Director by John Patterson. It is interesting to note that Sir Frederic was active as a weather forecaster until his retirement. In 1876, the young Stupart had issued the first storm warnings prepared in Canada, and the system of analysis and forecasting he helped to develop in the 1870's remained virtually unchanged throughout his career. In the decade before his retirement a new scientific and physical approach to meteorology was under development in Europe, and the Service was to find that many highly trained meteorologists would be required to carry on the work begun by the retiring Director and other veterans.

Directors Kingston and Stupart were in charge of meteorological activities in Canada for 60 of the 74 years between 1855 and 1929. Kingston came to the directorship as a mature and trained scientist, and it was through his planning and efforts that the Toronto Observatory became the hub of the new service and that forecasting was started in Canada. Stupart was the first Canadian-born meteorologist, received his training on the job and presided over an orderly expansion of services. While Kingston had wide scientific interests and can be called the Father of Canadian Meteorology, there is little doubt that Stupart was Canada's first operational weather forecaster and administrator of meteorology. Each man was a giant in his time and today's Canadian Meteorological Service bears their imprints.

9 Services for aviation

During the 1920's the need for meteorological services by aviation was slowly becoming apparent. Prior to this time aviators had given little thought to meteorology, but with the possibility of air transport becoming apparent, aviation began to realize its dependence on the science. An aviation section was set up in the Central Office at Toronto in 1928, and during a short period from that year until 1932, when an attempt was made to establish an air mail service in the country, some new airport observation stations were opened and additional technical personnel were employed.

It was, however, the voyage of the airship R-100 from Britain to Canada in the summer of 1930 that first required significant meteorological organization for aviation. As the Canadian Service was to be responsible for meteorological advice along the flight route west of longitude 35°, the forecast staffs at Toronto Central Office and at the newly opened Montreal St. Hubert Airport

office maintained a 24-hour service. Many observing stations in eastern Canada were asked to transmit 2 a.m. observations, necessitating the special nighttime opening of telegraph offices, and thus allowing the preparation and transmission of special information and forecasts to the airship. The airship remained for about two weeks in Montreal, with a side trip to Toronto before returning to England in mid-August. Meteorological services for the flight were generally considered satisfactory, but the experience did point out the need for trained personnel, more observations, better communications, and better methods of short-period forecasting.

10 End of an era

The demands by aviation for services in 1930 presented a new challenge to Canadian meteorology. Fortunately, as a result of the development of new theory and techniques by the Scandinavian school of meteorologists, weather forecasting could now proceed on a much better scientific basis than that previously used. The scientific prospects for meteorology were excellent and aviation was beginning to call for meteorological services in a clearer, louder voice than that ever used before by marine, agricultural, forestry or transport interests or by the general public, but unfortunately the country was sliding into a great economic depression. It would be a few years before the forward thrust could be picked up again, but in the meantime the old era – the leisurely nineteenth century "horse and buggy days" in meteorology – was over.

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A Brief History of Canadian Meteorological Services Part 2: 1930–1939[1]

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ABSTRACT
At the beginning of the 1930's the demand for aviation meteorological services was increasing rapidly. Before the Meteorological Service of Canada could significantly expand, however, the economic depression forced the cancellation of contracts and programs in aviation and the demand diminished greatly. Continuing to provide general public and marine forecasts and routine climatological services, the Service inaugurated seasonal forestry and agricultural forecasts during the mid 1930's. Taking advantage of innovations in meteorological science abroad, the Service began participating with the University of Toronto in a post-graduate training program in meteorology, and undertook to adapt the new meteorological theories to North American weather. During the late 1930's the demand for aviation meteorological services intensified again, leading to the establishment of aviation forecast offices to serve Trans-Canada Airlines at Vancouver, Winnipeg, Toronto and Montreal. In addition a trans-Atlantic aviation forecast office was set up at Gander, Newfoundland. During the decade, the number of professional meteorologists in Canada increased from less than a dozen to more than 50, while the number of telegraphic reporting stations was nearly doubled from 70 to 135.

1 A new era

During the decade following World War I many advances were made in meteorological theory and practical forecasting in the Scandinavian countries and Great Britain. Early in the 1930's officials in charge of the Meteorological Service of Canada began to realize that it would be necessary for its officers to understand the new air mass analysis theories and adapt them to North American conditions before any major improvements could be made in the provision of meteorological services. There was, however, a worldwide crippling economic depression during this period and meteorological services in Canada had to be curtailed as the funds available for meteorological expenditures were reduced from $402,000 in 1931 to $297,000 in 1934. Services for aviation were virtually eliminated with the cancelling of inter-city air mail services in

[1]Part 1 was published in *Atmosphere*, **9**, 1–15.

1932, the same year that general meteorological services were discontinued in Newfoundland. Within the Service however, increased attention was paid to training, research, and development, so that by the end of the decade an excellent foundation had been laid upon which the Service would be able to respond to the tremendous demands to be placed upon it by commercial and military aviation.

In January, 1932, Andrew Thomson, a Canadian with considerable meteorological experience in New Zealand and the South Pacific, was recruited and placed in charge of the Physics Division at Headquarters. Several young Canadians undertook post-graduate work in the United States and Europe, with the hope of being employed by the national service upon their return. Others took leave of absence without pay from the Service to study abroad – in 1933 D.C. Archibald, who had joined the Service a few years earlier and had become Superintendent of the Western Airways Weather Service took leave of absence to study in Norway. Also in 1933, the University of Toronto, in conjunction with the Service, established an M.A. course in meteorology and the first graduates – C.C. Boughner, F.G. Millar and M.N. Monsinger entered the Service the following year. Successive post-graduate courses were to produce, over the next few years, a core of professionals around whom it was possible to build a greatly expanded Service during World War II.

