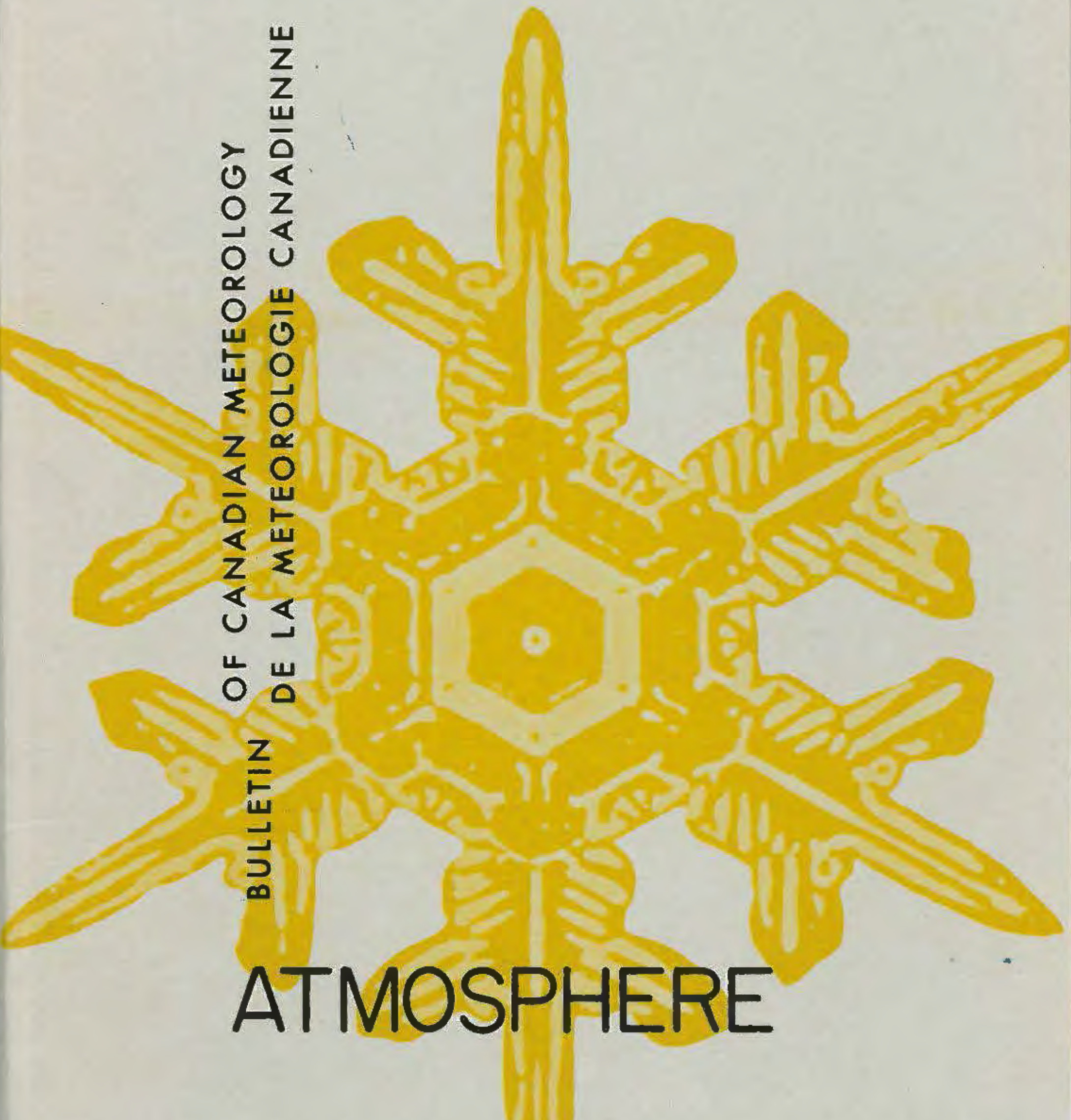

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12

ATMOSPHERE

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The Canadian Branch

ROYAL METEOROLOGICAL SOCIETY

The Executive Committee for 1966-67

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Effective 1 January 1967, The Canadian Branch of the Royal Meteorological Society will be known as The Canadian Meteorological Society. The Executive Committee and its address will remain the same.

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- IN MEMORIAM -

This issue of ATMOSPHERE is dedicated to Alexander Burnett (Burn) Lowe (1914-1966), Officer-in-Charge of the Prairie Weather Central, who died June 2, 1966 after a lengthy illness.

Born in Manitoba, Mr. Lowe spent his early years there, graduating in 1938 from the University of Manitoba. He joined the Meteorological Service of Canada in 1941, and after service at Whitehorse and Moncton, settled permanently in Winnipeg. He completed his M.A. studies in 1944.

In 1954 he volunteered for service aboard the icebreaker H.M.C.S. "LABRADOR" and was Meteorologist on board when she became the first ship to circumnavigate the North American continent in one year. On his return, his illustrated talk, based on his experiences, was much in demand at local service club and church group meetings.

After his return to Winnipeg, administrative duties made increasing demands on his time, but he remained active in various fields of meteorological investigation. His first paper, prepared in collaboration with Mr. E. Einarsson, was a study of local minimum temperature variations in the Winnipeg area. This was published as a technical circular in 1955 and is considered a classic in its field.

His interest in history and meteorology led him to investigate early weather records from a variety of sources. This time consuming and painstaking work resulted in the publication of articles on Canada's first weathermen in the Hudson's Bay Company Magazine "Beaver" and in "Weather". He also presented several radio talks on the CBC network on this and other meteorological topics.

Another, hitherto untapped, source of weather data next attracted his attention. By screening a multitude of early prairie newspapers, he, in collaboration with Mr. G.A. MacKay, prepared the first compilation and analysis of severe storms on the prairies. This work was published by the Queen's Printer in 1962, under the title "Tornadoes of Western Canada". It remains the only study of its kind available.

His interest in severe weather phenomena was a continuing and developing one. Papers which he wrote on the subject have appeared in the "Journal of Meteorology", the "Bulletin of the American Meteorological Society", and in "Weatherwise". His last published article, which appeared in the April, 1965 issue of "Weatherwise" described an unusual fall of hail near Kenora, Ontario. He was always willing, and eager, to devote his own leisure time to the personal investigation of such occurrences.

Mr Lowe was one of the organizers of the Winnipeg Centre of the Royal Meteorological Society and remained an ardent supporter until his death.

Besides presenting papers at meetings of the Winnipeg Centre, he was a past Chairman of the Centre and had held other executive positions.

He had a wide range of interests both within and outside his profession. He was a sports enthusiast and was an active and proficient golfer and curler. He was a cartoonist, artist, and photographer of great merit. His many friends will long remember his personal Christmas cards which always depicted a weather scene which he himself had either photographed or sketched.

Burn, as he was known to his many friends, combined to an unusual degree the qualities of administrator and scientist. He was always completely dedicated to the task at hand, and uniformly meticulous and thorough in its execution. He had the gift of reducing a problem to its essentials and of putting forth its solution in the most lucid terms. Despite his varied talents and his many accomplishments, he was the most modest and unassuming of men. He had a genuine concern for the welfare of others and was held in universally high regard by his fellow workers of all classes.

His untimely death has been a profound shock to his friends and associates and an irreparable loss to meteorology.

THE INAUGURAL STAGES

by

A.W. Brewer

The Royal Meteorological Society was founded in 1850 when England and Wales had a population of about 18 million and was technologically the most advanced nation. England proved to be capable of sustaining the society, though it may be mentioned that the Scottish Meteorological Society, which was also founded in the nineteenth century proved to be too small, and it was eventually united with the Royal Meteorological Society.

