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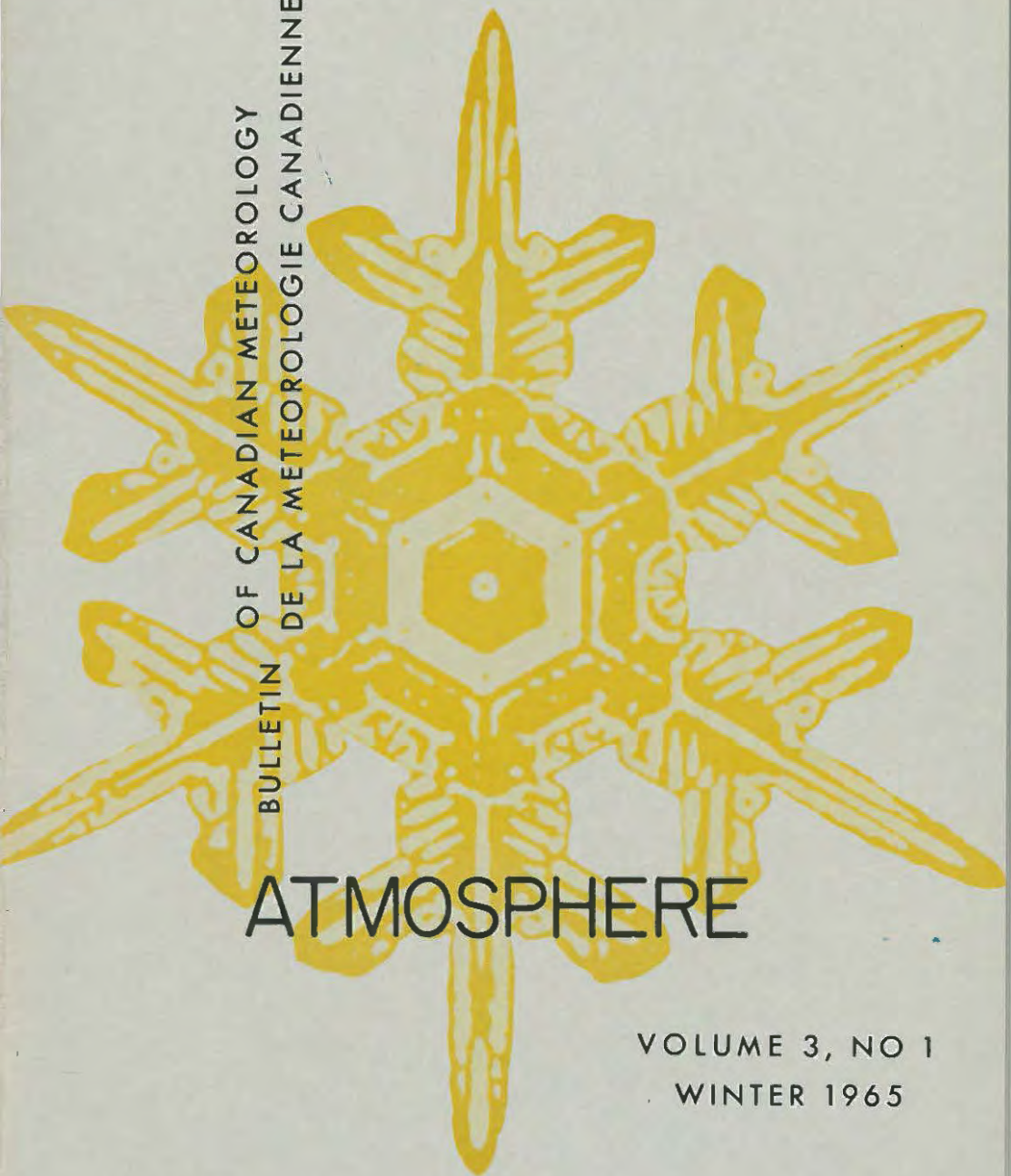
BULLETIN OF CANADIAN METEOROLOGY
DE LA METEOROLOGIE CANADIENNE



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AN EDITORIAL

This issue of "Atmosphere" might well be called "Meteorology in Canada", for it gives a rather interesting (and impressive) picture of the status of our science in Canada today. First, meteorology is not new to Canada, as will be seen from Professor Brewer's article. Our traditions are quite as strong as those of many countries. Secondly, the abstract from "Canadian Geophysical Bulletin", describing Meteorology in Canada, 1964, makes it quite clear that we are part of a most active and stimulating environment. Thirdly, Canadian meteorologists are contributing also on the international scene. The reflections of Dr. Godson, who is participating most illustriously in this field, are helpful in assessing the importance of such sharing with others.

Finally, although only the Editor knows this, we are now beginning to receive enquiries about subscription to "Atmosphere". We have had them from Canada, U.S.A. and U.K.

It is most encouraging!

EDITORIAL

Ce numéro de notre revue pourrait fort bien porter le titre suivant "La météorologie au Canada" car il donne une description intéressante et bien impressionnante de l'état actuel de la science au Canada. D'abord, la météorologie n'est pas une science nouvelle au Canada, ainsi que le démontre l'article de M. le professeur Brewer. Nos traditions sont aussi bien établies que celles de bien d'autres pays. Ensuite le résumé tiré du "Canadian Geophysical Bulletin" décrit la météorologie au Canada en 1964 et démontre fort bien que nous faisons partie d'un entourage stimulant et des plus actif. Enfin un autre article souligne que les météorologues canadiens peuvent contribuer à l'avancement de la science sur le plan international comme le prouvent les travaux du docteur Godson qui est un de nos plus illustres représentants. Nous pouvons alors mesurer l'importance de cette fraternité où tous les savants contribuent et partagent les fruits de ces recherches.

l'éditeur peut enfin informer les membres qu'il reçoit de plus en plus de demandes venant du Canada, des Etats-Unis et de la Grande Bretagne au sujet de notre revue. On veut même s'abonner à "ATMOSPHERE".

L'avenir s'annonce prometteur.

METEOROLOGY AT THE UNIVERSITY OF TORONTO

Part I. The Past.

by

Alan W. Brewer
Professor of Physics (Meteorology)
University of Toronto

Meteorology at the University of Toronto, and the Meteorological Service of Canada have a common origin. Both may be said to have begun on September 1st 1839, when Lt. (later Major General) Charles J.B. Riddell R.A. set sail to establish a magnetic observatory in Canada. When he arrived in Canada he was advised that, because of the nature of the rock formation, Montreal was unsuitable but that Toronto would be satisfactory. In Toronto he had some difficulty in finding a suitable site, but on 19th December 1839 he wrote to the Bursar of Kings (now University) College requesting the college's cooperation, and a grant of two acres of ground "for the erection of a magnetic and meteorological observatory". By 7th February 1840 the negotiations were complete for he reported to his senior officers".... The President and Council of Kings College have granted a space of ground amounting to two acres and four tenths of an acre as a site for the magnetic observatory on condition that the building to be erected thereon shall not be applied to other than scientific purposes, and in the event of the observatory being discontinued it shall revert to the college".

Lt. Riddell was a quicker worker than the University. The University had received a Royal Charter thirteen years before, but it was not to open its doors to students till three years later. By contrast the observatory which stood where the McLennan Laboratory stands now, was completed in 7 months. The equipment was primarily magnetic but it included a very full set of meteorological instruments. Air temperature and wet bulb temperature were measured and there were recording thermometers. The barometer was a very fine instrument. It remained the standard barometer for Canada until about 1943 and is still around and servicable in the Meteorological

Service. There was a special house built to accommodate the vane and pressure plate of Osler's Anemometer and support it at a height of 30 ft. above the roof of the observatory.