2 Research and Development

With the arrival of Thomson in 1932, the Physics Division at Headquarters undertook a daily study of current North American weather maps according to fundamental physical principles and the new methods of analysis and forecasting. These had replaced the older methods of forecasting in the aviation services of western Europe, but there were considerable difficulties at first in applying them to North American conditions. Graduate students in the M.A. course were trained in the new methods and, by 1934, practice aviation forecasts based on the new analysis were being prepared. Lack of data in northern Canada, however, detracted from the advantages of the new system and drew attention to the urgent necessity of establishing more stations in the north, especially in the vast area west of Hudson Bay, if the new methods were to succeed.

Meteorological research was not dormant in Canada during the 1930's. In the 1932–33 International Polar Year program, the Service manned stations at Chesterfield Inlet, Coppermine, Cape Hopes Advance and Meanook for a twelve-month period, during which a series of meteorological and magnetic observations were taken. Several brief popular accounts of Canada's program were written and a complete description of the expedition, with observational data, was published (Canada, Division of Meteorological Services, 1940). In the winter of 1936–37 the Service co-operated with the United States Weather Bureau in special investigations on the properties of cold air masses and 140 special aircraft flights were made at Fort Smith, N.W.T. to obtain upper air data. Water levels in the Great Lakes became a matter of concern during the 1930's,

Dr. John Patterson, F.R.S.C., Director of the Canadian Meteorological Service, 1929–1946.

lake water temperature observations were begun and research was carried out on the measurement and theory of evaporation. Early in the period agriculturalists and entomologists reiterated their need for joint studies with meteorologists on the control of plant diseases, but, unfortunately, little meteorological research was carried out in this field during the decade.

In addition to the research conducted within the Meteorological Service, scientists in associated disciplines were beginning to show interest in meteorology and climatology. Articles were published having to do with hydrometeorology, drought, agricultural meteorology, maritime meteorology, weather periodicities, etc. In particular, N.B. Hatchey, a hydrographer at the Atlantic Biological Station, published several papers during the decade having to do with meteorology, oceanography, and fisheries research. At the National Research Council, J.W. Hopkins became interested in agricultural meteorology and published a dozen papers between 1935 and 1941 dealing with climatic conditions in the grain growing areas of western Canada.

Many scientific improvements and technological innovations were put into use during the 1930's. The telegraph companies replaced Morse code telegraphy with a new teletype system late in 1931, the same year that ventilated psychrometers were introduced. In support of aviation, pilot balloon observations (*pibals*) were begun at several stations in eastern Canada in 1930, but, most of these observations had to be discontinued in 1932. Special aircraft flights, to obtain upper level temperatures and humidity data (*apobs*), were

begun on a regular basis at Toronto in 1934, at Edmonton in 1937 and in the same year at Botwood, Newfoundland. Attention was being given to the development of the radiosonde, but not until 1941 did use of this instrument supersede aircraft flights as a means of obtaining upper air data.

3 General forecast services 1930–1939

During the early 1930's the daily public weather forecast continued to be the most important service provided by the Service to Canadians. In 1931 a staff of 10, including 3 meteorologists-in-training, were required each morning in the Toronto Headquarters forecast room to prepare weather forecasts for southern Canada from the Rockies eastward to Newfoundland; while a smaller force of 3 or 4 men was required in the evening for similar work. Daily forecasts for southern British Columbia were prepared and issued by a small staff at Victoria. Surface observational data, taken at 8:00 a.m. and 8:00 p.m., were received in Toronto from about 76 stations in Canada and Newfoundland and from 160 in the United States within 40 minutes after the observation hour; the analysis was then completed and forecasts were issued by 9:40 a.m. and p.m. daily. The Toronto office prepared forecasts for twenty districts and the Victoria office for five. For financial reasons all forecasting for Newfoundland was suspended in 1932, but in 1935 several observing stations were re-opened and the Service began to again furnish forecasts twice a day. In November 1933 the Service undertook to supply forecasts for all Canadian forecast districts to the Canadian Radio Commission for national transmission and broadcasts at 10:35 p.m. EST each day. In addition, local radio stations began to broadcast local, regional or provincial weather forecasts during the early 1930's.

4 Special forecast services 1930–1939

The prime purpose for establishing the Meteorological Service in 1871 had been to issue warnings for mariners on both coasts and the Great Lakes, giving notice of the approach of storms. This service was continued during the 1930's and the Government Marine wireless stations began broadcasting the warnings and forecasts. Although those concerned with agricultural and forestry operations depended largely upon the general weather forecasts, special forecasts for fruit spraying activities were issued during the spring and early summer in some parts of the country. In the spring of 1935 a seasonal office was established at Penticton and a frost warning service inaugurated for the Okanagan Valley of British Columbia. In season a daily forecast fire weather service was provided from Headquarters for Ontario, Quebec and the Maritime provinces and "shippers bulletins" showing temperature, rainfall, wind and weather for representative places across Canada and the United States were prepared daily and transmitted to chief shipping centres.

5 Civil aviation services 1930–1936

Note was made in Part 1 of the special meteorological services provided for the

visit of the R-100 to Canada in 1930. In his history of aviation in Canada, Main (1967) remarks: *One notes with astonishment in the records of that period the emphasis laid on the solitary visit of the R-100 rather than on the ground work being laid for the air mail service which commenced the same year.*

The Canadian Meteorological Service did, however, provide general weather forecasts and spot weather information for such air mail routes as an eastern one between Montreal and Windsor and a trunk route on the Prairies between Calgary, Edmonton and Winnipeg. The Service was in the process of establishing several airport offices when the demand for aviation and meteorological services was drastically reduced in 1932 as all inter-city air mail contracts were cancelled by the Post Office. Of the newly established offices, only that at St. Hubert, P.Q., was retained. However, forecasts continued to be regularly provided for scheduled commercial flights between Montreal and Albany and there were numerous requests for special aviation forecasts. In addition, both the St. Hubert office and Headquarters were involved during the early 1930's in providing special weather information and forecasts for long distance flights from Canada to Europe and Asia which were the vogue during this period.