The Canadian Branch of the Royal Meteorological Society was established in 1939, the centenary of the establishment of the Toronto observatory, when Canada had a population of about 11 million and an economy changing from being based on agriculture and minerals to include substantial manufacturing. The Branch has grown and developed with Canada. It was originally based in Toronto but the Montreal centre was formed in 1953, and centres are now also active in Vancouver, Alberta (which meets in both Calgary and Edmonton), Winnipeg, Ottawa, and Halifax. The centres are self sustaining. They represent a major scientific activity.

Also meteorology in Canada has been developing a new limb. Prior to 1939 Meteorology existed almost exclusively to serve the people of Canada, giving assistance in directions and by means which were fairly well understood. Meteorological research was very limited.

The Meteorological Service of Canada established a Research and Training branch in 1946, and progress in research since then has been steady, both in the Meteorological service and in the universities. Meteorological research has been active at McGill for a long time. In 1960 an air sea interaction programme became active at U.B.C. and in 1962 the University of Toronto changed its policy from passive assistance in a Meteorology M.A. programme; and it appointed meteorological staff of its own. Today there are effective groups at Universities at Calgary, Edmonton, Saskatoon, Winnipeg, Western Ontario, Guelph, and Acadia, just to mention the most obvious.

This change has been reflected in the participation by the Canadian Branch of the Royal Meteorological Society in the annual meeting of the learned societies. The Branch met at Kingston in 1960 and held discussions for three sessions only. By contrast, in 1966, we held a three day meeting at Sherbrooke with some duplication of sessions, and we were proud enough to invite the President of Royal Meteorological Society to see us. He came and returned to England impressed.

We had come of age. We voted to ask that the Canadian Branch of the Royal Meteorological Society should be dissolved and we voted that on January 1st, 1967 the Canadian Meteorological Society would carry on the work which had been begun and which was shown to be established.

We now have the task of making our own society a success.

OUR OUTLOOK FOR "ATMOSPHERE"

During the period of existence of the Canadian Branch of the Royal Meteorological Society, its members received the QUARTERLY JOURNAL and WEATHER. The need was for a periodical to carry the business of the Branch from the executive to the members. This need has been met admirably by ATMOSPHERE.

We now face a drastic change. The members of the Canadian Meteorological Society will receive the periodicals of other organizations only if they separately subscribe. Obviously ATMOSPHERE must expand its scope in order to fill this impending need.

Additionally, we feel that we can fulfill the Society's aim of furthering meteorology in Canada by publishing a periodical that can appeal to everyone who has an interest in Meteorology. Here we are thinking of the hundreds of meteorological technicians, cooperative observers, and even the school teachers who must convey to their classes a feeling for some of the "why" of weather. If any articles that appear in ATMOSPHERE can clarify a hitherto obscure concept, or enhance the knowledge or interest of these segments of our population, then the Canadian Meteorological Society will have performed a valuable service while simultaneously fulfilling one of its stated aims.

With the above as rationale, our plans take the following form. Firstly, we hope to have several articles each issue as well as announcements of the Society and interesting news and notes pertaining to meteorology. Secondly, we hope to interest boards of education across Canada in subscribing to ATMOSPHERE for their school libraries and science departments. Thirdly, an attempt will be made to present the Canadian Meteorological Society to everyone who is formally connected with meteorology, and subsequently to those others in Canada who have no formal connection, but possess an interest in the subject.

One important step towards these goals is the acceptance of advertising for inclusion in ATMOSPHERE. This will permit us to produce a larger publication as well as to dress it up as part of our program to widen its appeal. It will permit the printing of extra copies to be used for promotional purposes. It will also permit the inclusion of diagrams and photographs in our periodical, a luxury we could not otherwise afford.

This first issue might be considered as a type of shakedown cruise. We are attempting to innovate while maintaining the standard of excellence established by our predecessors under Professor Orvig. Doubtlessly, we shall fail in some respects, but we hope that you will bear with us. Should you have suggestions or comments, they will be most welcome, and will be given serious consideration. In order to initiate a LETTERS TO THE EDITORS section, some of your comments might even find their way into print the next issue.

E.J. Axton CO-EDITORS J.A.W. McCulloch

INTER ALIA

This is the first of a series of new departments for ATMOSPHERE. As the name suggest, it is planned to use this department for news, notes, announcements and short reports that should be of interest to the members of the Society.

Congress

Quite appropriately, the first note is intended to acknowledge the efforts of those who worked behind the scenes to make the Sherbrooke meetings last June so successful.

First of all, Gaston Paulin of the Department of Meteorology of McGill University acted as local co-ordinator and was responsible for many of the physical arrangements. He undoubtedly had considerable assistance from many of his colleagues, but while the latter have managed to remain anonymous, their contributions were nonetheless valuable.

The Program Committee of M.B. Danard, D.Davies, C.M. Penner and Roy Lee provided a balanced program of wide interest. This group, as well as the authors who offered to present papers are to be congratulated for their fine showing.

The executive of the Canadian Branch all contributed heavily behind the scenes. In particular, the efforts of M.K. Thomas and E.J. Axton should be noted.

Personalities

Mr. J.R.H. Noble was elected President of Region IV (North and Central America) of W.M.O. in early October at the fourth session in Asheville, N.C.

Dr. J.V. Iribarne, former Director of the Institute of Atmospheric Physics at the University of Buenos Aires has been appointed Associate Professor of Physics (Meteorology) at the University of Toronto.

Dr. J.L. Sullivan, of Australia, has been appointed Director, Environmental Assessment, Occupational Health Division, replacing Dr. M. Katz, the well known air-pollution authority who has moved to the University of Syracuse. Dr. Sullivan is expected to arrive in Canada about December 1.

Dr. H. Weiler, who recently received his Ph.D. from the Institute of Oceanography at U.B.C., has joined the Department of Mines and Technical Surveys. He will be undertaking research on air-water interactions over the Great Lakes.

R.E. Stewart, has fulfilled the requirements for the Ph.D. degree at the University of Waterloo under Professor G.T. Csanady. He has accepted an appointment in the Department of Bioenvironmental Engineering of the University of Florida, to undertake research and teaching in meteorology and air pollution.

SYMPOSIUM ON TURBULENCE IN BOUNDARY LAYER - KYOTO, JAPAN

A symposium on turbulence in boundary layers was held in Japan in September, sponsored by the International Association of Meteorology and Atmospheric Physics and by the International Association of Theoretical and Applied Mechanics. The registration totalled 131 and included meteorologists, oceanographers and mathematicians interested in the flow of fluids. The 92 papers will be published as a special issue next March of the journal, "Physics of Fluids".

The problem of flow over a uniform solid of infinite extent has largely been solved. The micrometeorologist is therefore turning his attention to air flow over water, which is still a mystery, and to experimental probing of the planetary boundary layer (extending from a height of 200 ft. up to the geostrophic wind level at 2500 ft. or so), our descriptive and theoretical knowledge of which is very incomplete. The Soviet Union has built a tower 1,000 feet high; the English are using cabled balloons, and other groups have instrumented aircraft. Priestley of Australia expressed the view that the vertical flows of heat and momentum at the 900-mb level, about which we know practically nothing, are the most important missing links in numerical modelling of the atmosphere.

Research into air flow over irregular surfaces such as cities is being largely ignored by micrometeorologists. This is because the problem is so difficult; even in the controlled conditions of a wind tunnel, there is still not a satisfactory model for the flow around a simple cylinder or sphere, or flow over a flat plate.

Canadian contributions included: Mechanics of air-water interface - Professor R.W. Stewart, University of British Columbia (a 40 minute review paper); Concentration fluctuation in turbulent diffusion - Professor G.T. Csanady, University of Waterloo; Three-dimensional turbulent boundary layers with heat transfer at the wall - Professor E.A. Eichelbrenner, University of Laval; The use of radioactive tracers in studying mass transfer in the atmospheric surface boundary layer - P.J. Barry, A.E.C.L., Chalk River and R.E. Munn, Toronto.