In 1841 Lt. Riddell was compelled by ill health to return to England, and he was succeeded by Lt. (later General Sir) Henry Lefroy. Lt. Lefroy had been at St. Helena organising an observatory there while Lt. Riddell was building the one at Toronto. He came with a considerable reputation to the double task of running the observatory and carrying out a magnetic survey of British North America. This latter took him on long journeys during which time Lt. Younghusband looked after the observatory. Captain Lefroy was an enthusiastic meteorologist. He frequently attended scientific meetings in the U.S.A. and attempted to introduce into Canadian Grammar Schools the U.S.A. practice of making meteorological observations. He was clearly of great ability and merited high academic standing. He was President of the (Royal) Canadian Institute for more than three years and he was elected Fellow of the Royal Society of London in 1848.

The original plan had provided for a life of 3 years only for the observatory, but in 1853 it was still being financed from England. Funds were obtained with increasing difficulty as time passed, so that the continuance of the observatory often seemed in doubt. Lefroy and others made great efforts to maintain it. He was formally supported by the (Royal) Canadian Institute and others in requests to the Legislative Council of the Province of Canada that it should assume financial responsibility. In a masterly document, sent to the Governor General in November 1852, Lefroy discussed the need to maintain the observatory and outlined desirable development. His suggestions included proposals that the activities of the observatory be widened to include astronomy and that it should be equipped with a substantial telescope, that the University should establish three or four Physical Scholarships to be associated with meteorology, and that one of the Professors in the faculty of arts should be appointed to be superintendent of the observatory and receive special salary for the work.

The efforts were successful, the Province accepted financial responsibility and about 10th April 1853 Captain Lefroy finally handed over the observatory to Professor Cherriman who was author-

ized by the President of Toronto University to receive it on behalf of the Province of Canada.

In 1855 Professor Cherriman was made Professor of Meteorology and Director of the Observatory, and about the same time Professor Kingston, head of the Naval College, Quebec was appointed Professor of Philosophy in the University of Toronto. However, before Professor Kingston arrived Cherriman obtained the chair of Philosophy, which he presumably preferred to Meteorology, and Professor Kingston was then appointed Professor of Meteorology. (Politics have always been important in universities!). In this way Toronto University was the first University in the British Commonwealth to have a chair in Meteorology.

At that time a college was not clearly distinguished from a University, and both were very different from our modern view. The curriculum was fixed and required only professors in Classics, Mathematics, Philosophy, Chemistry and Natural history and a tutor in English and Modern Languages. There would be about 100 students, and the annual expenditure would be about $20,000. To have an observatory and a professor of Meteorology was a considerable experiment, perhaps they felt that since they had got one they needed the other. There can be little doubt about the importance of Lefroy in this matter. He had contributed greatly to Toronto life and he must have left behind a very deep impression.

The calendars of University College from 1857 onwards are preserved. They show the course in Meteorology and that there was a Meteorology scholarship available worth £5 per year. (This would pay fees for the session for five or six hours of lectures per week).

The outline of the lectures given from an early calendar is given below:

"Subjects of lectures:

Preliminary remarks on the nature and object of the science. A brief examination of some of the properties of gaseous bodies. A description of the construction and use of meteorological instruments, and of the mode of registering and classifying the data which these instruments severally furnish.

Considerations relative to temperature, with its diurnal and annual variations and geographical distribution.

An enquiry into the causes and physical peculiarities of different winds.

An investigation of aqueous phenomena, including the variations in the hygrometric condition of the atmosphere; the formation of clouds, fog, dew, rain and snow; comparative prevelance of rain in different periods and in different regions.

Examination of the laws relating to the diurnal, annual and geographical fluctuations of barometric pressure. Connection between wind and the indications of the barometer, and aqueous precipitation.

Practical application of Meteorology, with reference to animal and vegetable life and the industrial occupations of man.

(Text books - Koemtz's Meteorology, by Walker; Drews Practical Meteorology.)

Demonstrations are given by the Professor at the Magnetic Observatory."

The records show the course developing slowly and then after 1869, two courses were offered, an ordinary course and a course "For Honours". The records show that from a total student population of 60 or 70, one or two students took the course each year, but no summary of the lectures is included. Throughout the period Professor Kingston also gave lectures on the application of meteorology to agriculture, for the University was also exceptional in having a course in Agriculture. He had responsibilities to the Observatory, and made efforts to organize observations and interest throughout Canada.

The subject was not always accepted as proper for the University: in 1860 Ryerson, giving evidence to a committee (which never reported), declared "That the chairs in Modern Languages, in English and History and Meteorology had been an unnecessary extravagance and that five professors were all that the College needed." (Meteorology seems to be in fair company).

In 1880 Professor Kingston retired for reasons of health and he died the same year. He seems to have been long remembered but he was not replaced. There was to be an interval of more than 50 years before Meteorology would be taught again.

- to be continued -

METEOROLOGY IN CANADA 1964

An Abstract from the text of

CANADIAN GEOPHYSICAL BULLETIN

Vol.17, Dec. 1964

to be published by the

NATIONAL RESEARCH COUNCIL OF CANADA

The following is a part of the material describing meteorological research presently under way in Canada. The full text, with Abstracts of published papers and a Bibliography, will be published in early spring, 1965, by the Associate Committee on Geodesy and Geophysics, N.R.C.

UNIVERSITY OF BRITISH COLUMBIA

Air/Sea Interaction - The object of this programme is to learn more about the exchange of momentum and energy between the atmosphere and the sea. The observations at the present stage are limited to the lower 3 to 5 metres of the atmosphere and the upper 2 to 3 metres in the sea at a location approximately 400 metres offshore in the Strait of Georgia.

Measurements in the atmosphere are being made of: the small scale structure of atmospheric turbulence using hot wire anemometers (millimetre scale) and a thrust meter designed by L.A.E. Doe, Bedford Institute of Oceanography (decimetre scale); momentum flux using both u and x wires (hot wire anemometers); the mean wind velocity profile above waves using Thornthwaite cup anemometers; the relation between surface elevation fluctuations (waves) and the motion of the adjacent atmosphere; and temperature profiles and heat flux using six vertically spaced thermistors.

Measurements in the water include mean current velocities and the two dimensional spectra of wind generated waves.

Most of the latter part of 1963 and the first part of 1964

was devoted to the construction of instruments incorporating improvements suggested by field experience in 1963. The sensor and recording systems were designed so that measurements of wind and waves could be made simultaneously to permit the study of correlations between the various parameters.

The field observation programme was commenced in May, 1964. Unsuitable wind directions and damage to the sensors by floating logs delayed the acquisition of data but by the end of July sufficient had been collected from the atmospheric side of the boundary and on wave elevations to permit analysis to be started. The field station was closed down until September when it was reopened for further wave-direction spectrum and associated wind measurement work.

It is too early to be specific about results from the 1964 summer observations; it is expected that a good deal of the analysis will be completed by mid-1965.

Local wind studies - An investigation has been started on the local wind circulation in the coastal fjords of British Columbia. Initially, it is aimed at a study of the variations in time and position of the surface wind.