Despite the economic depression, aviation and the supporting services which made this new transportation medium possible, did develop and expand. As part of an economic relief program for unemployed workers, the Government built a number of emergency landing fields in 1934–35 and sixteen of these were later equipped to take meteorological observations. Also in 1934, to meet local demands, aviation forecasts were regularly prepared at Headquarters for Ontario and western Quebec, and a scheduled airway service which required weather forecasts was begun in the Maritime Provinces. Also the network of observing stations was slowly but surely expanding into northern Canada. Although stations were opened at Coppermine, Ft. Norman and Chesterfield in 1930, the depression limited expansion to some fringe area stations such as Fairview, Alta., and Clarke City, P.Q. over the next six years, but a major expansion began in 1937 with the installing of stations at such locations as Port Harrison, P.Q., Arctic Bay, N.W.T. and Fort Nelson, B.C. By 1939 forecasters had telegraphic data available from 275 observing stations in North America and 135 of these were Canadian stations, compared to 70 in 1930.

Prior to 1930, observational data had generally been available only twice daily although some of the new airport stations were providing data and information in the popular "sequence" code a few times each day. Hourly weather observations became generally available throughout the United States in the mid 1930's and by late 1938 such information was to become available throughout the day and night from dozens of airways stations in Canada. In 1936 arrangements were made to have several stations in eastern Canada begin observing and transmitting a third synoptic observation at 2:00 p.m. each day, and by the end of the decade four synoptic observations at 0130, 0730, 1330, and 1930 EST were regularly taken and transmitted from most synoptic stations.

Three members of the forecast staff at Botwood, Nfld. (left to right): J.R.H. Noble, Dr. P.D. McTaggart-Cowan, H.H. Bindon.

6 Professional staff in 1935

It is interesting to note that as late as 1935 the professional strength of the Meteorological Service of Canada was overwhelmingly concentrated at the Toronto Headquarters. There were meteorologists at Victoria (F.N. Denison) and Winnipeg (A.R. McCauley) but senior meteorological technicians were in charge of the observatories and offices at Quebec (M. Royer), Saint John, N.B., (F.M. Barnes), Montreal/St. Hubert (J.F. Carmichael), and Vancouver (E.B. Shearman). The Quebec office was primarily an observing post, but Vancouver served both the public and shipping and the St. John Observatory provided extensive services to the public. In 1931 there had been offices at both the Grain Exchange and the airport in Winnipeg, but with the curtailment of the Prairie air mail service the airport office was closed and the meteorologist moved to the downtown office. Meteorologists at Headquarters in 1935 included Patterson, Thomson, Connor, Boughner, Archibald, Middleton, Jacobsen, McPherson, Troop, Chisholm, Millar, Monsinger and in the Forecast Office, O'Donnel, Fox, Chilcott and Thorn.

Joint Meeting of Royal Meteorological Society and American Meteorological Society, Toronto - August 28-29, 1939

Back row (l to r): G Emmons, **Ralph Anderson**, **Don S Ross**, **J Hank Sabraw**, JC Hagan, **WE Knowles Middleton**, **Abraham (AJ) Connor,** CG Andrus, W Reed, H Solberg, AT Doodson, SS Schworm, **Ratje (RC) Jacobsen**, CJ MacGregor, **L Gilchrist, Harvey W Halbert.**

Middle row: Miss KM Ellis, **F Graham Millar**, **Arthur S G Grant, Jim M Leaver, Don McIntyre**, DE Newton, **E Wendell Hewson,** Bernhardt Haurwitz, **Don C Archibald**, JO Wilhelm, **Balfour W Currie, Clarence C Boughner, Murray N Monsinger, RT Zoch, Alvin D Thiessen, Andrew Thomson**, WN McLean, Mrs B Haurwitz, **GM Schrum** (behind Mrs. Haurwitz).

Front row: **EF Burton**, VW Ekman, HR Byers, Jacob Bjerknes, David Brunt, CF Brooks, Sidney Chapman, **John Patterson**, FW Reichelderfer, Fred JW Whipple, Sverre Pettersen, WM Elsasser.

(Canadian delegate names are in **bold**)

7 Trans-Atlantic services 1935–1939

At an Ottawa international conference convened in 1935 to arrange the necessary meteorological services for experimental flights across the North Atlantic, Canada assumed responsibility for weather information and forecasts for the area extending from Montreal through Newfoundland to 30° west longitude in the mid-Atlantic ocean. Supporting services were organized in 1936 and the first experimental flights were carried out in 1937 after a meteorological office had been installed at Botwood, Newfoundland and the St. Hubert office upgraded. One of the most active participants in developing the Newfoundland services was P.D. McTaggart-Cowan, a Canadian Rhodes Scholar who studied meteorology in England before returning to Canada. He quickly became the ranking expert on North Atlantic meteorology and aviation forecasting and later served as Director of the Meteorological Service of Canada. An account of trans-Atlantic aviation and meteorology published by McTaggart-Cowan (1938) is a most valuable record of the developmental work carried out the previous year. It is perhaps interesting and significant to note that the three most recent Directors of the Service – Dr. A. Thomson, Dr. P.D. McTaggart-Cowan, and Mr. J.R.H. Noble, were active participants in launching the pioneer trans-Atlantic aviation service in Newfoundland during this period.

Trans-Atlantic flying boat experimental flights were made in the summers of 1937 and 1938 by Imperial Airways and Pan American Airways and in the summer of 1939 about 50 round trips were made, carrying both passengers and mail. The Weather Office was moved from Botwood to Gander Airport and by 1939 the staff consisted of 4 meteorologists and 11 assistants. The Gander Office also issued public weather forecasts and storm warnings for the Newfoundland area. By the end of the 1939 season, however, with the outbreak of war, there was some uncertainty as to the immediate future of civil aviation and meteorology in Newfoundland.