The Canadians distinguished themselves not only in the scientific sessions, but also in a singing contest that was held one evening. The competitors included the English with "Cherry Ripe", the Americans with "Whiffenpoof Song", the Australians with "Waltzing Matilda", the Soviets with a rousing cossack song, etc. The Canadians under the inspired direction of Bob Stewart gave a stirring rendition of "Alouette"!

(The above note courtesy R.E. Munn)

*Some Results and Prospects of Scientific Research in the Institutes of the Hydrometeorological Service of the USSR (1965-1966)

by

Academician E.K. Fedorov **

The basic function of the Hydrometeorological Service is to provide meteorological and hydrological information to the national economy.

We are spending about 99 per cent of our material and manpower resources on discharging this responsibility. The discharging of our other responsibility (warning of the national economy about adverse meteorological and hydrological phenomena), takes only about one per cent of our resources at the present time. It is hoped that the percentage of our activity in discharging the latter responsibility will steadily increase in future years.

It is well known that successful long-term planning and the designing of certain projects and measures in the national economy require information on the normal, the most probable and the extreme conditions of meteorological and hydrological processes. Information on the current weather and hydrological phenomena and their forecasts are necessary for the operation of all agricultural and many industrial enterprises, as well as aviation and other forms of transport and numerous other segments of the national economy.

The scientific research establishments of the Hydrometeorological Service play a very important part in all current activities of the Service concerning the acquisition, processing and analysis of incoming information. In addition, they study the nature and the mechanisms of meteorological and hydrological processes, devise methods for their forecasting and modifications and perform many other related duties. More than 10 per cent of our manpower and still a greater percentage of our financial resources have been allocated to the scientific research institutes. If we consider also the considerable amount of scientific research done at regional offices and by scientific excursions under the guidance of research institutes, the percentage of manpower engaged in scientific research activity is still greater.

*A speech given to the Scientific-Technical Council of the Hydromet. Service on February 11, 1966, translated from Meteorologiya i Georologiya, #6, 1966 pp 3-11. by A. Nurklik, Meteorological Branch, Department of Transport.

**Director of the Main Administration of the Hydromet. Service

On the other hand, our scientific research institutes are, by no means, the scientific research establishments in the true sense of this word; they all carry a significant part of the operational workload of the Service. This aspect of the activity constitutes a large (more than 75%) percentage of the output of the Hydrometeorological Centre (earlier Central Forecasting Institute. Transl.), a considerable percentage of the output of the Arctic Institute, the Main Geophysical Observatory, the State Hydrological Institute, the Institute of Applied Geophysics and of the rest of scientific research institutions. The operational aspect of activities of research institutes consists in issuing various forecasts, preparing reference materials and making the calculations necessary for the implementation of certain measures in the national economy, etc.

A close relation between the operational and scientific research activities is a characteristic and, I hope, a healthy feature of our scientific institutions. The introduction of the results of scientific research into operational routines poses no problem in our Service. Even though some individual studies and some new instrument designs are overlooked, all the important results of our scientific research efforts are very quickly incorporated into operational procedures, sometimes even before they are completed. For instance, we have been using long-range weather forecast methods operationally for some time without waiting for the time that they will be brought to a proper reliability level.

For a number of reasons, the greatest part (probably more than 50%) of the research work in meteorology in our country is carried out in the scientific research institutions of the Service. The research efforts of the Academy of Sciences and the universities in this field have so far been relatively small.

The above state of affairs imposes a great responsibility on the scientific research institutions of the Service, but at the same time creates particularly favourable conditions for their productive and successful functioning. The main task confronting us is to make use of these favourable conditions, to strive for a greater useful output, to increase the output efficiency of each scientific worker and by that the output efficiency of all institutions engaged in meteorological and hydrological research. It seems to me we should examine our results and future perspectives from the latter point of view.

During the report year, scientific advisory boards in major research fields were created at the Main Administration of the Hydrometeorological Service for the co-ordination of research. The membership of these boards consists of representatives of the Service departments and other interested institutions. These boards are: the Scientific Advisory Board on Weather Forecasting, in which work the members and institutions of the Academy of Sc. take part; the Scientific Advisory Board on Climate and Agrometeorological

Resources; the Scientific Advisory Board on Water Balance and Water Resources and finally the Scientific Advisory Board on Modification of Weather.

The research on seas and oceans carried out by institutions of the Hydrometeorological Service is co-ordinated by an interdepartmental scientific advisory board of the State Committee on Science and Technology. It is evident that we must organize a commission or some other agency which would unify the marine research activities within our Service.

It should be noted that the State Hydrological Institute and other of our hydrological institutions take active part in the work of the Advisory Board on Water Economy Problems of the State Committee on Science and Technology.

All these advisory boards carried out a large volume of work in 1965. Specifically, they examined the results and plans of research projects and discussed the results of the most important studies. Here I shall only briefly dwell on some aspects of activity in the major research fields.

THE WEATHER FORECASTING PROBLEM

Undoubtedly, weather forecasting is the most difficult problem in our sphere of activity and, perhaps, even one of the most difficult problems in the entire present day science. As is well known, the most difficult problem here is the devising of methods for the long-range forecasting of the atmospheric processes which determine the weather in various regions of the earth. In this field, we succeeded in expanding somewhat the scope of studies. Some staff members of the Main Geophysical Observatory have joined their colleagues at the Hydrometeorological Centre and at other institutions in a concentrated effort to produce long-range weather forecasting methods. They have already reported on the first results. However, it cannot be stated as yet that they have made substantial progress in this matter.

Some studies which advance this problem have been carried out at the Hydrometeorological Centre. For instance, much can be expected from the further development of a numerical long-range forecasting model incorporating the moisture circulation and heat fluxes. We shall hope that the testing of this model will be successful and will represent a substantial step toward the solution of this difficult problem.

Some results have also been obtained in devising statistical and synoptic long-range forecasting models. Specifically, methods for forecasting the monthly precipitation amount in various regions of the country have been finalized and methods enabling one to forecast the temperature variations within a month and the temperature deviations in each month in a temperature anomally forecast for several months have been devised. There have been some achievements in forecasting the weather for seasons, in forecasting cold and heat waves, etc. Some progress has also been made by our regional institutes in improving the present long-range forecasting in individual regions of the country.

Thus, during the report year, we have expanded somewhat the arsenal of techniques and methods that can be utilized for the long-range forecasting of weather. However, the qualitative level of recently developed methods does not differ much from these we had before. Their verification is still low and they do not, by far, satisfy the requirements of the national economy.

Some advances have also been made in the field of medium range (3-5 day) forecasting. In the first place, the development and introduction into the operational routine of a hemispherical, dynamical, medium-range forecasting method should be mentioned. Some improvements have also been made in the synoptic methods of weather forecasting for 3-5 days. As a result, the quality of forecasts for several days is increasing systematically and approaches the quality level of 24 hr. forecasts.

In the domain of 24-hour forecasts, the further development of numerical models continued; in particular, the successful application here of complete hydrodynamical equations has brought about a higher verification rate of forecasts. In this field, a clear prospect exists for a wider application of numerical techniques. In conformity with this, we are equipping the Hydrometeorological Centre and its first regional office at Novosibirsk, as well as the other subdivisions, with computers.