Bute Inlet was the site of this year's experiment. From its entrance, on the mainland coast opposite the centre of Vancouver Island, it runs northward inland for 40 miles between ridges of height 5000 ft. or more. The inlet is fed not by one valley running in the same general direction, but by two valleys of approximately equal size, entering at right angles to the inlet at its head. This year's observations were concerned primarily with the flows in these two valleys and the inlet, and their interaction.

For this experiment portable instrumentation was made by combining an anemometer, a wind-vane and a chart recorder made by three separate companies. This weighed about 10 lb per unit (exclusive of mast or tripod) and was capable of recording continuously for a week on a 6 volt lantern battery. Recordings were obtained for 3-4 days at the beginning of July, giving winds representative of the inlet and each of the two valleys. Occasional observations were also made on board ship, at anchor between the

valleys. Analysis of results is still in progress, though first impressions suggest that each valley has a normal circulation unaffected by the presence of the other. Further instrument sites along the shores of Bute Inlet, and also of Indian Arm, nearer to Vancouver, have been investigated with a view to further work in this line, such as a study of the variation of wind with position and time along an inlet.

UNIVERSITY OF ALBERTA

On the Edmonton campus co-operative studies on hail and on Arctic climate have continued. As well work is underway on the distribution of temperature and pollution around the city of Edmonton and a bench mark station with instrumentation to study the soil temperature and the flow of moisture and heat in the lowest layers of the atmosphere has been established at the University farm at Ellerslie.

An analysis of past records plus the collection and analysis of data from several locations along the Bow River valley are included in Chinook studies at Calgary.

UNIVERSITY OF SASKATCHEWAN

Laboratory projects in cloud physics together with climatological and synoptic investigations are in progress.

UNIVERSITY OF WESTERN ONTARIO

The investigation of the spectra of horizontal wind velocity includes one location where wind velocities and gustiness are observed at 5 elevations on a television tower within 800 feet of the ground. Similar observations are being carried out at a separate location on a 150-foot tower. Special instrumentation has been developed for recording velocity fluctuations at the various tower positions.

The microclimatology of cities is being studied through the use of mobile observations of temperature near the

ground and across the city. Another is concerned with ground temperatures and ground water flow; a new mobile field station is being set up on the north shore of Lake Erie, some 6 miles east of Port Stanley, and preparations are underway for the measurement of mean temperatures along the slope of a 120-foot cliff above the water's edge.

The Tropospheric Physics Group has four research projects underway:

(a) The diffusion of heat and moisture between the ground and the air above it, with particular reference to the distributions of temperature and water vapour in turbulence at the ground. This project makes use of special radio techniques, including rapid-response refractometers and thermometers that were developed at the University.

(b) The study of temperature profiles in a laboratory model, which simulates a part of the lower troposphere. In the present work, the model simulates the temperature distributions and velocities within convective cells above ground with different albedos, in a dry atmosphere.

(c) The study of laminar structure in air temperature, humidity and refractivity within the layer of frictional influence above ground, with the aid of a sensitive microwave radar. The emphasis here is upon the relationship between this microstructure and its environment.

(d) The direct sounding of the air in the layer of frictional influence with rapid-response instruments, for information on the micro-structure of temperature, humidity and wind shear. Ballon-borne refractometers and temperature sondes, and rocket-borne smoke generators have been designed and constructed at this University especially for this purpose. An extensive study of refractometer response at high relative humidities is included in this work. Projects (c) and (d) are being transferred to a field station off the campus, for combined observations.

UNIVERSITY OF TORONTO

A cold room for the examination of hailstones is now in regular use and experience is being obtained in the etching of surfaces, the making of replicas, microscopic examination, and density measurements of hailstones.

The measurement of Solar ultra violet intensities at about 2100 Å has been completed. A paper on this work will be published shortly. New calculations of ozone production have been made and are awaiting checking.

In co-operation with U. of T. work is proceeding at Guelph on a heat and water budget study of the Speed River basin.

WATERLOO

Work is proceeding on the dispersion of heavy particles in the atmosphere but is handicapped by the absence of an ideal site. In co-operation with the Great Lakes Institute and the Meteorological Branch studies of diffusion near the lake interface in both the water and the air are being pursued. Also studies of wind roads are being made.

COLLEGE JEAN-DE-BREBEUF

Geophysical measurements include the atmospheric electrical potential and air-to-earth current density and results are published in their Bulletin de Geophysique.

McGILL UNIVERSITY

Research on the heat balance of the Arctic has been extended to consider moisture and sensible heat flux over the sub-tropical Atlantic. Dynamical studies have demonstrated interaction between the stratospheric polar vortex and the tropospheric vortex. Projects are thus underway to model the stratosphere, including radiation, with the troposphere as a boundary, to prescribe the

complicated non-linear interactions by spherical harmonics and to consider the role of diabatic heating at the lower boundary. These studies require magnetic tape data files and extensive use of McGill's (IBM-7040) computer facility.

The Alberta Hail Studies project, supported by the Research Council of Alberta, NRC and the Canadian Meteorological Service, continued its summer observational program in Alberta, with analysis carried out at McGill. A considerable degree of "intermittency" in observed hailfall has been noted, and the 10-cm radar has revealed evidence of small-scale echo structure. Related studies included an investigation of the characteristics of tall storms, which suggested that entrainment is not a major inhibition to large storms; this finding is in agreement with the conclusions of a theoretical study of entrainment in cumulus involving a numerical model in which precipitation plays a part. A study begun of the effects of vertical wind shear on severe Alberta storms and the analysis of hail size spectra, and the relations between radar reflectivity, hail concentration, and hailfall rate were brought up to date.

The heat balance of a growing hailstone was examined; the heat capacity of a hailstone may be sufficient to delay appreciably the onset of the "wet growth" phase. Laboratory measurements continued on the nucleation of supercooled droplets of distilled water, of rain water, and of melted hail.

The analysis of radar data at McGill includes a study of the occurrence of first echoes relative to the local topography and an evaluation of radar grey-scale CAPPI display, the facsimile transmission of the scope record into the forecast office briefing room and its use in briefing of aircrews. Vertical profiles of total precipitation within the area of radar coverage were developed and an automated technique of producing these profiles was devised. These profiles show a systematic variation with airmass stability; the height at which the maximum precipitation rate occurs being related to the total positive area in the atmospheric sounding.

Studies continue on the distribution of duration and amounts of rainfall by intensity, with particular interest in high intensities.

Techniques of measurement of snowfall rate continue to be studied, considering the attenuation of a narrow optical beam (e.g. a laser). Theoretical studies were made of the scattering of microwave radiation by droplets in close proximity to one another, as well as of the refractive index gradients responsible for radar "angels".

The analysis of atmospheric pollution data, together with temperatures and winds, led to the formulation of a model of urban ventilation for Montreal.

Radiation calculations have been programmed to compute infra-red heating rates at any atmospheric level due to water vapor, carbon dioxide, and, less reliably, ozone, on the basis of Kondratiev's or of Elsasser's tables. For any given atmospheric sounding, results can be obtained in less than one second of machine time per level.

A program of radiation observations has been started. The long-term objective is to examine specific radiational characteristics of city air, with special emphasis on nocturnal fluxes. As a starting point, solar and sky radiation is being recorded (day and night) by a Suomi-Kuhn sonde.

OTHERS

An investigation of the characteristics of Montreal snowfall by Weather Engineering Corp. has revealed a good relationship between the density and the predominant crystal form of freshly-fallen snow.

At St. Mary's University, Halifax, studies of fog droplets are continuing.

