NATIONAL METEOROLOGICAL CONGRESS

Dalhousie University
Halifax, N.S.

June 11-12, 1964

As previously announced in "Atmosphere", our annual Congress will be held this year in Halifax. At the same time, the Canadian Association of Physicists will be meeting at Dalhousie.

Single room accommodation will be available at the University for $ 6.00 per day, including breakfast. The road distance from Montreal is 830 miles travelling via Bangor, Maine. The meeting dates being Thursday and Friday permit rail travel with "bargain" fares which are, from Montreal, $ 28.00 one way including meals and lower berth. The time is about 22 hours. T.C.A. operate some 8 flights per day and the one way fare, economy, is $ 48.00 from Toronto. The flying time is 3-5 hours depending upon the particular flight.

A map of Dalhousie University will be found on the last page of this issue.

PROGRAMME

WEDNESDAY, JUNE 10

5.30 - 6.30 p.m. Reception by Dalhousie University

THURSDAY, June 11

9.00 - 11.45 a.m. Joint Session with the Canadian Association of Physicists.

Chairman : B.W. Boville

75* B.W. BOVILLE, A. ROBERT, B.E O'REILLY, P. MERILEES AND R. BYRON-SCOTT : The General Circulation.

RECESS

30 C. QUON : Wave Forecasting, Problems and Techniques.

30 A.W. BREWER AND A.W. WILSON : Measurement of Ozone Production by Solar Ultraviolet Radiation in the Stratosphere.

* Time, including discussion.

Noon-2.45 p.m. Lord Nelson Hotel

Luncheon[+] and Annual Meeting of the Canadian Branch, Royal Meteorological Society, and Presentation of prizes.

3.00 - 5.00 p.m.

PHYSICAL AND DYNAMIC METEOROLOGY

Chairman : D.P. McIntyre

25 E. VOWINCKEL and B. TAYLOR : Evaporation and Sensible Heat Flux over the Arctic Ocean.

25 E. VOWINCKEL and S. ORVIG : The Heat Budget over the Arctic Ocean.

RECESS

30 J. MAYBANK and M. QURESHI : Alternative Explanations for Precipitation Anomalies.

20 J. DEROME : Large-scale Vertical Motion and the Occurrence of Severe Storms.

6.30 -8.30 Tour of the Bedford Institute of Oceanography.

FRIDAY, June 12

9.00 - Noon

ANALYSIS AND PREDICTION

Chairman : J.M. Leaver

25 R.A. HORNSTEIN : Synoptic Problems of Eastern North America.

25 D.E. McCLELLAN and D.E. PAGE : Vertical Motion Computations.

25 E.C. JARVIS : The Application of a Prediction Technique to East Coast Cyclogenesis.

RECESS

25 D. DAVIES : The Problem of Short Wave Resolution in Numerical Forecasts.

25 J. SIMLA and R. ASSELIN : Effect of Different Wind Approximations on Barotropic Forecasts.

25 W.S. CRESWICK and H.B. KRUGER : The Operational Use of Bogus Data in Objective Analysis.

+ Registration and Luncheon tickets ($ 3.45) at R.M.S. Table in the Hall.

2.00 - 4.30 p.m.

THE TROPOSPHERE

Chairman : R.E. Munn

20 R.C. SRIVASTAVA : A Model of Convection (with Entrainment and Precipitation).

20 J.P. BRUCE and U. SPORNS : Area Rainfall Frequencies for Nova Scotia.

20 R.E. MUNN and E.J. TRUHLAR : Average Vertical Profiles of Temperature and Mixing Ratio at Suffield.

RECESS

25 H.J. WILSON : Atmospheric Pollution at Saint John, N.B.

20 H.F. CORK : Low Level Inversions Near Lake Erie.

20 O. JOHNSON : Medium Range Travel and Diffusion of Aerosol Clouds.

THE GENERAL CIRCULATION

B. W. Boville, A. Robert, B. O'Reilly
P. Merilees and R. Byron-Scott
McGill University, Montreal

How do the large scale dynamical (motion) systems operate to maintain the observed long term thermal state of the atmosphere ?

Theory suggests that in a statically stable, rotating fluid with small vertical extent , quasi-horizontal eddies are favoured over vertical overturnings and observations confirm that such eddies do most of the work in the atmosphere. This conclusion comes as no surprise to the synoptic meteorologist who sees several such storms on his weather chart every day. These storms are required to play a highly selective role, they must convert potential energy into kinetic energy and they must feed this kinetic energy up the spectrum into the planetary waves and the zonal flow and down the spectrum in the usual turbulence cascade to overcome frictional dissipation.