In addition to the forecasting of weather phenomena, the forecasting of weather dependent conditions (such as hydrological, agricultural, ice, etc., conditions), constitutes a large part of the operational activities of the Service. In these forecasts, the future condition of weather is only one of the components of the forecast. The other components are based on the evaluation of correlations between various past conditions and the magnitude of the forecast elements. In some cases, the estimation of the future weather in such forecasts occurs in an implicit form. Undoubtedly, crop forecasts are the most important of these forecasts. For the second year, we are issuing crop forecasts for the estimation of total yields of basic crops in the entire country and in individual, basically agricultural regions. The verification of these forecasts is satisfactory. In spite of the crude nature of methods for the estimation of the dependence of crop conditions on meteorological and other factors, the verification of these forecasts, issued by the agrometeorologists of the Hydrometeorological Centre, is not bad. It follows from a large number of users' letters that they have been of great value to the national economy. One should also mention the water-level forecasts for water bodies, the river freeze-up and break-up forecasts, the ice forecasts for arctic seas, and some other forecasts issued during the current year. Most of the methods used for forecasting these phenomena have been improved during the report year which has increased the accuracy and reliability of these forecasts.

During the current year, the most favourable route forecasts for ships crossing the Atlantic were improved and were used by a greater number of ships than in previous years. At the present time about 20 ships receive these forecasts daily. Due to these forecasts, the economy in the sailing time from the western ports of the USSR to ports in Cuba is 8-10 hrs. on the average. This economy in time is somewhat smaller for the fishing fleet in sailing to fishing grounds off the coast of Canada. In 1966, we hope to extend similar forecast to our ships sailing in Pacific.

The studies directed to the improvement of forecasting methods will constitute also in the future the most important research activity of our institutes. Here we must skilfully apply the knowledge already available for the improvement of forecasts, extensively develop and use numerical techniques, take measures for equipping our institutes and weather offices with proper computers and study the mechanism of individual meteorological phenomena, in particular those which are hazardous to aviation. Finally, we must carefully choose the "supporting" programs, i.e., studies in the atmospheric physics which are, first of all, necessary for the raising of the quality of forecasts.

It seems to me that we should direct particular attention to the study of the interaction between the ocean and the atmosphere. We are frequently talking about the ocean-atmosphere interaction as the possible key to the solution of the long-range weather forecasting problem. We have already at our disposal considerable means for the study of this interaction and these means will significantly increase in the future when a number of ocean-going research ships, currently being built for us and other Government Departments, become operational. However, we are still too slow in formulating concrete research problems of the atmosphere-ocean interaction studies and in planning their execution.

MODIFICATION OF WEATHER

The modification of weather is the second interesting problem on the list of our research activities. Our experiments with cloud seeding have convinced us of the reliability of this technique in dispersing supercooled clouds and fogs over air fields, and have enabled us to make some progress in hail prevention.

It could be stated that the techniques available for the dispersion of supercooled clouds and fogs are completely reliable and that their future operational application on air fields of civil aviation is only a question of economy. Regarding hail prevention, interesting and successful results were obtained in two recent years by the High Altitude Geophysical Institute and the Caucasian Expedition for hail prevention studies managed by the former. The participants of this expedition were the Transcaucasian Hydrometeorological Institute, the Hydrometeorological Service of the Armenian SSR and the Hydrometeorological Service of the Gruzian SSR (Georgia). As a result of hail prevention measures taken by this expedition, the hail damage in the experiment area, amounting to several hundred thousands of hectares, decreased by 4-5 times on the average per two years as compared to the control area.

In 1966 we intend to increase the hail prevention experiment area to 800-900 thousands of hectares. If the hail prevention measures in 1966 yield similar favourable results, we shall expand, in the near future, these measures to all parts of the USSR where they are economically justified. According to preliminary estimates, the latter area would amount to 4-5 million hectares. At the present time, the cost of preventive measures amounts approximately to one per cent of the crop value. Thus, the preventive measures would be justified even if the decrease in hail damage is 10-15 per cent. Actually, as was mentioned above, this decrease is several times greater.

In 1965, as in the previous years, experiments on precipitation re-distribution (seems to mean their prevention over some and inducement over other regions) and on precipitation inducement were continued. However, no significant progress can be reported in the solution of these problems. Nevertheless, we will continue our efforts in this field, in particular, our cloud seeding experiments in mountains, in order to arrive, in the near future, at some definite conclusion on the precipitation re-distribution and inducement possibilities.

We should also initiate studies on the possibility of using the supercooled cloud seeding technique for the large-scale modification of weather and for the prevention of thunderstorm activity. Concerning the prevention of thunderstorm activity, it is likely that we would obtain about the same results as with the hail prevention measures.

During the report year, the search for suitable warm cloud seeding agents continued and produced some results. However, this problem has not significantly advanced toward its solution and, therefore, we must increase our efforts in this field in the future.

Finally, we must not forget theoretical computational studies on the climate modification possibilities. These studies should continue, on a small scale, in the Institute of Applied Geophysics and in the Main Geophysical Observatory.

At the present time, weather forecasting and weather modification are still scientific research problems. We conclude from some general evidence that they can be solved. However, we do not exactly know the direction in which we should pursue our studies in order to arrive at their solution and therefore we obtain negative results in some of these directions.

We are spending about 25-30 per cent of all the resources of our scientific research institutes on the study of weather forecasting and weather modification problems. Our remaining research efforts are of a different nature and involve a large number of diverse problems. These problems may be termed as scientific technical problems. In this category we would list most of research problems of climate and agricultural resources, water balance and water resources, almost all marine research problems, the Arctic and Antarctic study problems and the research problems associated with devising new measurement methods and instruments for gathering hydrometeorological information. In all these studies we are confident of obtaining positive results. No principal scientific difficulties are encountered here. We already know in advance how to solve a particular problem and we may err only somewhat in choosing the most economical way of doing this. The speed and effectiveness of solving this type of problem depends mainly on the correct organization of effort and on the availability of corresponding budgetary means. The accomplishments in the scientific technical research will be briefly discussed below.

PROBLEMS OF CLIMATE AND AGRICULTURAL RESOURCES

During the report year, the preparatory works continued for a capital publication which describes the climate of our country on the basis of about an 80 year record. The second part of this publication, dealing with air and soil temperatures was, in essence, completed in 1965. An extensive monograph on the climate of the Ukraine and an Aeroclimatological Reference Book were also completed; the aviation meteorological characteristics for many air fields were prepared and a large number of other studies were carried out. In particular, a considerable number of studies were carried out for the Building Code, i.e. for the documents which guide builders and building designs. For instance, the combined ice and wind data, necessary for the building design, were worked out for various localities of the Soviet Union.

During the report year, projects were developed for the study of the dependence of crop yields on meteorological parameters. Important studies on this problem were initiated in the fields of the Ukrainian Sc/Res. Hydrometeorological Institute and the Institute of Applied Geophysics. One should also mention the initiation of air pollution studies in some industrial regions of the Soviet Union. In our country there are several tens (about 50-60) localities where the obnoxious industrial discharges pollute seriously the atmosphere. At the present time we are surveying all these localities in order to determine the nature of pollution and the area of the maximum surface concentration of pollutants, and to select sites for systematic air pollution observations. This activity, guided by the Main Geophysical Observatory, will be expanded considerably in 1966.

WATER BALANCE AND WATER RESOURCES

Studies in this field continued and the preparations for a capital publication on the water resources of our country approached the completion stage. The first series of this reference material, namely the available hydrological records for water bodies, have already been assembled. In 1965, a considerable amount of work was also carried out in assembling the material of the second series dealing with the basic hydrological characteristics of water bodies, and the preparatory works for the third series on the surface water resources advanced well.

The State Hydrological Institute, in co-operation with hydrological observatories of many of our regional hydrometeorological Services, has carried to completion a voluminous work on the evaluation of the present and future water balances in 150 districts, 19 economic regions, and 15 republics. The possible changes in the discharge of 30 rivers due to industrial, but particularly due to agricultural measures, have been determined. These are very large and important studies of a reference nature, and are necessary for providing service to many branches of the national economy.