8 A new department

A major result of planning that had been underway in the mid 1930's for domestic aviation in Canada was the establishment of a new Department of Transport in November 1936. Attached to the Marine Department since its formation, the Meteorological Service of Canada now became the Meteorological Branch of Air Services of the new department. In this re-organization the Meteorological Branch was freed both of those ancillary responsibilities which it had carried since 1871 and of others which it had developed during the intervening 65 years. Some of the resources of the Service had been devoted to observations and research in terrestrial magnetism and astronomy and in the provision of a time service at several locations across the country. Meteorologists had also been responsible for seismological observations at Toronto and Victoria and, in the early years of the Service, had conducted hydrographic surveys. All of these responsibilities were transferred to agencies in the Department of Mines and Forestry. The Meteorological Branch was now free to devote its efforts to providing a better weather service for Canada.

9 Civil aviation services 1937–1939

With the establishment in 1937 of Trans-Canada Airlines (as the present Air Canada was called until 1965), the new Meteorological Division acquired tremendous responsibilities and challenges. To service the meteorological requirements of TCA the Division would have to establish several forecast offices at TCA divisional headquarters, provide meteorological staff at many of the intermediate airports and operate a 24-hour service. More frequent observations at an increased number of off-airways observing stations would be required. It would also be necessary of course to connect all forecast offices and airports with a leased teletype system. The airlines began local services in western Canada late in 1937, by June 1938 passenger service had been extended to Toronto and Montreal and finally, the trans-continental link was made when flights began to Moncton in September 1939.

Fortunately, and as a result both of good planning by the Meteorological Service and the depressed economic conditions of the country, the University of Toronto post-graduate course in meteorology had attracted a few dozen bright mathematics and physics graduates from 1933 to 1937. By recruiting and training these men the new Meteorological Division was able to establish and staff aviation forecast offices at Vancouver, Winnipeg, Toronto/Malton, Montreal/St. Hubert and for trans-Atlantic purposes, as mentioned previously, at Gander, Newfoundland. In addition, many new meteorological assistants were recruited, trained and posted to the forecast offices and to half a dozen intermediate airports.

10 Climatological services 1930–1939

With the increased attention to new theories and techniques in meteorology and particularly to aviation forecasting, climatological services became somewhat neglected and inadequate during the 1930's. The provision of climatological data and information, of course, pre-dated the provision of forecast services, and the Service continued to collect, process and publish historical climatological data. In 1931 data were published for approximately 750 stations in the *Monthly Record* and the *Monthly Weather Map*, and in various federal and provincial year books. The number of climatological stations in operation during the decade varied from 750 to about 900 as the economic situation precluded any significant expansion in this area. At Headquarters, about 1,000 special requests for information regarding the climate of Canada were answered each year while a considerable volume of this kind of work was handled at other offices, notably Victoria and Saint John. An innovation in 1936 was the preparing and publishing, during the growing season, of a weekly weather summary for the grain area of the Prairie Provinces.

Meteorological agents in Victoria, Edmonton, Moose Jaw, and Saint John supervised the cooperative climatological observers in their respective areas of the country. Observers in Manitoba and Ontario corresponded directly with Headquarters, while the Quebec Streams Commission cooperated with the federal department by supervising climatological stations in that province.

A.J. Connor, who was then known as the Dominion Climatologist, was responsible for the preparation of considerable statistical climatological data and the publication of reports and articles dealing with climatic conditions in northern Canada and the Prairie Provinces. Also during this period he prepared a major report on the climate of Canada for the Köppen-Geiger *Handbuch der Klimatologie* (Connor, 1936). An American graduate student, C.E. Koeppe (1931) published a thesis entitled *The Canadian Climate* – the first, and to this day the only book devoted to the climate of the country.

11 Services for the Armed Forces

Prior to 1939 the Royal Canadian Air Force had not expressed a need for any regular, full-time meteorological service. Annual meetings and visits had taken place between Headquarters meteorological personnel and RCAF officers but it was not until late in 1938 that the RCAF requested regular forecasts and professional services for their units. At the outbreak of war in September 1939, one meteorologist and one assistant had just been posted with the RCAF at Vancouver, the first direct involvement of civilian meteorological personnel with the military in Canada. The meteorological requirements of the Royal Canadian Navy in the 1930's were limited to forecasts and information which were prepared in Toronto and forwarded to Halifax for radio broadcast to vessels at sea during the summer season. The requirements of the Canadian Army were apparently minimal and no special services had been requested prior to 1939, when operational advice for artillery units was requested.

12 September 1939

On September 1, 1939, just before the outbreak of war, the total Canadian meteorological establishment consisted of no more than 51 graduate M.A. meteorologists, 20 meteorological assistants corresponding in some respects to today's B.A. meteorologists, 57 meteorological observers, 26 teletype operators and 59 administrative and clerical personnel. While this was a major expansion in comparison to the size of the staff in 1931, and even in 1935, the next few years were to see an almost ten-fold expansion.

In addition to those at Toronto, professional meteorologists were now stationed at 11 other locations across the country and a single teletype circuit extended from Moncton, N.B., to Vancouver, B.C., with a sub-extension from Lethbridge to Edmonton in Alberta. The Canadian meteorological circuit was connected with the U.S. Weather Bureau teletype circuits by ties from Vancouver to Seattle and Toronto to Buffalo.

The traditional public weather forecasts were still being prepared by the old methods and provided from Toronto and Victoria for southern Canada, but trans-continental aviation forecast offices had just been opened and developmental work had shown that trans-Atlantic aviation weather services were not only feasible but essential. Special forecasts for agriculture and forestry had become regular seasonal features, but climatological services to provide information and data were somewhat restricted by lack of resources.

At a joint meeting of the Royal Meteorological Society and the American Meteorological Society in Toronto late in August, 1939, the Controller of the Meteorological Branch, Mr. John Patterson (1940), presented an address titled *A Century of Meteorology* in which he concluded with the words: *For you young men who are just entering the Service there is a very great future in meteorology. ... Of all sciences, meteorology will probably make the greatest advance in the next hundred years. This then is your opportunity.*

Most of the meteorologists who heard John Patterson were unaware of how firmly the Meteorological Division was tied to commercial and military aviation and how radically any event which affected aviation would also affect meteorology. Within a few days war was to break out in Europe; Canadian aviation was about to be asked to undertake programs not dreamed possible that August. And meteorology in Canada, about to be so necessary to the progress of the British Commonwealth Air Training Plan, was to expand by a whole order of magnitude.