CANADIAN METEOROLOGICAL SERVICE

A short summary of some of the research activities of the Meteorological Branch is given in the following.

The Air Pollution and Turbulence Group uses special in-

strumentationand towers to measure the small-scale fluctuations of wind and temperature, including fast-response bi-directional vanes, thermocouples and vertical anemometers. As part of its program, special co-operative 200 ft. micro-meteorological towers have been erected at Montreal, Ottawa, Chalk River, Rolphton, Hamilton, Sarnia and Whiteshell.

The meso-scale (1-50 miles) is significant both from the point of view of its interaction with other scales and because it plays a dominant role in short-period weather fluctuations. To study these phenomena a meso-network of recording stations has been set up within a radius of 30 miles of Malton Airport. Research is in progress to develop a fully automated system (from observing to forecasting by computer) to handle the airport terminal forecast problem of this scale.

Three different types of measurements of atmospheric ozone are being made in Canada: (1) surface ozone, of interest in air pollution studies, is being measured along with other pollutants at several locations; (2) the vertical distribution of ozone is being observed using balloon-borne detectors at Goose Bay and Fort Churchill. These stations are part of a network in North America. The measurements are important in the study of the general circulation of the stratosphere, and in some aspects of stratosphere-troposphere interchanges; (3) the total ozone in a column is being observed in four locations in Canada, as part of a world-wide program.

The processing of the sonde observations has been handled by computer programming. The other types of data are now being considered. Once these problems have been solved, investigations of many types will be possible.

With the advent of meteorological satellites there has been much interest in the possibility of obtaining vertical atmospheric profiles of certain parameters or constituents (e.g. temperature, ozone) by indirect sounding methods. An indirect sounding method is one in which the measuring device is not passing through the atmosphere in the vertical to obtain the vertical profile. Although this is an attractive method of obtaining the desired information, it turns out that the vertical resolution attain-

able is not really very good, being of the order of many kilometers. This result has been obtained by an analysis of a classical indirect sounding method, the so-called Umkehr effect, used to estimate the vertical distribution of atmospheric ozone. In this method, a ground-based spectrophotometer is used to measure the intensity ratio of two wave-length bands in the solar ultra-violet light scattered downward from the zenith sky over a half-day. The measurements are sensitive mostly to the total amount of ozone in the atmosphere, but there is sufficient variability due to differences in the vertical distribution that the gross features of the distribution may be estimated.

Research is undertaken to elucidate the nature and amount of the transfer between troposphere and stratosphere both directly using velocity components and the principle of conservation of mass (continuity equation), and by the interpretation of consistent tracer data. This type of study should contribute to a clarification of the nature of the physical processes contributiong to tropopause formation and maintenance, to interactions (e.g. energy exchange) between stratosphere and troposphere, and to the development of a model adequately describing this important provocative but somewhat intractable region of the atmospheric engine.

Cloud Physics Research Programs - Studies in the physics of clouds and precipitation are undertaken both in the laboratory and the natural laboratory - the atmosphere. For the past five years a project, to determine the effect on precipitation of inoculating clouds with chemicals dispersed within the clouds by means of aircraft has received major attention. The economic importance of being able to exercise control over precipitation warrants this intensive study. Although it is recognized that 'cloud seeding' can under certain circumstance cause rain to fall from clouds which would not normally precipitate there is not universal agreement as to the exact circumstances and extent. In large scale field studies, the problem is to determine what rainfall might have fallen had the clouds not been 'seeded'. A statistical approach to this problem must also in the final analysis be supported by a physical investigation. Experiments in the field are therefore performed under closely controlled conditions and supported by a good observational program involving atmospheric measurements at both the earth's surface and at all levels to well above the cloud habitat. An especially instrumented all weather aircraft with a precise navigational system and operated by the National Research Council and the RCAF provides a capability of measuring parameters in and around the

clouds. The aircraft can collect cloud samples to determine drop size distributions, determine cloud liquid water contents, sample aerosols and indicate turbulence and winds as well as measure standard meteorological parameters. Radar observations of precipitation and lightning activity are also recorded on the ground along with certain aerosol observations.

A new trailerized 5 cm weather radar set is being put into operation to be followed closely by installation of a 3 cm system. Plans are underway to acquire by 1966 a Doppler type radar to measure cloud droplet velocities within the clouds and by 1968 a 10 cm weather radar will be added to the complex. The increased radar facility will provide greater potential for cloud physics and radar meteorology research.

Studies of air motions in the middle stratosphere (60-90,000 ft) are in progress using grid point data acquired in recent years. These studies deal with the dynamics of stratospheric flow, the resolution of this flow on large and small time scales and over a range of space scales from planetary to a few hundred miles, and with the relationship of this flow to atmospheric motion in the lowest 10 to 20,000 ft.

Multi-factor Analysis - Detailed analysis of relatively local atmospheric processes is being carried on using the full resources of the most powerful computers available in order to disentangle the influence of a large number of measured parameters; these are considered separately and in their combined effect. The data for such studies are the punched-card archives, now approaching 20 years in length, of hourly weather observations and atmospheric measurements taken at a large number of stations. The data and the analysis techniques developed open the way to a large number of important and challenging studies. In particular, the statistical approach being used attempts to avoid the two pitfalls of assuming a linear relationship between the dependent and independent parameters and of ignoring the higher order interaction effects.

Numerical Weather Prediction - The Research Section of the Canadian Meteorological Service is carrying on an active program of research in numerical weather prediction. At the Central Analysis Office automatic data-processing and prediction for a hemispheric grid are fully operational. Development continues on more complex problems such as multi-level models, the inclusion of latent heat and the forecasting of precipitation.

A small group is devoting its attention to the development and improvement of quantitative or objective short-range forecasting techniques. A method for producing quantitative precipitation forecasts has been developed as well as a semi quantitative, objective technique for forecasting the development of East Coast Cyclonic Storms. Work is underway on studies of satellite cloud photographs and the development of short-range prediction techniques, particularly using measured radiation data and thermodynamic principles.

There is evidence that the atmosphere has certain preferred long-period modes of oscillation. One of these that is well-marked, particularly in the tropics, is the so-called 26-month or biennial oscillation. The significance and causes of this oscillation are not well understood. Study is proceeding in the Meteorological Branch to see whether this is basically a forced perturbation arising from solar influences. To determine this, the space and time variation of long-period oscillations of a great number of atmospheric and geophysical phenomena are being investigated. Methods used include elaborate harmonic analysis procedures making use of advanced techniques in filtering and separation of signal from noise.

Hydrometeorology - Major recent efforts have been on studies of winds and other factors affecting currents near Douglas Point, Lake Huron, of the formation and dissipation of ice on the Great Lakes and of meteorological factors affecting Great Lakes levels. Current efforts are concentrated mainly on the latter question in view of the currently very low levels of the Great Lakes and proposed plans for their regulation.

Studies of critical meteorological conditions producing maximum floods have recently been completed. These studies provide criteria for major dam construction programs on the St. John River, N.B., the Columbia River, B.C., and many Prairie rivers. Projects are underway in connection with the flood control program in the Thames and Metropolitan Toronto Region basins in Ontario, the Portage Mountain Dam on the Peace River, B.C., and hydroelectric developments in Nova Scotia and Newfoundland. Special evaporation studies are being conducted to aid in reservoir design on the Prairies.