The State Hydrological Institute has also done considerable work in preparing data for the Building Code on the normal run off, annual distribution of run off, maximum river discharges and on river bed deformations, etc.

Beginning with 1966, the water balance will be evaluated for shorter periods, probably for seasons, and later on, likely for still shorter time intervals. At first, the water balance evaluations will be carried out by hydrological observatories and larger hydrological stations for individual sections of river basins, and after the elapse of some time, these evaluations will be extended to cover the entire territory of the USSR.

Lately, the strongly lagging study of sub-surface waters have gained some momentum. The Hydrometeorological Service and the Ministry of National Resources (Geology) have taken joint action for the improvement of sub-surface water studies conducted by our establishments and geological institutes. In 1966, efforts will be increased in the study of relationships between the surface and sub-surface water regimes.

A considerable but still inadequate effort with respect to demands has been spent on the study of water pollution and sedimentation of pollutants. The Hydrochemical Institute presented its first, although still incomplete, report on the survey of water pollution in our water bodies, and many laboratories of regional offices were equipped with instruments for a careful analysis of water pollution.

Finally, it should be noted that some results have been obtained in the study of flash floods and avalanches in mountains. These results describe the pre-conditions for the development of flash floods and avalanches and also the first flash flood warning apparatus and a number of measures for the prevention of avalanche damages.

Studies of the World Oceans, especially the Arctic and Antarctic, continued during the report year. The State Oceanographic Institute and the Far East Hydrometeorological Institute prepared a number of manuals, reference books, tide tables, etc., for the fishing industry. They also co-operated with our own and foreign institutes in the study of Kuro-Sivo current.

The Far East Sci-Res. Hydrometeorological Institute has conducted interesting studies on the estimation of tidal wave propagation and has mapped the threatened coastal areas. During the Pacific cruises of our hydrometeorological research ships "A.I. Voeikov" and "Yu. M. Shakalskii", interesting and important observational data were accumulated which contradict the present ideas on the atmospheric circulation over Pacific.

The Arctic Institute has prepared a monograph on the ice conditions in the Arctic and has completed a voluminous work which generalizes the physical and geographical studies of seas and islands in the Soviet Arctic. It should also be noted that preparations for the publication of the Antarctic Atlas, which undoubtedly will be a unique composition are, in essence, already completed.

METHODS AND INSTRUMENTS OF MEASUREMENT

In this research field a large number of studies were completed in 1965. The most important of them are inter-related, and deal with the design of automatic instrument systems in the framework of the technological reconstruction plan of our Service. As a result, new prototypes of fully automated and semi-automated weather stations, the first types of the "obloko" cloud radar, and other instruments have appeared. These instruments constitute vital links in the general automation plan of the Hydrometeorological Service.

As a result of the efforts of our instrument designers, some earlier instrument designs, for instance, that of the anemometer and some other instruments, were found to be faulty and are being replaced by improved designs at the present time.

The development of aerial methods for the study of the underlying surface continued during the report year. Serious efforts in this direction were concentrated on the study of the applicability of radio methods in aerial snow survey. During the last and the present winters, experimental aerial snow surveys were carried out over an area of about 0.5 million KM^2

and the obtained data were carefully compared with these of conventional snow surveys. The results have so far been encouraging and it is hoped that the results of experiments in the 1965-66 winter will enable us to arrive at the final conclusion as to the advisable limits of the employment and the economical effectiveness of the aerial snow surveys.

The aerial method of surveying crop and pasture conditions was developed and introduced into the operational routine.

The analysis of a large volume of precipitation data measured by radar and the classic methods and the study of the precipitation measurement accuracy of rain gauges constituted a significant methodological work in 1965.

There are some of our research results in the domain of scientific technical problems. Do we manage them properly? Evidently, we might have achieved here considerably greater results. The research in this field consists in describing various regimes, in disclosing relationships between various processes in order that they can be evaluated quantitatively and, finally, in the study of methodological problems, dealing with the development of new techniques and instruments for various measurements.

As was already mentioned above, the solving of technical problems is always possible but we do this very slowly without a correct idea about the importance of individual problems to the national economy. We work simultaneously on too many problems. One is inclined to think that the useful output in this field of scientific research may considerably be increased. To achieve this, one must, in the first place, know better and more precisely the requirements of the national economy with respect to the scientific technical research, namely what kind of information is necessary for each Branch of the national economy and what harms accrue to it from the inavailability of this information. We should not only know the nature of the required information but also all its volume and significance. Only by taking into account these factors and the significance and the cost of damages to the national economy caused by the inavailability of needed information, can we correctly plan the corresponding studies, and with this also the development of Hydrometeorological Service for various branches of the national economy. Therefore in 1966, while carrying out planned scientific research, we shall determine more precisely not only the needs of the national economy for various kinds of meteorological and hydrological information, but also how the necessary data must be resolved in space and time, and the required accuracy of data.

By finding out and defining the requirements of the national economy with respect to hydrometeorological information, we can correctly formulate the tactical technical tasks of the rational system of observations carried out by our Service, and compose a requirement reference and description system which we must project into the future. From it we can get the basic conditions for the plan of utilization of all this material in the national economy. We must know the entire volume of the information needed, since then we have a clear idea about the measures that must be taken for ensuring it.

An important question that requires solution is the management of scientific technical research. Is it right to continue our present "piecemeal" tactics, i.e. to simultaneously pursue research in many different directions which unavoidably results in slow progress in each of these directions? Evidently, it is not. The studies of this nature must be carried out by a strong concentration of efforts on individual research problems for short periods of time, similarly as we are solving right now the precipitation measurement and snow survey problems. It is evident that at each given time, we should be working on a limited number of such research projects and, in return, complete each of these in a relatively short time. Only by organizing our efforts in this way, we shall be able to keep pace with the needs of the rapidly expanding national economy.

Examples of such concentrated action already exist. We subjected all research in the field of observational methods and instruments to the needs and objectives of the Master Plan for the automation of the Service. Owing to this, we have now a clear picture on the entire volume of the necessary technological reconstruction and we can, from now on, sensibly assign to a new method or to a new instrument design its proper place in this system. Moreover, we know also what the design of a new instrument must be in order that it will fit into this system and when and how it must be manufactured.

In the similar cardinal manner, we solved last year the problems concerning the accuracy of various rain gauges in precipitation measurement, and the possibility of using radar for this purpose. These problems have been studied for a long time, for decades, and only now with this crash program have we obtained seemingly definite information on precipitation errors of different rain gauge types and on the radar capabilities in precipitation measurement.

Thus, I assume, we must significantly change the order of solving scientific technical problems. We should, in the first place, determine the requirements of the national economy (or the Service) and evaluate the necessary work volume, then draw up a precise plan for satisfying these requirements in the entire extent of the Service (i.e., including the network observations, processing and analysis of data, automation of computations, etc.) and finally proceed to the actual realization of this plan by concentrating considerable manpower to individual problems for short periods.

Soviet research workers in the field of meteorology and hydrology have very great opportunities for a successful solution of research as well as scientific technological problems. It is our duty to utilize these possibilities to the fullest extent in order to ensure the most effective use of the rich natural resources of our country in the national economy.

EASTERN SNOW CONFERENCE

The Eastern Snow Conference is an international group of businessmen, engineers, foresters, and scientists from Eastern Canada and the Northeastern United States who meet annually for the interchange of information related to snow, ice, frost, hail, and other phenomena associated with the winter season. Membership is open to all interested individuals.