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A Brief History of Meteorological Services in Canada Part 3: 1939–1945

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ABSTRACT
When the concerns of the Meteorological Division turned from peace to war in 1939–40 the Division was in the midst of a major expansion to meet the needs of Trans-Canada Airlines. Civil air requirements for meteorological services continued to increase, and to these were added the meteorological needs of the Royal Canadian Air Force for operations and for the British Commonwealth Air Training Plan, the Royal Air Force and the United States Army Air Force for their ferrying activities over the Atlantic Ocean and to Alaska, and the much smaller needs of the Royal Canadian Navy and the Canadian Army. By developing an analysis and forecasting system based on several forecast centres previously planned for civilian aviation, by setting up still more forecast centres for military purposes and by staffing nearly 100 "dependent" forecast offices at training and operational military stations, the wartime meteorological needs in Canada were largely met, although in northern Canada the United States assisted by establishing many observing stations and some forecast offices. To do this it was necessary for Canada's national service to recruit and train 350 new meteorologists and a large number of assistants during a period of extensive manpower scarcity. Services to the public were greatly curtailed and for a period both the broadcasting and publishing of weather information were prohibited. At the end of the war the Meteorological Division was faced with the major task of reorganizing in order to provide, to the public, services commensurate with the wartime advances in meteorological theory and practice.

1 Autumn 1939

In 1939, the Meteorological Division, Air Services Branch, Department of Transport, was expanding rapidly to provide the meterological services required by commercial aviation – principally Trans-Canada Airlines. Meteorologists at aviation forecast centres across Canada were forecasting for the TCA terminals and routes extending from Victoria, B.C. to Moncton, N.B. A fledgling trans-Atlantic aviation forecast office existed at Gander, Nfld. Public weather forecasts and storm warnings were issued from Victoria, B.C. and from Head Office in Toronto – public services that had been routinely provided for several dec-

ades. Climatological data and information were prepared and issued regularly from Head Office in data periodicals and on request.

It had been a hundred years since the opening of the Toronto Magnetic and Meteorological Observatory, and nearly 70 years since a national meteorological service was first organized. The Service had expanded during periods of national prosperity and had been cut back during periods of economic depression – especially in the early years of the decade just coming to a close. Meteorology had not "gone to war" in 1914–18 – would meteorological services be required this time or would meteorology drift into another austere period?

Immediately with the outbreak of war the broadcasting of weather information and the publication of weather reports and forecasts in the newspapers of central and eastern Canada was prohibited for national security reasons. While continuing to forecast for the airways, the Meteorological Division was asked to provide operational weather services for the Royal Canadian Air Force and the Royal Canadian Navy, and was soon to begin planning for the provision of meteorological instruction and weather forecasting services for units of the British Commonwealth Air Training Plan.

2 Civil airways services

By 1940 the Meteorological Division was supplying a 24-hour aviation weather service for the Trans-Canada Airlines route across the country from aviation forecast centres located at Vancouver, Winnipeg, Toronto/Malton, and Montreal/St. Hubert (to be relocated at Dorval in 1941). Synopses and forecasts were mainly based on surface synoptic weather analyses since there were no Canadian upper air stations. Hourly reports, or "sequences", as well as all Canadian surface synoptic and pilot balloon observations were made available, along with surface and upper air data from the United States, by means of a teletype system which extended from the Pacific to the Atlantic. Late in 1939 a new aviation forecast centre to service the RCAF and Navy had been organized at Halifax, and early in 1941 a new centre was established at Lethbridge, Alta. to provide additional services for TCA.

In 1940, trip forecasts were issued for each TCA scheduled flight, and regional aviation forecasts valid for the next 8 hours were issued every 6 hours. In addition to their analyzing and forecasting duties the M.A. meteorologists at the forecast centres were responsible for personally briefing TCA pilots and dispatchers to assist them in planning and carrying out the scheduled flights. Although the aviation forecast centres were established primarily to serve civil aviation, analyses and forecasts originating at these centres were most essential to the large organization that was built up to provide services for the Armed Forces. Officers-in-charge at the main forecast offices during most of the wartime period were A.R. McCauley at Vancouver, D.H. Smith at Lethbridge, D.M. Robertson at Winnipeg, W.E. Turnbull at Toronto, F.J. Mahaffy at Montreal, and Dr. M.J. Oretzki at Moncton.

3 British Commonwealth Air Training Plan

In December 1939 Canada accepted responsibility for a major share in the British Commonwealth Air Training Plan which called for establishing 58 flying schools to train air crew in Canada between April 1940 and April 1942. It was estimated that 26 of these schools would each require a meteorologist, and the following quotation is from a letter dated March 20, 1940, written by the Acting Deputy Minister of National Defence to the Deputy Minister of Transport. *It is requested that your Department provide the Meteorological Instructors that will be necessary under the British Commonwealth Air Training Plan at Service Flying Schools, Air Observers' Schools and Air Navigation Schools and a Meteorological Advisor at Air Force Headquarters. These gentlemen will be required not only to carry out normal forecasting and reporting duties, but to lecture pupils passing through the Schools on the subject of Meteorology ....* Accordingly, in April 1940, J.R.H. Noble went from Toronto Head Office to RCAF Headquarters in Ottawa as Meteorological Advisor, while D.B. Kennedy was posted to the Trenton RCAF Station, and W.J. Green to Camp Borden.

However, as the war situation deteriorated during 1940 and the training program accelerated, it was soon found that the meteorological requirements of the BCATP were increasing markedly. Many RAF-staffed schools were moved to Canada from the United Kingdom, overlapping courses were brought into the schools and several meteorologists were required at most schools to handle the lecturing, forecasting and briefing duties. The Meteorological Division was then forced to markedly increase recruiting of qualified men and to introduce an intensive training program for meteorologists. Instead of the 27 meteorologists originally requested, more than 300 civilian Department of Transport meterolologists served with the RCAF and RAF at 68 different BCATP stations during the war.