Co-operative ten-year investigations with federal and

Alberta agencies are now underway to determine the role of vegetation in the water balance of the Rocky Mountain East Slopes source region of the Saskatchewan River, and to find out whether purposive changes in vegetation could increase river flow volumes without undue flooding or additional sedimentation. Efforts in connection with developing meteorological aspects of river forecasting procedures are at present concentrated in Ontario, but future activities in this field are anticipated in New Brunswick and in British Columbia.

Studies of the Great Lakes are expected to be intensified as a result of investigations being launched by the International Joint Commission. Other hydrometeorological research will also be greatly increased in the next ten years as Meteorological Branch's contribution to Canada's program for the International Hydrologic Decade (1965-1974).

In the tobacco weather fleck project, the microclimatic studies contributed much to the interpretation of many complex physiological and air pollution problems associated with this disorder. A new sensitive lysimeter using zinc chlorid solution as the floatation medium and differential transformers as the measuring device to detect displacements was developed by our personnel in collaboration with the Ontario Agricultural College at the University of Guelph.

In the Forest Meteorology Project which was started in the summer of 1964, and which is expected to continue during the next few years at Petawawa, the Meteorological Branch is working in collaboration with the Canada Department of Forestry. This study will concern the atmospheric part of the forest environment as affected by varying degrees of thinning, by physiographical peculiarities, and by the temperature and humidity stratification above and below the crown. A 200-ft tower with 8 levels for measuring temperature, humidity and wind is being used. Another notable feature of the instrumentation is the design and construction of moving sensors which provide space averages rather than point source values of the various meteorological parameters.

SOME REFLECTIONS ON THE INTERNATIONAL ACTIVITIES OF A NATIONAL METEOROLOGICAL SERVICE

by

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Meteorological Service of Canada
Toronto

1. INTRODUCTION

It is frequently necessary for national meteorological services to pause and redefine their objectives and functions. This exercise is usually straightforward with respect to domestic activities, but this is no longer the case for international activities, since the documentation of requirements is seldom readily available. In what follows, the analysis is carried out specifically for Canada and its Meteorological Service, although the arguments will apply in a much more general manner.

The following abbreviations are employed:

WMO: World Meteorological Organization (A United Nations Specialized Agency).

ICSU: International Council of Scientific Unions (non-governmental).

IAMAP:: International Association of Meteorology and Atmospheric Physics.

COSPAR: Committee on Space Research.

IQSY: International Years of the Quiet Sun.

IHD: International Hydrologic Decade.

IUGG: International Union of Geodesy and Geophysics (parent body of IAMAP).

2. INTERNATIONAL RESPONSIBILITY

In carrying out its activities, the Meteorological Service has a definite and eagerly-accepted responsibility to the citizens of Canada. This is not solely a question of employer-employee relationships, nor of loyalty to an assembly of consumers, but goes much deeper. It is rooted in the loyalty to Canada of Canadians, a doubly-rivetted linkage in the case of Federal civil servants. This, in its larger sense, constitutes the major and collective motivation of the Meteorological Service of Canada. It is not the only motivation or loyalty, however, on a collective basis, and frequently must share top-billing on an individual basis.

We may recognize two fundamental entities which make possible the activities of the Meteorological Service - the Canadian citizens as employer and consumer, on the national side, and the science of Meteorology, on the international side. We should have clear-cut responsibilities and loyalties to both; we cannot serve either effectively without serving both.

We can, of course, serve the science of Meteorology in many ways, with a variable feedback to our own activities at home. We can publish in the open literature the results of our research and development projects; here the direct feedback is obvious but we should not lose sight of the indirect feedback, the critical discussion, and further elaboration and application of our ideas which will appear subsequently in the literature. We can participate in international scientific symposia and conferences, by presenting research papers and joining in discussions, and the feedback here is also primarily direct and obvious. We can also assist in the advance of the science by presenting or by publishing review papers or articles, and by writing monographs or text-books. In these latter cases, the feedback is neither direct nor obvious, and the primary motivation is of service to the science. These activities are of importance, however, particularly to those in the developing nations, and we must be prepared to donate the time of our staff in those fields in which they have an international reputation.

We can also serve by promoting the organizational aspects of our science - WMO on the governmental side, primarily but not exclusively concerned with operational aspects, and various organs of ICSU on the non-governmental side, primarily but not ex-

clusively concerned with research aspects. Here, our participation is partly official (even for ICSU bodies, in which case we work through the National Research Council and its Committees), and, to this extent, represents a routine function requiring no justification. However, the breadth and depth of our participation is a matter for debate, particularly on the ICSU side. Questions of feedback arise here also; in the case of WMO, it is essential to participate in technical discussions of operational questions since we will in time be expected to carry out our activities along lines decided at such meetings. Even in the case of ICSU bodies (IAMAP, COSPAR, IQSY Committee, ICSU Committee on Water Resources and its IHD Subcommittee, etc.), it is distinctly advantageous to participate in discussions leading up to a large international scientific program, to ensure that our views have been considered and to accelerate our implementation of such programs. It is only fair to point out, nevertheless, that a nominal participation can secure almost optimum feedback. However, in the case of ICSU bodies it is decidedly helpful to have access to the inner or executive bodies, and the same is true to a somewhat lesser degree with WMO.

In the case of WMO, breadth and depth (beyond normal representation at Commission, Regional Association and Congress meetings) relates to participation in working groups and election as officers of Commissions or the Regional Association. These are all onerous activities, with fair feedback in the former case but little in the latter case. Nevertheless, when competent experts or officials are available, our responsibility is clear-cut. We should never ask for representation unless our nominee is at least on a par with others suggested, so that our effective contribution to the working group can be ensured. In the case of Commission officers, we can permit the democratic procedures of WMO to settle any questions of value and competence, neither insisting on nor rejecting a nomination of a Canadian.

In the case of ICSU organs, membership on Commissions or Joint Committees of Union Associations (or their equivalents, such as COSPAR Working Groups, etc.) carries only nominal tasks and responsibilities, not in any way comparable to a WMO Working Group. Although there is a relatively small number of ICSU executive posts in the field of meteorology, these are not only

onerous but require considerable back-up (on the sub-technical, clerical and office service side) that is normally not needed in the case of WMO officers. Here again, one should let democracy prevail and leave the selection to Nominating Committees and Assemblies, being prepared to provide the back-up also when called upon, as a token of faith in and support of the non-governmental organs of science. Since these embrace both governmental and non-governmental scientists, they are the primary forums for the discussion and advancements of science (as WMO recognized in its "Working Arrangements" with ICSU and IUGG).

3. INTERNATIONAL PRESTIGE

So far, we have discussed the Canadian responsibility to the international science of Meteorology, in some facets with strong feedback and in other facets with very little. In addition to feedback of scientific knowledge into the operational and research activities of our Service, there is an additional "reverse flow", which will be almost invariably strong, even when the true feedback is weak. This is the flow of appreciation and respect for the achievements and national an international activities of Canadian Meteorology and of Canadian Meteorologists - in other words, the development of our prestige in the eyes of world science and world scientists. This is largely a personal matter; some of us (through insensitivity or modesty) neither seek nor appreciate prestige, while for others it is a shining star whose motivating influence dominates our ambitions.

Although predominantly of a personal impact, international prestige cannot help but rub off, to some extent, on the bulk of the professional staff of our Service - both headquarters and field. We can also expect to encounter its downstream effects at Canadian universities when on recruiting missions, particularly now that Meteorological groups at several universities are in a position to influence departments of Physics. It will also have an indirect bearing on all our professional contacts, within the Department and with other Federal Departments. If our scientific status is recognized, our contacts with other professional groups will be more effective and more productive.