The 1967 annual meeting will be held at the Sheraton-Brock Hotel, Niagara Falls, Ontario, on February 9th and 10th. (This will be the second time the meeting has been held in Canada since establishment of the Conference in September 1940). Seven technical papers and a panel discussion are scheduled for the one-and-a-half day meeting. There will be a conducted tour of the Niagara River area on the first day with a banquet the first night. The banquet speaker will be Mr. K. Stanley - Architect in Charge of Pavillions - Expo '67 and his topic will be 'Expo 67'.

Further information may be obtained from:

Mr. J.A.S. Milne,
President, Eastern Snow Conference,
Ontario Hydro,
620 University Avenue, Toronto 2, Ontario.

or

Mr. Gordon Ayer,
Secretary, Eastern Snow Conference,
United States Geological Survey,
Post Office Box 948, Albany 1, New York, U.S.A.

REPORT FROM THE TORONTO CENTRE

JANUARY 26, 1966

For the third meeting of the season the Toronto Centre was fortunate in having as its speaker Dr. E.R. Lemon, Specialist in Agricultural Meteorology, Cornell University, and the U.S. Department of Agriculture.

As an introduction to his topic "Progress in Agricultural Meteorology", Dr. Lemon outlined the various energy transformations that take place in a soil-plant-atmosphere community. The factors of greatest concern are net radiation, evaporation and photosynthesis. The latter process is of particular interest to Dr. Lemon.

Much of Dr. Lemon's research at Ithaca has been directed towards obtaining a better understanding of the processes that control the partition of solar radiation in crops. It is only on this basis that man can ultimately increase the efficiency of water use in crop production.

Many excellent slides were shown and discussed, illustrating the instrumentation used, and typical profile measurements of carbon dioxide, water vapour and temperature, within such crops as cotton, corn and orchard grass. An infra-red analyzer which measures very small differences in carbon dioxide concentration at various levels near the ground, gives an indication of the effectiveness of the photosynthesis process. The two components of the energy budget - latent heat transfer and photochemical storage - go hand in hand in the problem of water use efficiency. Within the narrow wave lengths where photosynthesis conversation takes place efficiency in corn production is about 7 percent. Photosynthesis rates appear to be related to both sun and wind. Since most of the carbon dioxide used for photosynthesis has to be advected from storage in the atmosphere, wind is effective in its control. Dr. Lemon combined two techniques - the energy balance and momentum balance equations to obtain values of carbon dioxide fluxes.

In conclusion Dr. Lemon expressed optimism at the prospects of further improving the photosynthesis part of the energy budget by improvements in genetic techniques and by altering the geometric designs of plant communities.

Following a lively discussion period on such questions as the variation in drag coefficient, the effects of reductions in transpiration losses and the use of chemical sprays to alter stomatal openings, Mr. MacHattie thanked the speaker on behalf of the Toronto Centre for a very interesting account of his work.

FEBRUARY 22, 1966

A large, enthusiastic audience attended the fourth meeting of the session to hear two hydrometeorologists of the Meteorological Branch, Mr. G.A.

McKay and Mr. D. Storr, give very interesting accounts of their work in western Canada. Beautiful colour slides were used to advantage to illustrate the talks.

Mr. McKay, who is seconded to the Prairie Farm Rehabilitation Administration at Regina, described his role as one of support to water resource planners in the Prairie Provinces. Hydrometeorological studies and climatological archives form the basis for planning and hydrologic design and forecasting. Meteorological networks, data and analysis make it possible to determine how much water there is to share, and how reliable is the supply. Flood and river forecasting methods were outlined although it was noted that on the prairies the advantages of floods to agricultural communities often outweigh damages, and in these areas damage is seldom catastrophic. Mr. McKay discussed the storm-rainfall analysis and maximization techniques and wind set-up and wind-wave action studies which are so fundamental in dam and spillway design. He concluded with a description of the end product of much recent study and analysis, the South Saskatchewan Dam. Construction activity began in the fall of 1958. As it nears completion this 210 foot high dam, ranking as one of the largest rolled-earth fill dams in the world, has cost more than one hundred million dollars. The dam's impact on the prairie economy is exciting to consider.

Mr. Storr's laboratory is the East Slopes (Alberta) Watershed. Until this research programme was established in 1962 little thought had been given to managing the water resources of the area on an intelligent and scientific basis. The east slopes of the Rockies are important in any study of prairie water resources since the mountains are the principal source of fresh water in Alberta and Saskatchewan. According to Mr. Storr the aims of the multi-agency East Slopes Research Programme are to improve the quantity, timing and quality of the water supply on the prairies. To do this a team of scientists composed of a hydrologist, meteorologist, forester and a groundwater geologist has been given the task of conducting intensive studies of the hydrology of typical small watershed basins. In Alberta this means the study of basins covered by the three main types of trees, spruce-fir, aspen and lodgepole pine. The oldest of these, the Marmot Creek Basin is established in a spruce-fir cover. In this basin of 3.5 square miles in area 26 sites measure rain, 9 measure total precipitation and there are 18 snow courses. Although this sounds like a saturation of measuring points the number will have to be increased slightly to adequately measure the precipitation for a water balance study. In his concluding remarks Mr. Storr touched briefly on the evapotranspiration losses in the typical forests and the methods of measuring the losses using eddy flux and energy budget techniques.

The long discussion period which ensued indicated the obvious interest of the audience in the lectures.

A Note on the Extreme Intensity of Ground-Based Temperature Inversions at Canadian Micrometeorological Towers

by

I.M. Stewart
Meteorological Service of Canada

1. Introduction

The intensity of ground-based temperature inversions is of interest in air pollution meteorology, particularly in the case of stack height design. A preliminary assessment of the extreme intensity of such inversions was given in 1963 by Munn, Emslie, and Wilson (1), using data from five micrometeorological towers in Ontario. A considerable amount of new data has since accumulated, and in addition data from towers in Manitoba and the Arctic are available. The purpose of this note is to extend and bring up to date the original work of Munn et al.

2. Sources of Data

Measurements of vertical temperature differences are made on micrometeorological towers operated by a number of Canadian agencies with a common interest in atmospheric diffusion. Resistance bulb thermometers are used as sensors, and a continuous record of temperature difference is made on a strip chart recorder. Hourly temperature differences are abstracted from the charts by the originating agency, and monthly tabulations of these hourly observations are produced by the Meteorological Branch.

Table 1 gives a brief description of the towers from which data were available. A detailed study of the Canadian tower network has been published by Wilson, McLernon, and Bradt (2).

3. Results

Temperature difference tabulations from the seven towers were examined and the monthly maximum inversion intensity noted. Table 2 presents the results. The figures in brackets indicate the number of months of record which were available for study.

The extremes of inversion intensity shown in Table 2 are not directly comparable due to variations in the vertical interval over which the measurements are made, and differences in the length and period of record. However, some generalizations can be made. Towers such as those at Whiteshell, Sarnia, and Ottawa, which are located in rural or suburban areas record more intense inversions than the Montreal tower, which has an urban exposure. This contrast is the result of the urban heat island effect, which reduces the intensity of inversions over cities.