Although professional meteorologists ultimately provided service at nearly a dozen different types of schools under the BCATP, most served at Air Observer and Service Flying Training Schools, the former to train observers and navigators, and the latter pilots. Working within guidelines sent by teletype from the district centres and from a special centre at Rivers, Man. the meteorologists analyzed weather maps, provided local forecasts and briefed the pilots, both students and instructors, before flight training commenced each day and night. As another major responsibility they gave ground school instruction in meteorology to student air crew. At all times the meteorologist-in-charge at each station served as advisor to the Officer Commanding on all meteorological matters.

Late in 1942, the divisional liaison officer at RCAF Headquarters, Mr. Noble, advised of the desirability of appointing meteorologists to the different RCAF Commands to supervise all meteorological activities throughout the Force. However, at this time the RCAF was organizing "navigation visiting flights" and ultimately a meteorologist was appointed to each of these. Meteorologists such as R.H. Craddock, H.V. Tucker, W.G. Clark, and F.M. Kelly, conducted inspection visits during the next two or so years as members of these

visiting flights and contributed considerably to standardizing the presentation of services at the schools as well as providing Head Office with full reports on field activities. The British Commonwealth Air Training Plan formally ceased at the end of March 1945, and by early 1946, only 7 RCAF flying training schools remained at which meteorological personnel were stationed.

4 RCAF operational units

Within a few weeks of the outbreak of war in September 1939 the Meteorological Division, acting on requests from both the RCAF and the Navy, set up a forecast office at the Eastern Air Command Headquarters in Halifax, N.S. Analyses and forecasts were issued for flying patrols and for convoys leaving from and arriving at Halifax. As patrol flying increased in 1941, dependent offices were set up at 4 bases, while in Newfoundland the forecast centre at Gander expanded to service the RCAF needs. By 1943, however, with the increasing submarine menace several more dependent forecast offices were installed, and additional forecast centres were organized at Gander and Goose Bay to service the RCAF. In September 1944 there were 50 meteorologists posted at 12 RCAF operational units along the east coast.

In 1941 civilian meteorological observers were sent to a few new RCAF seaplane patrol bases following the establishment of a forecast centre at Western Air Command Headquarters in Victoria, B.C. In April 1943, the main forecast centre was moved to Vancouver leaving a smaller forecast centre at Victoria and meteorologists were posted to most of the bases. Exclusive of those at the Western Air Command Headquarters forecast office, there were in September 1944 nearly 40 meteorologists on duty at 10 RCAF units in British Columbia.

RCAF activities in central Canada were largely in connection with the BCATP, but there was sufficient long-range flying from Ottawa to require the establishment of a forecast centre at Rockcliffe, and for limited periods at Kapuskasing, Ont., and at Montreal/St. Hubert, while an office at North Bay, Ont. provided services for the RAF Transport Command Training Centre. Duties of meteorologists at these operational units were to provide weather analyses and forecasts, to brief operational personnel on anticipated weather over their routes, and to provide general meteorological advice to the RCAF.

Canadian meteorologists did not have an opportunity to participate in the RCAF's United Kingdom and European operations during World War II. Official policy was changed in 1945, however, and several dozen meteorologists had either joined the RCAF, or were about to, for service in the Pacific area when the war ended.

Where forecast centres had been established primarily to provide services to the military there was the tendency for the RCAF to look to the meteorological officer-in-charge as a staff officer responsible for any problems with services in that area. This was the situation at both Vancouver and Halifax where the officers-in-charge were G.L. Pincock and R.A. Hornstein. Civil aviation forecast offices had less responsibility for meteorologists serving the RCAF, but in the Prairie Provinces, D.C. Archibald, who had organized aviation services in

that area a decade earlier, acted as western superintendent during the early war years as well as officer-in-charge of the Winnipeg forecast centre.

5 Trans-Atlantic Ferry Command

Civilian overseas flights from Newfoundland were severely restricted during the summer of 1940, but in the fall of that year plans were made for ferrying long-range bombers from mainland America to Europe via Newfoundland. The organization of a proper weather service for this proved to be most difficult on account of the lack of observations, not only over the Atlantic but also in Quebec and Labrador, the necessity to code all radio signals and the general lack of land-line communication facilities. However, regular meteorological services for the oceanic flights were commenced in the fall of 1940. As ferrying activities were stepped up in 1941, meteorological advice and forecasts became more important, and as the flying range of the new bombers increased, the headquarters for ferrying operations was shifted to Montreal's new Dorval Airport. In January 1942, the Royal Air Force Ferry Command took over responsibility for all ferrying operations and the Dorval Meteorological office began preparing the main forecasts for trans-Atlantic operations, while the staffs at the Gander and the newly established Goose forecast centres tailored the forecasts to operational plans if necessary and briefed flying crews.

During the next three years Ferry Command operations expanded to include the northeast route through Greenland to the United Kingdom, the direct route from Goose or Gander to the United Kingdom, a middle route through the Azores to the Mediterranean and North Africa, and a southern route through the West Indies to South America and across to central Africa. Dr. P.D. McTaggart-Cowan, Meteorological Officer-in-Charge, first at Gander and then at Dorval, was principal meteorological advisor to the RAF Ferry Command and played a very significant role in organizing the necessary meteorological services for these operations. Other senior meteorologists who subsequently were in charge at Gander and Dorval were H.H. Bindon and K.T. McLeod.

6 Navy and Army

During the war the Meteorological Division provided a limited amount of meteorological services for both the Canadian Army and the Royal Canadian Navy. Early in the war Naval requirements were met by the preparation of Fleet Synoptic Messages containing weather data and forecasts for broadcast. Both the Royal Navy and the United States Navy traditionally employed meteorologists, and in 1942 the Royal Canadian Navy recruited a number of former departmental meteorologists. The Meteorological Division continued to provide the basic service, however, and these men were used primarily for briefing and liaison duties within the Navy. With the use of smaller vessels for anti-submarine patrol in the St. Lawrence River and Gulf in 1943, and the increasing importance of weather on convoy activities the Ottawa/Rockcliffe, Sydney, N.S., Victoria, B.C. and Halifax offices provided extensive services for the Navy during the final two years of the war.