In relation to research and development staff, international prestige is a major factor determining morale, and well worth promoting for that reason alone. Increased recognition of the merits of the work performed by oneself and by one's colleagues leads to increased work output, and a chain reaction ensues. It may be pertinent at this point to draw attention to the analogy with another physical concept, that of "critical mass" (in the sense used for atomic bombs). Sufficient staff must be provided in research and development units to carry out all the needed service and support functions (for the unit and for the service), plus a small uncommitted surplus to engage in creative and basic research activity. The output of this "surplus" will draw attention to the broader, more operationally-oriented, activities of the rest of the staff and soon all will enjoy enhanced prestige at home and abroad. This will improve the recruitment of basic and specialized professional staff, and increase the morale of the units, which will increase prestige even further.

4. THE ROLE OF CANADA IN INTERNATIONAL METEOROLOGY

In determining the extent of Canadian participation in international meteorology (both the science and its organization), one must bear in mind the status of Canada internationally, and of its Meteorological Service in particular. On the former question, it is quite apparent that Canadians are very acceptable in international circles for executive posts, being from neither a very large and powerful nation, nor a country controlled by a major power, nor one with militant geographic or trade ambitions. On the latter question, it is well known that the Canadian Meteorological Service is one of the largest in the world, relatively modern in its forecasting and climatological activities, with an exceptionally high level of academic background for its professional staff. It is small wonder that Canadians are in constant demand for executive posts on WMO Technical Commissions, and on ICSU bodies as well (the Senior vice-president of ICSU is a Canadian, Dr. Harrison, as was its former president, the late Dr. Steacie).

It is clear, therefore, that although the staff available for such appointments may be relatively small, the demand for their service internationally will be relatively great. Our responsibility to World Meteorology is such that we should not turn a deaf

ear to these pleas for our participation in global operations which have as their goal the improvement of the lot of all people, everywhere.

5. THE ROLE OF CANADIANS IN INTERNATIONAL METEOROLOGY

We may conclude by a brief consideration of the most important aspect of international participation - the individuals directly concerned. First, we can recognize that only a small fraction of those qualified to participate in such activities actually desire to do so. Of course most scientists in research and development units appreciate the freely-given opportunity to publish in the open international literature. The only point to be made here is that posts in National Defence laboratories should seldom, if ever, be considered as permanent, since security restrictions on publication will either cause frustration and eventual resentment, or else eat away at the desire of the individual to do research worthy of open publication.

Again, not all scientists desire to attend international symposia and conferences, and of course they cannot be forced to do so. On the other hand, those wishing to attend and of the appropriate stature should be encouraged at every opportunity. For the junior man, personal feedback may be the greatest possible "efficiency booster"; for the more senior man, feed-back to his unit may be the major accomplishment; for the international expert, the boost to Canadian prestige begins to be an important factor to consider.

Very few scientists have any wish to prepare monographs or textbooks, and relatively few feel they have the time to prepare extensive review articles. Nevertheless, these activities should be actively supported whenever a natural desire can be recognized, and there should not be any suggestion that such activities must be carried on outside normal working hours.

Participation in WMO activities (including technical assistance) is almost in the class of donations to a charitable organization. As a well-developed Service, we can provide extensive guidance to others not so well-developed. Individual experts, whether on Working Groups or on Technical Assistance Missions, gain relatively little in prestige but are rewarded by the knowledge that their

know-how will advance the well-being of mankind, as a whole. Since the personal and scientific rewards are at best indirect, few will seek appointments such as these. However, since we have so much to offer, we can scarcely refuse to permit those who seek to serve the advancement of mankind the opportunity to do so.

In the case of executive posts within WMO and ICSU, again very few will aspire to such onerous, time-consuming and relatively unrewarding functions. Here the feedback, except for prestige, to the service is small, and is largely offset by the large fraction of personnel time devoted to these activities, including travel and sub-professional assistance. The problem is not that so few Canadians seek such posts but that so few of any nationality seek such posts. As a result, if a Canadian is both willing and acceptable, it is our duty to make him available, as our contribution to international relations and international science. Only by so doing can we be sure that we are best serving Canada by best serving Meteorology.

Toronto Centre

November 1964:

The 25th anniversary of the formation of the Canadian Branch of the Royal Meteorological Society was commemorated by the Toronto Centre on November 5, 1964, at a 25th Anniversary Dinner attended by 180 members and guests of the Centre. The speaker for the occasion was Mr. J.R.H. Noble, recently appointed Director of the Canadian Meteorological Service, who took as his topic "Meteorology in Canada: A Look at the Past and Some Thoughts about the Future".

The history of the Royal Meteorological Society dates back to 1850, with the granting of a Royal Charter by Queen Victoria and the assumption of the name Royal Meteorological Society dating from 1866. The granting of a charter by the R.M.S. to an overseas branch of the Society in Canada took place in May, 1939, followed by organization of the Canadian Branch in August, 1939. Chairman of the Organizing Committee was Dr. Andrew Thomson, while the first executive was composed of Dr. J. Patterson, Chairman; Mr. W.E.K. Middleton, Secretary; Mr. F.G. Millar, Treasurer, and one representative for each of Vancouver, Winnipeg, St. Hubert, Newfoundland and Halifax. The Newfoundland representative was Dr. P.D. McTaggart-Cowan, while the present Director of the Meteorological Service, Mr. J.R.H. Noble was the St. Hubert representative. The first regular meeting of the Branch was held on February 2, 1940, with 17 members and 11 guests in attendance. Since the total membership of the branch was then only 34, this represented an attendance of 50% of the total membership. From this modest beginning, the ranks of the Branch have swelled to a present membership of about 385, with Centres at Toronto, Montreal and Winnipeg.

In his remarks to those assembled to celebrate the 25th Anniversary of the formation of the Branch, the new Director of the Meteorological Service, Mr. J.R.H. Noble, was introduced by former Director Dr. Andrew Thomson. Mr. Noble drew attention to the fact that there was added significance to the anniversary in so far as the history of meteorology in Canada is concerned, since it was on September 1, 1839 - 125 years ago - that Lieut. Riddell sailed

from England to establish the magnetic and meteorological observatory which later expanded into the Meteorological Service of Canada. Although originally scheduled to be established in Montreal, the observatory was actually set up in Toronto since the Montreal area was deemed unsuitable for magnetic observations. The speaker did not comment on the possible change in the course of the history of meteorology in Canada had the original plan to establish the observatory in Montreal been carried out.

From its early beginnings in 1839, when weather observations were taken as part of normal duties by the British Army at Fort York, Mr. Noble sketched the history of meteorology in Canada up to the present time, when the Canadian Meteorological Service is one of the largest in the world, and meteorology is winning increased attention in Canadian Schools and Universities. More than 2200 Canadians now make meteorology their life work and there are perhaps as many as 4,000 more who contribute on a day-to-day basis.

In turning his attention to the future, Mr. Noble's thoughts were towards continued expansion of meteorology in all areas of Canadian activity. Assuring us that "We haven't seen anything yet", he outlined some of the areas in which the most spectacular advances might be expected - satellites, rockets, computers, etc., not only within the government service but also in the International Field and in the greatly increased contributions from Canadian Universities.

The meeting concluded with a vote of appreciation to the speaker sponsored by Mr. M.K. Thomas, Secretary of the Canadian Branch, and with the presentation to Mrs. Noble of the 25th Anniversary arrangement of fall flowers decorating the speaker's table.