TABLE 1

Location	Operating Agency	Exposure	Height of Sensors Upper	Height of Sensors Lower	Period of Record
Ottawa, Ont.	Occupational Health Div. Dept. of Nat.Health & Welfare	Suburban	196 ft.	20 ft.	Dec.59-Oct.65
Sarnia, Ont.	Ont. Research Foundation	Rural	196 ft.	20 ft.	Mar.61-Mar.66
Detroit, Mich. Windsor, Ont.	Intl. Joint Commission	Suburban	300 ft.	20 ft.	Nov.55-Nov.64
Montreal, Que.	Quebec Ministry of Health	Urban	196 ft.	20 ft.	Mar.62-Jun.64
Chalk River, Ont.	A.E.C.L.	Rural	250 ft.	30 ft.	Jan.61-Apr.65
Whiteshell, Man.	A.E.C.L.	Rural	196 ft.	20 ft.	Sep.63-Apr.66
Resolute, N.W.T.	Meteorological Branch	Open, tree-less terrain	100 ft.	6 ft.	Mar.61-Jun.63

TABLE 2. Extreme Temperature Inversion (F°)

TOWER	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	YEAR
Whiteshell	20.3 (3)	28.4 (3)	23.8 (3)	15.4 (3)	20.4 (2)	18.8 (2)	18.0 (2)	14.5 (2)	21.3 (3)	21.0 (3)	15.3 (3)	19.1 (2)	28.4
Ottawa	21.6 (6)	14.2 (5)	12.8 (6)	12.0 (5)	10.4 (5)	11.9 (6)	12.5 (6)	11.5 (6)	11.8 (6)	13.0 (6)	10.3 (5)	10.8 (6)	21.6
Detroit-Windsor	13.0 (7)	13.5 (8)	16.0 (9)	16.0 (10)	15.0 (9)	14.5 (8)	12.5 (7)	14.0 (9)	17.5 (10)	19.5 (10)	16.0 (8)	19.5 (7)	19.5
Sarnia	17.0 (6)	14.7 (5)	10.0 (6)	16.5 (6)	17.0 (6)	18.5 (6)	17.0 (6)	15.5 (6)	15.5 (6)	18.2 (6)	16.0 (6)	17.0 (6)	18.5
Resolute	3.2 (2)	3.4 (2)	6.3 (3)	15.6 (3)	16.4 (3)	8.6 (3)	7.7 (3)	1.6 (2)	1.3 (2)	3.6 (2)	2.5 (2)	2.5 (2)	16.4
Chalk River	8.7 (3)	10.0 (3)	8.7 (3)	9.2 (4)	10.5 (5)	9.5 (4)	9.3 (4)	8.9 (4)	6.8 (3)	9.8 (3)	9.8 (3)	5.7 (3)	10.5
Montreal	9.0 (1)	8.7 (1)	10.3 (3)	6.2 (3)	4.8 (3)	6.7 (3)	5.0 (1)	5.0 (1)	5.5 (1)	5.8 (1)	7.3 (1)	6.0 (1)	10.3

The inversion of 21.6° at Ottawa was found by Munn (1) to be due to warm air over-running a pool of colder air trapped in the Ottawa Valley. A similar effect might be expected at Chalk River, which is in the same valley, but the most intense inversion reported there was only 10.5°. Downslope winds which occur at night in the narrow, steep-sided valley at Chalk River probably account for the relatively weak inversion, since the overturning air would result in higher minimum temperatures. Also it is possible that the Ottawa River is acting as a heat source in the ice-free months (the Chalk River tower is within 1500 feet of the river).

The most intense inversions at Whiteshell, Ottawa, and Windsor occurred during the fall and winter months. This is to be expected since these are the months in which the night is longest, and hence the months in which intense radiation inversions are most likely to develop. Maximum monthly inversion intensities at Sarnia and Chalk River do not vary more than a few degrees throughout the year, except for the minimums observed at the former tower in March, and at the latter in December. However, at Resolute there is a definite annual cycle, with a maximum in the spring. This is thought to be due to the influx of warm air aloft, at a time of year when the air near the ground was still being cooled by the ice and snow-covered surface.

The most intense inversion found occurred at Whiteshell at 0700 CST, February 22, 1966. This inversion is of interest because of its length as well as its intensity. The inversion began at 1800 CST February 17, and persisted until 0500 CST, February 23. Its intensity increased steadily, the nightly peaks reaching 16.8°, 19.9°, 22.0°, 23.6°, and finally 28.4° early in the morning February 22. Figure 1 is a graph of the temperature differences during the twelve hours **preceding** and following the maximum inversion intensity. The gradual increase in intensity during the night and the rapid decrease after sunrise is typical of the diurnal cycle during the life of this inversion.

Temperatures at the twenty-foot level of the Whiteshell tower were very low during the period under study, falling to $-52.5^{\circ}F$ on February 18. The time of the nightly minimum at the twenty-foot level corresponded closely to the time of maximum inversion intensity, as can be seen from the graph of the twenty-foot temperatures in Figure 1.

Figure 2 is the surface weather map for 0600 CST, February 22, 1966. The high pressure area over southern Lake Winnipeg had remained almost stationary from February 18 to February 22, and the clear skies and light winds which accompanied it produced conditions extremely favourable for the development of an intense inversion. The high moved southeastwards on February 23, and strengthening winds and higher surface temperatures destroyed the inversion.

4. Conclusion

Intense ground-based temperature inversions were found at Canadian micrometeorological towers in rural or suburban areas, while weaker inversions were found at towers located in cities. Topographical effects were found have an important influence on inversion intensity. An inversion of $28.4^{\circ}F$ in 176 feet was recorded at Whiteshell, after an anticyclone stagnated over southern Manitoba for several days.

5. References

(1) Munn, R.E., J.H. Emslie, and H.J. Wilson, 1963:- "A Preliminary Analysis of the Inversion Climatology of Southern Ontario", Canada, Department of Transport, Meteorological Branch CIR 3834, TEC. 466.

(2) Wilson, H.J., J.S. McLernon, and P. Bradt, 1965:- "Micrometeorological Installations in the Canadian Air Sampling Network", Canada, Department of Transport, Meteorological Branch CIR 4344, TEC. 589.