Services for the Canadian army were largely limited to the provision of surface and upper air data and forecasts for artillery units on the coasts and at training camps in central Canada. The Division provided personnel for a research station at Suffield, Alta., where confidential wartime research work was carried out. Division personnel also participated in Army cold weather tests conducted during the winter of 1943–44 in Newfoundland and Saskatchewan, and for two exercises – Eskimo and Polar Bear, carried out during the winter of 1944–45 in Saskatchewan and British Columbia, respectively, where experience was gained in moving men, equipment, and supplies over difficult terrain in severe winter weather.

7 Northwest staging route

Planning for inland air routes through northwest Canada to connect Alaska and the Yukon with central Canada and the United States began in 1940. Early in 1942 meteorologists were posted to a few stations on the route and forecast centres were opened at Edmonton and Whitehorse to provide services for the RCAF and for civilian aviation companies providing military transport. The United States Army Air Force stationed meteorological staff at all airports used by that organization to provide meteorological information and forecasts to their air crew.

When the airway to Alaska became of the utmost importance to the United States, and after the decision to build the Alaska Highway was made, it was found that it would be quite impossible for the Meteorological Division to provide the required observations and services. Accordingly, in 1942 the USAAF was authorized to open and operate several dozen supplemental observing stations throughout the Northwest complete with the necessary communication facilities. Operation of the basic meteorological service along the route continued to be carried out by the Meteorological Division led by Dr. T.G. How, Officer-in-Charge of the Edmonton forecast office. In 1944 a third Canadian forecast centre was opened at Prince George, B.C., and late in 1945 the USAAF turned over to the Canadian Service those stations and facilities that the Meteorological Division thought necessary for peacetime operations, while the other stations were abandoned.

In conjunction with the operation of the Staging Route it was decided in 1942 to build a pipe line from the Norman Wells, N.W.T. oil fields to a Whitehorse, Y.T. refinery in order to guarantee Alaska sufficient fuel for military and civilian purposes. Accordingly, the USAAF was granted permission to establish a number of supplementary observing stations in order to support this CANOL Project and to establish a forecast office at Norman Wells. The USAAF abandoned the project late in 1944 as the war situation in the Pacific improved and several stations were taken over and operated by the Meteorological Division and the Royal Canadian Corps of Signals, an organization that had provided most pre-war arctic and sub-arctic observations for the Division. Also incorporated into the system in 1945 were several USAAF stations in northern Manitoba and that part of the Northwest Territories west of Hudson Bay.

8 Public weather

In contrast to the remarkable expansion in aviation weather forecasting, public weather forecasting was curtailed during the war years. In 1939, forecast offices at Toronto Head Office and Victoria, B.C., using analysis methods developed by Stupart, Webber and others in the past century, were responsible for all public forecasting. The forecast services were of such significant value, however, that although the publishing and broadcasting of forecasts were prohibited in eastern Canada, many special arrangements were made to supply forecasts to government officials, fishermen, fruit growers, resort operators, etc. With the outbreak of war in the Pacific in December 1941 the broadcasting of weather information and forecasts was prohibited throughout the entire country, although brief district forecasts were published in the local press in central Canada. It was not until the end of the war in Europe that Canadian newspapers were again permitted to publish any weather information they wished, and radio stations, to broadcast reports and forecasts.

In addition to the public forecasts prepared at Toronto and Victoria, the Gander Trans-Atlantic Forecast Office had become responsible for public weather forecasts in Newfoundland during 1939. Late in 1940 the military aviation forecast office at Victoria, which moved to Vancouver in 1942, became responsible for public weather forecasts in that province. On the Prairies the Lethbridge Forecast Centre provided warnings of severe storms likely to affect ranchers in Alberta, and the Winnipeg Grain Exchange Office was maintained to provide weather information to agriculturalists and others on the prairies. Beginning in 1940 the military forecast office in Halifax became responsible for storm warnings on the Atlantic coast and, in the spring, for special forecasts for the Annapolis Valley fruit growers of Nova Scotia. In British Columbia each spring a special office was set up to provide a frost warning service for the Okanagan and other fruit growing valleys. Fire weather forecasts for portions of Ontario, Quebec and New Brunswick, continued to be prepared and issued from Toronto each summer directly to the proper authorities.

9 Climatological services

Basic climatological information services were provided, principally from Head Office under A.J. Connor and C.C. Boughner, during the war years as data were urgently required to assist in the planning and building of new airports and other defence installations. The *Monthly Weather Map*, and in season the weekly *Weather Summary for the Prairie Provinces*, were issued regularly, but publication of the *Monthly Record* fell several years in arrears. In 1941 the publication of a *Monthly Meteorological Summary* was begun at Toronto Head Office and within a decade there would be more than two dozen such local summaries published across the country. The total number of weather reporting stations in Canada remained at about 950 during the war years. Although reports were received from the new military stations the number of ordinary civilian climatological stations decreased due to lack of programs for station inspection and observer recruiting. There was a marked increase in the demand

for climatological data and information towards the end of the war as former military air crew and engineers, who had come into contact with meteorology for the first time, began to realize the value of both weather services – climatological data and information in addition to weather forecasts – for peacetime pursuits.

10 Technical developments and research

It was extremely fortunate for the development of wartime meteorological services that the Meteorological Division was already well into an expanding phase to service the requirements of the new Trans-Canada Airlines in 1939. Several new observing stations had been opened each year since 1935, both along the airways and in northern Canada, and on September 1, 1939 the teletype system had become transcontinental. Pilot balloon observations were taken at 22 Canadian stations in 1939, and aeroplane soundings at 3, while good progress had been made in the development and testing of a radiosonde instrument.