J.D.H.

December 1964:

Sixty members and guests of the Toronto Centre, Royal Meteorological Society, Canadian Branch, assembled at 175 Bedford Road in Toronto on December 1, 1964, for an interesting talk by Mr. W.E. Markham, Officer-in-Charge, Ice Forecast Central, Halifax.

Mr. Markham's subject was "Problems in Ice Forecasting", which he introduced by a review of the aspects of oceanography which enter into ice forecasting, and their inter-relationships with the meteorological aspects. The basic problems discussed by Mr. Markham were those of forecasting the time at which sea ice will form and the depth to which it will form, also how it will move once it has developed. Density and salinity of the water are very important in determining at what temperature and to what depth sea ice will initially appear. Combination of these parameters with meteorological factors such as insolation, cloudiness, air temperature, precipitation, wind, etc., is required in order to produce a forecast of ice formation. Mr. Markham indicated that considerable success had been achieved in forecasting the formation of ice in the Gulf of St. Lawrence using a 30-day weather forecast, insolation data, etc. Further growth of the ice after initial formation is less complicated and is predictable by empirical formulae developed in the Russian Arctic which have been found to work well in the Canadian Arctic as well.

Problems of forecasting the direction and speed of motion of sea ice have also been attacked on an empirical basis and the relations between ice movement and wind speed are now fairly well known. Determination of the average wind over an ice field still remains a difficult problem, but there has been considerable success in relating roughness parameters, etc., to the movement of the ice under the influence of the wind, and there have been a number of refinements to the original formula of ice movement 28° to the right of the wind with 2% of its speed. Both meteorologists and oceanographers are able to contribute much to the understanding of each other's problems.

At the conclusion of his talk on the problems of ice forecasting Mr. Markham ventured a few comments on his trip to Russia in the spring of 1964 as the Canadian expert on ice forecasting in an official party headed by the Assistant Deputy Minister, Marine. Some interesting slides and commentary concerning various manifestations of life in Russia today accompanied this portion of the talk.

Mr. Markham was introduced by Mr. A.G. MacVicar and was thanked on behalf of the gathering by Mr. D.C. Archibald who commented on the increasing importance of ice observing and ice forecasting in the Canadian economy.

J.D.H.

February 1965:

The first meeting for 1965 of the Toronto Centre, Royal Meteorological Society, was held on February 2nd at 175 Bedford Road. On this occasion the audience heard the Executive Secretary of the American Meteorological Society, Mr. Kenneth C. Spengler, holding forth on his favorite topic "The Activities of the American Meteorological Society".

Mr. Spengler outlined the many projects, services and activities of the American Meteorological Society. Canadian participation in many of these activities is high, and this fact combined with Mr. Spengler's enthusiastic approach no doubt accounted for the lengthy question period. Many of the activities of the Society were already quite well known in Canada, such as the publication of the "Journal of the Atmospheric Sciences" and the "Journal of Applied Meteorology", the "Bulletin of the American Meteorological Society" and "Weatherwise". Sponsorship of scientific meetings by the Society was also well known, and many of these meetings usually have a good representation of members from Canada. Mr. Spengler regarded the sponsorship of scientific meetings as perhaps the single most important function of the Society. There are many other important ones, including the publication of books, the granting of awards and many educational activities. There are also the Seal of Approval Program for Radio and TV broadcasts, the Visiting Scientist Program, the Certification of Consulting Meteorologists Program, the Popular Science Program and the Educational Film Program, and the employment services, translation service, professional directory, policy statements and publication of "Meteorological and Geophysical Abstracts".

Following his talk and the question and answer period which followed, Mr. Spengler showed one of the educational films of the American Meteorological Society. This film, entitled "Above the Horizon", produced by the National Film Board of Canada, was very well received by the audience and considered by many to be one of the best of its kind.

The meeting concluded with an expression of appreciation and vote of thanks to Mr. Spengler moved by Mr. P.P. Saltzman.

J.D.H.

Montreal Centre

November 26, 1964:

Mr. W.S. Creswick was in the chair for the third meeting of the session of the Montreal Centre, held as usual in the Physics Building of McGill University. The speaker was Dr. T.W. Wormell of Cambridge, at present a visiting professor at McGill.

Dr. Wormell had taken as his subject the lightning discharge and dealt with current investigations of this phenomenon. He began by reviewing atmospheric electricity and its manifestations, indicating the charging of the upper atmosphere by means of thunderstorms and the concurrent slow return leakage. The main electrical manifestation of thunderstorms was lightning, which could be observed photographically and by electrical means as well as visually.

Dr. Wormell then went into the details of lightning flashes as they appear on photographic records obtained with moving lens systems. There were three main stages in the lightning flash: the step leader, the return stroke and the dart leader, the largest amount of electricity being moved by the return stroke. The charge distribution inside the thunderstorm can be deduced from observations of the peripheral electrical field. It appears that during a complete lightning stroke a large part of the cloud is discharged sectionally: in South African thunderstorms these sections are arranged vertically whereas in England they are arranged horizontally.

During the discussion Dr. Wormell took up two other points. In the case of the behaviour of raindrops in strong electric fields, it appeared that a diameter of 1 mm was a minimum for effective electrical exchange between drops. Dr. Wormell did not believe that lightning could arise in clear skies, but stated that a lightning stroke had been observed by radar to have travelled up to 50 miles from the source of the discharge.

J. Tissot van Patot

February 2, 1965:

The fourth meeting of the 1964-65 season was held in the Macdonald Physics Building of McGill University, with Mr. W.S. Creswick of the Meteorological Branch, Department of Transport acting as chairman. The guest speaker for the evening was Mr. W.A. Dwyer, Superintendent of Forecasting and Information for the Australian Meteorological Service.

Speaking on the topic "The Role of Australia in Modern Meteorology", Mr. Dwyer discussed the organizational structure of the Australian Bureau of Meteorology, pointing out many similarities to the Canadian counterpart. The arrangement of a meteorological service is influenced by many diverse requirements and conditions, which must all be reconciled in order to provide an efficient and satisfactory organization. Mr. Dwyer specifically itemized the geographical, meteorological, economic, and political factors.

Australia is the only island continent in the world. The country is subjected to tropical cyclones and the Asiatic monsoon in the north, and to low pressure systems in the south.

Since this talk occurred in February, it was not without some envy that the audience heard of the absence of snow and freezing temperatures in Australia, where the lowest and highest mean monthly temperatures are 35F and 100F respectively. Annual rainfall varies from 4 to 100 inches over the continent. This is compensated for, however, by evaporation rates of from 30 to 100 inches yearly.

Australia's primary industry is agriculture, and therefore meteorology has a prime responsibility to the farmer and rancher.

In the area of research, major problems are: extended range forecasting, tropical cyclone prediction, aerodrome forecasting, and investigation of the subtropical jet.

The Joint Approach Control, Meteorological Advisory Service has been formed because of the danger to aircraft of convective turbulence. This is an operational research unit employing radar at both Brisbane and Sydney.

Australia is active in international meteorology, participating through the WMO, ICAO, and the Australian AAS.

At present, the Bureau operates on an annual budget of 4.5 million pounds, with a staff of 1250. The latter figure is expected to increase by 50% in the next five years.

Jerry Pell

THE AAAS MEETINGS

Montreal, December 1964.