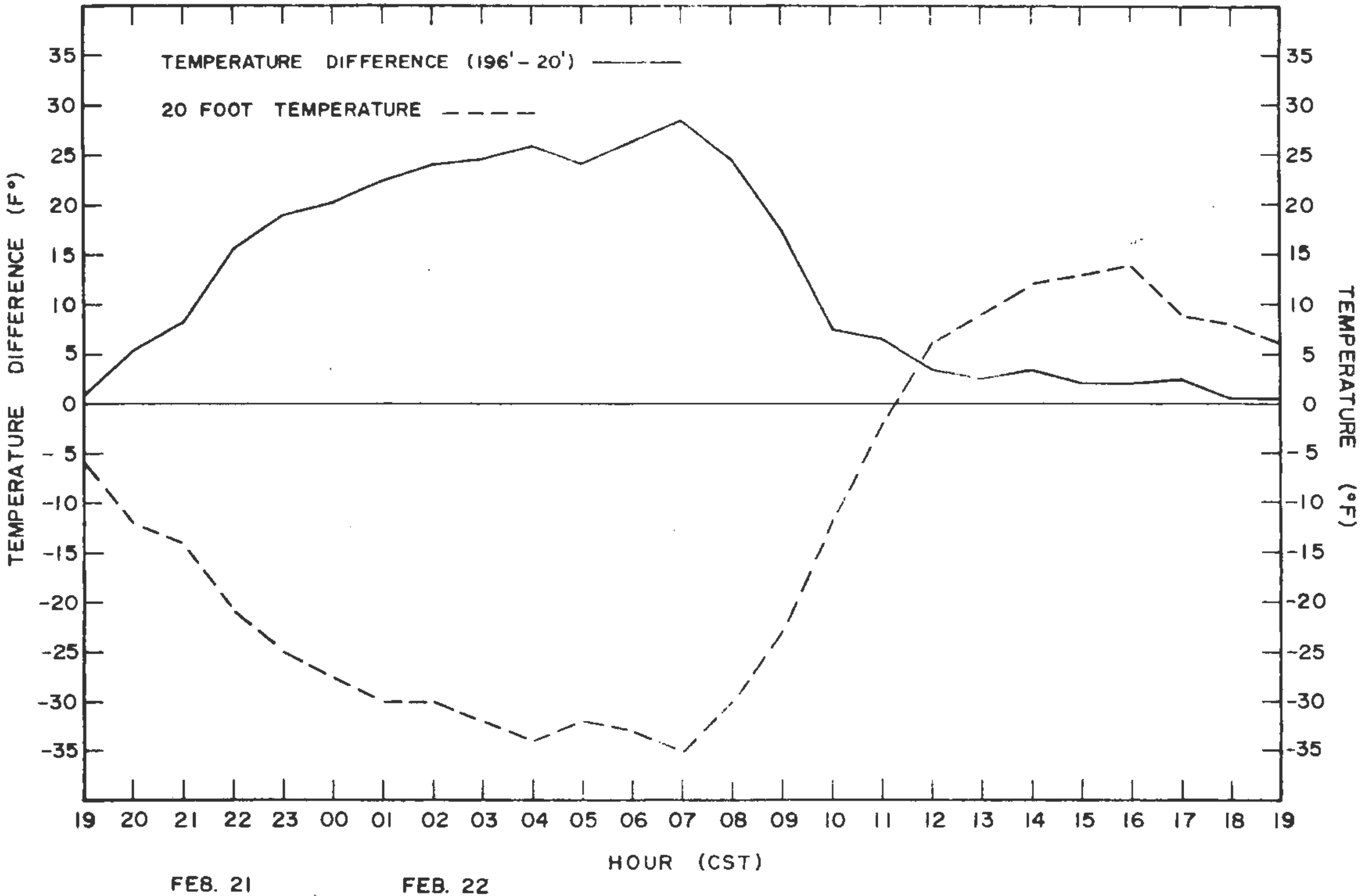

Figure 1 - Hourly Temperature Difference and 20-foot Temperature, Whiteshell Tower

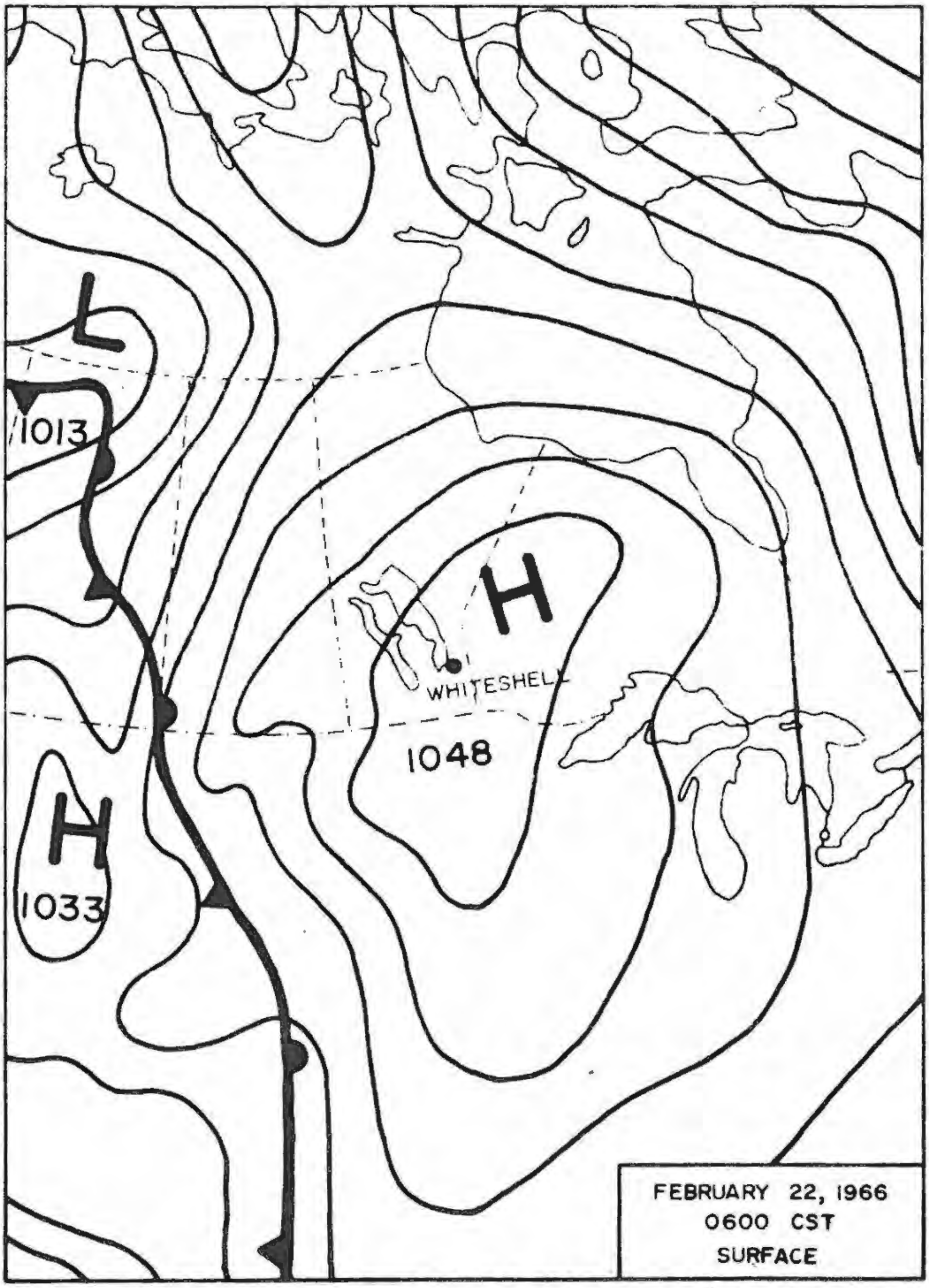

Figure 2 - Surface Synoptic Analysis 0600 CST, February 22, 1966.

THE HIGHEST TEMPERATURE IN CANADA ?

by

J.G. Potter

There is always interest in extreme weather occurrences and in whether or not they set a new record for the event. Anyone who has had experience in determining what actually constitutes a record realizes the difficulty in determining whether or not a reported value is a true extreme. Is it the result of observer error or instrument error, or is there some circumstance which makes the value unrepresentative? When an event is investigated soon after it occurs, the problem is a simple one. The person who made the observation is available for a discussion of procedures, and the accuracy and representativeness of the exposure of the instruments can be verified. When the event is not checked shortly after it occurs, the possibility of verifying it some years later becomes remote.

In determining the highest temperature on record for weather stations in Canada, it is necessary to examine data for earlier years when unusual temperatures were perhaps not of the same interest as today, and where there is no record available of any check made on the data at the time of the occurrence. Thus, while the record low temperature of -81.4°F which occurred at Snag, Y.T. on February 3, 1947 has been investigated and documented by Thomas (1963), the highest temperature has been accepted as 115°F. This temperature was reported by the climatological observer at Gleichen, Alberta, on July 28, 1903 and no similar check was made on this value. A recent review of this temperature in connection with a project to transfer all past weather data of temperature and precipitation to punched cards has raised grave doubts as to its validity.

In the records of the Climatology Division there are reported temperatures greater than 115°F. It has been established that such reported values have been due to errors in reading the thermometers on the part of the observers, or due to faults in the thermometer. For example, the observer at Fort Simpson, N.W.T., a synoptic reporting station, reported a maximum temperature of 119°F on July 5, 1928. The temperature reported at the time of the 4:00 p.m. synoptic observation of the same day was 73°. On two other occasions in the same month maximum temperatures of 110° and 115°were reported at this station at the morning observation when the temperatures at the time of the regular observations of previous afternoon and of that morning were 68° and 49°, and 79° and 50° respectively. This report for July 1928 at Fort Simpson was the first report completed by a new observer who obviously had difficulty in completing some portions of his report, and these reported values of extremely high maximum temperature were not accepted at the time of the original processing. As a matter of fact, no data for the month for this station were carried in the regular publications or the abstracts of the Climatology Division.