There was a great expansion of synoptic and hourly station networks and communication facilities during the war years. From 128 synoptic stations in early 1940 the number was more than doubled to 270 by March 1944, of which 61 were USAAF operated. There were no radiosonde stations in early 1941, but by March 1945 there were 25 in Canada, of which 12 were USAAF operated. The USAAF installed major weather communication circuits in both the northwest and northeast portions of the country which helped to expand the teletype mileage from less than 3000 in 1939 to 14,200 in early 1946. Isolated observing stations in northern Canada, however, were never incorporated directly into these networks but used short-wave radio to transmit observational data to the nearest relay point or terminal on the teletype system.

Because of the critical demand for meteorological services there were few meteorologists or resources available for research during the war. Fortunately the Division had begun using the new air mass and frontal analysis methods for instructional purposes in 1933, and later for aviation forecasting, and the rapid expansion of the Division during wartime allowed the new M.A. graduates to test and develop all aspects of the new methods. In 1939 Dr. E. W. Hewson was honoured by the Royal Meteorological Society for his contributions to research in air mass properties and during wartime published his research into atmospheric pollution. In addition, Hewson and R.W. Longley, both engaged in training and instructional duties during most of the war period, wrote and published *Meteorology: Theoretical and Applied* which was used as a text for many years after the war. Others were able to find time in the midst of their wartime duties to carry on investigations into upper air characteristics, temperature frequencies, aircraft icing, precipitation variability and forecasting techniques that were published in the meteorological journals of the time.

Selected Meteorological Division meteorologists also participated in classified research into the anomalous propagation of radio waves, weather radar, gas warfare, and the Japanese fire balloon problem. Early in the war W.E.K.

Intensive Training Course IV for Meteorological Assistants, Gr. III, held at the Meteorological Division from October 15, 1941 to January 31, 1942.

Middleton published books on instruments and visibility, and for the next several years, with R.C. Jacobsen, led research and development on the Canadian radiosonde instrument, an automatic weather reporting buoy, a new thermometer screen ventilating system and a new ceiling projector.

11 Personnel training

In September 1939 the full-time staff of the Meteorological Division numbered 213, of which 51 were meteorologists and 57 were meteorological observers. Over the next 6 years the Division was to recruit and train an additional 350 meteorologists and a large number of assistants in order to open and operate an additional dozen forecast centres and to maintain dependent weather offices at several dozen air training schools and operational war units. At the end of the war the total full-time staff of the Meteorological Division numbered 900 persons.

In planning for the provision of meteorological services to the Armed Forces it was decided to send to the military stations only those meteorologists who had had some experience at civil aviation forecast centres. This quickly proved to be impossible and it became necessary to recruit university graduates with a background in mathematics and physics and to give them a short Intensive Course in Meteorology lasting 3½ months. The first such course began in November 1940. The need continued and one course followed another until 12 had been given and 350 graduates produced by 1944. Lacking an M.A. in meteorology, these men were classified as Meteorological Assistants, Grade III, and although they remained civilians, most were stationed at military establishments during the war.

The University of Toronto's graduate course in meteorology, begun in 1933, was terminated with an early graduation of the 1941 class because of the urgent need for graduates in the field. Although there was no longer sufficient time to conduct the M.A. course, the Division did have an increasing need for independent forecasters, and so the first Advanced Course, some 4 months in length, was begun in the fall of 1941 for meteorologists who had already successfully completed the first course. Six Advanced Courses were held in wartime from which 92 meteorologists graduated. By March 1946, 117 meteorologists of both categories had been released to return to their former professions or to other employment. Chief instructors during wartime included D.B. Kennedy, E.W. Hewson, J.M. Leaver, R.W. Longley, and A.M. Crocker.

The recruitment of meteorological observers proved to be very difficult because of wartime manpower regulations. While military deferments were possible for wartime professionals in meteorology, these were not granted to technicians, even those in isolated postings. Men were usually recruited locally and trained at an aviation forecast centre before being sent out to the observing stations. At military stations all assistants were in the RCAF so there was not the manpower problem that occurred at civilian stations. Early in 1942 the RCAF began to employ women as observers and plotters and they proved to be most efficient at the work. Late in 1943 the Meteorological Division undertook to train airmen and airwomen assistants for the RCAF, and several courses were

conducted at Toronto in 1944. At the end of the war many of these military assistants were recruited for regular civilian employment with the Division.

12 Administration

From the vantage point of the 1970's it appears that meteorological services were provided in Canada during wartime by an organization with a uniquely simple structure. While the Meteorological Division of 1939 had most of its professionals concentrated in the Toronto Head Office, those in charge of the branch offices and the airways forecast centres reported directly to John Patterson, the Controller (as the Director was called at that time). Over the next five years as hundreds of meteorologists were recruited and trained and a dozen more forecast centres and more than 60 other offices were established, these were administered without the building of a modern administrative organizational structure. Meteorologists across Canada knew that all authority came directly from Toronto and that practically every piece of correspondence from Head Office would be signed "J. Patterson".

Controller Patterson did, however, have valuable assistance at Headquarters in administering the provision of meteorological services. The Assistant Controller, Andrew Thomson, devoted full time to this work, while several of the meteorologists responsible for the training courses also assisted. In addition, other meteorologists were brought to Headquarters from time to time to assist in the never ending administrative work of transferring personnel from station to station as requirements changed and training courses were completed. But it was doubtful if any decision of importance was made that was not formulated by, or did not carry the approval of, "J. Patterson".

13 The challenges of peace

Military requirements for meteorological services began to decrease early in 1945 and by autumn of that year had been reduced to a small fraction of the previous year's demands. Approximately a third of the wartime meteorologists left the Service, while the remainder were about to be absorbed into the organization to undertake those jobs that had been neglected during the war. However, the challenges of peace were to be great, for the public was demanding a service equal to that provided to the Armed Forces during wartime. Should the Service be decentralized? How should a revitalized public weather service be organized? What percentage of resources should be spent on long neglected meteorological research? These were the "challenges of peace" which faced the leaders of government meteorology in Canada late in 1945.

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