The American Association for the Advancement of Science visited Canada for the sixth time, to hold its 131st Annual Meeting, at the end of the year 1964. Montreal was the venue, for the third occasion, the last being 1882: lack of adequate convention space had prevented such a gathering in Canada since the end of World War II (apart from a Division of the Association), but the construction of the Queen Elizabeth Hotel had now afforded the necessary facilities.

The American Meteorological Society normally participates, but on this occasion the Canadian Branch of the Royal Meteorological Society seized its opportunity to act as a co-sponsor - the first since its foundation in 1939. Previous joint meetings of the two Societies (Toronto 1939, 1953) had been arranged by the Parent Society.

There were two meetings of meteorological interest.

28 December

The first of these was also one of five interdisciplinary symposia of the Association as a whole and was entitled "Possible Meteoric or Lunar Influence on Meteorological Phenomena". Dr. Walter Orr Roberts, Director of the U.S. National Centre for Atmospheric Research, had made the arrangements and took the chair in the presence of over 250 scientists.

Dr. E. Keith Bigg (CSIRO, Sydney: at present NCAR and Imperial College) read the first paper, on the origin of ice nuclei, with particular reference to this being extra-terrestrial as postulated by E.G. Bowen. There had been many apparently insuperable physical objections, but current work was weakening some of these. For example, a higher count in Antarctica than in Australia suggested that the soil was not the source: and the small size of high level nuclei as measured by the electron microscope supported this view. There were still difficulties to be cleared up over the

residence period in the stratosphere, but he was becoming convinced that Bowen's basic concept of the extra-terrestrial origin of the nuclei - although too great in size by a factor of ten - was essentially sound.

Glenn W. Brier (U.S. Weather Bureau) followed with an account of his investigation of the effect of the phases of the moon on the weather. This would be published in the Monthly Weather Review in February 1965, and followed on his recent work in which no conclusive evidence of a calendaricity effect on U.S. weather could be established. However, a sunshine deficit coupled with rainfall maxima a few days after new and full moon was consistent with a tidal effect on the weather as were daily rainfall maxima at 5 am and 5 pm.

In invited comments, Dr. Ralph Shapiro (Air Force Cambridge Research Laboratories, Massachusetts) a previous critic of, and latterly a co-author with, Mr. Brier, did not rule out some small lunar effect. Dr. Jan Rosinski (NCAR) had found a time lag between the meteor showers and particle concentration of 40-66 days, rather than the month postulated by Bowen, but pointed out the possibility that nuclei entered the troposphere through the tropopause break or funnel. Every occasion of high rainfall examined had given a concentration of nuclei under the jet. Concluding, Dr. Fred Whipple (Director, Smithsonian Astrophysical Observatory), under the heading "What to make of it all?" asked for a further series of measurements on the masses of the incoming particles and spoke in warm appreciation of Dr. Bigg's work.

29 December

A "Symposium on Meteorology" had been arranged by Prof. Walter Hitschfeld (Chairman of the Department of Meteorology, McGill University, and a past Chairman of the Montreal Centre) who had been able to bring together three authorities on the interrelated problems of radiation and meteorological dynamics. In the chair, Prof. Hitschfeld presided over a fascinated audience of about 100 persons.

In the first paper Prof. Richard M. Goody (Harvard University) considered that work in the field of energy dynamics had lagged

but had been put in its proper perspective at the recent Third International Symposium on radiation processes (Leningrad, 1964) It was a question of linking the equations of motion with those of heat equilibrium. This could be done in a sixth order differential equation, unique solutions of which were possible, but not on the basis of geostrophic dynamics alone. He had been able to simulate atmospheric conditions in the laboratory, where an oscillating temperature above a surface corresponded to day and night effects. A difficulty was that the constitution of the stratosphere was not yet known in full detail. (Readers of the report of the Leningrad meeting will recall that S. Manabe, starting with an isothermal atmosphere and using the mean value of extra-terrestrial insolation, got a temperature and wind distribution after 200 days in good agreement with that observed, including tropopause and jet stream).

Prof. J. Stewart Marshall (McGill University, a Past President of the Canadian Branch) then reviewed the capabilities of weather radar, taking as illustration recent developments at McGill. There they had been able to produce (with much credit to Dr. Marceli Wein) pictures suitable for facsimile transmission in which echoes at any arbitrary constant level above the surface appeared in sharp-edged shades of grey, on a scale in which successive shades indicated steps of 4 in the observed rate of rainfall. It had been found that in a young storm the maximum rate of rainfall was at the top of the cloud and that as the storm aged this maximum progressed downwards towards the surface. For the purpose of the Symposium, this demonstrated ability of radar to record the distribution of water substance with height in the atmosphere could presumably be used to deduce the transport of energy by convection and latent heat.

The proceedings concluded with an address by Dr. P.W. Thompson, (NCAR), President of the American Meteorological Society, who spoke on numerical weather prediction. He reviewed the work of the U.S. Weather Bureau in this field but devoted most of his time to problems that had not been solved. It was, of course, hopeless to attempt to forecast 24 hours ahead on anything less than a hemispherical coverage: and we would never be able to observe the initial state of the atmosphere. However, on a 24-hour basis an accuracy of 80%, a little better than subjective, had been achieved by the computer. Progress would depend on an understanding of the relation between small-scale statistical motions and motions on the atmospheric scale and the handling of the heat gains and losses

of the atmosphere, as discussed by the previous speakers. Incorporation of this material into the computer programme would increase the number of algebraic operations to be performed from 10^9 - accomplished in about 1/10 of a day and hence operationally useful - by a factor of another hundred and a new and faster computer - already under construction - would be necessary to control the time factor. Dr. Thompson thought that the question of the silent areas of the map would best be handled by a network of constant level balloons, each with a life of about a month, whose automatic reports would be collected and relayed by a commercial satellite system.

J. L. Galloway

OBITUARY NOTICE

W. E. Turnbull

We regret to report the death of W.E. (Fred) Turnbull, Regional Meteorologist in the Toronto Air Services Region of the Department of Transport, Mr. Turnbull died in Toronto on 11 Dec. 1964, at the age of 54, after an illness of several months.

Mr. Turnbull was born in Fillmore, Saskatchewan, and attended the University of Manitoba where he attained a degree (B.A.) in Physics in 1934 and an M.Sc. in 1935. Following some three years of research at The Cancer Relief and Research Institute in Winnipeg, he joined the Canadian Weather Service as a meteorologist in 1936. Mr. Turnbull carried out forecasting duties at Toronto, Winnipeg and Montreal until 1939, when he became Officer-in-Charge of the Malton Forecast Office. He was promoted to Regional Meteorologist for the Toronto Region in 1949 and continued in that position until his death.

Many meteorologists, technicians and communicators throughout the Canadian Weather Service will recall the considerate and competent administration they enjoyed under his supervision. His contribution to the weather needs of Canadian and United States Agencies in aviation and marine fields has left him many sincere friends.

Fred was one of the first weathermen to move into the

field of weather dissemination to the general public via radio. Agricultural interests were particularly appreciative of the efforts he made in tailoring the forecasts and associated meteorological information to the needs of farmers. His early morning broadcasts over some eight years brought him a large rural audience. His daily evening programmes over a powerful Toronto radio station brought him a well-deserved reputation as Ontario's Weatherman.

Mr. Turnbull was the most friendly and loyal of colleagues. He was a man who was regarded with respect and affection by all who knew him, and the Toronto region will never be quite the same without him. He leaves a widow, a son and two daughters to whom we extend our deepest sympathy.

T. L. W.