General circulation studies concentrate mainly on energy in its various forms, and the corresponding conversions on a global scale. The present survey shall attempt to illustrate three aspects of the general circulation problem. The distribution of temperature, winds and other directly observable variables, forms the first part. An analysis of the variability of these parameters is presented along with comparisons between winter and summer in both hemispheres.

Features of the atmosphere such as vertical motion, mean meridional circulations and the flow of heat from the equator to the poles, remain highly speculative because they cannot be measured directly. The second aspect deals with the evaluation of these and other similar quantities and uses them to prepare detailed energy budgets of the atmosphere. At this stage, the role played by the various types of eddies becomes evident and discussions about the mechanism involved become possible.

Finally, the construction of analogues provides the meteorologist with a powerful means of testing proposed theories and of assessing the efficiency of the conversion mechanisms. Recent investigations of the deficiencies of atmospheric models indicate that the importance of non-linear interactions has been seriously underestimated. The problem of non-linear wave growth must be considered carefully in order to achieve a true understanding of the general circulation problem.

WAVE FORECASTING : PROBLEMS AND TECHNIQUES

C. Quon

Bedford Institute of Oceanography
Dartmouth, N.S.

The problems in wave forecasting arise from the extreme difficulty in obtaining accurate wind velocity profiles over water surfaces, in the determination of a unified expression for energy spectra of ocean waves, and in the deduction of wave length and other parameters from such spectra. One also encounters such problems as energy dissipation due to interactions between cross seas, and between a cross wind and an existing sea. Because most seas are partially composed of swells which sometimes have propagated across half an ocean, a wave forecaster is also faced with the problem of wave decay in a dispersive medium. Wave refraction is of particular importance in coastal waters because of the rapid change in water depth. Accurate prediction of the concentration or dispersion of wave energy due to refraction calls for careful computations.

Modern techniques by use of computers to solve some of these problems will be discussed. Some results obtained for the Gulf of St. Lawrence and Lake Superior by using these techniques will be shown.

MEASUREMENT OF OZONE PRODUCTION BY SOLAR ULTRAVIOLET RADIATION IN THE STRATOSPHERE

A. W. Brewer and A. W. Wilson

University of Toronto

A balloon-borne radiometer has been used to detect solar ultraviolet radiation in the stratosphere in the 2100 A window between the Schumann absorption region of oxygen and the Hartley absorption region of ozone. Improved instruments, calibrated to give an absolute measurement of the intensity of radiation in this window at heights of 15 to 30 km , will be flown from Trinidad in April 1964. Since absorption of this radiation by oxygen is responsible for the production of ozone, the results should give a value for the ozone production rate in the equatorial stratosphere , and provide a useful check on the photochemical theory.

EVAPORATION AND SENSIBLE HEAT FLUX OVER THE ARCTIC OCEAN

E. Vowinckel and Bea Taylor

McGill University, Montreal

Apart from long wave radiation, evaporation and sensible heat flux are the only means of transporting energy from the surface into the atmosphere. They are therefore vital components in all energy budget considerations. However, they are also the most elusive elements in the energy budget. While radiation calculations can be compared to actual observations, no method exists of measuring and observing evaporation and sensible heat flux directly. These fluxes have been calculated for each month over the Polar Ocean and the Norwegian-Barents Sea.

Sverdrup's evaporation formula was used, and it was first examined how the K-coefficient in that formula depends on the wind speed frequency distribution. Thus the effect of the Arctic wind conditions could be taken into account. Seasonal maps were constructed of mean wind speed . Previously obtained surface temperatures were used, but some additional examinations were carried out, using various assumptions for extreme surface temperatures in summer and winter.

Evaporation and sensible heat flux were calculated separately for the following areas : Central Polar Ocean, Kara-Laptev Sea, East Siberian Sea, Beaufort Sea, and belts of 5°latitude of the Norwegian -Barents Sea.

The values for the different areas are presented in tables and figures. Evaporation over ice surfaces has a double maximum - in spring and fall - and a main minimum in winter . Over open water surfaces the evaporation shows a summer minimum and a broad maximum in winter. If small parts of the ocean were to remain open longer in fall, or during the whole winter, the heat loss would increase very rapidly.

Sensible heat flux is often calculated from evaporation by the Bowen ratio. The small evaporation values over the Polar Ocean give unreliable values for sensible heat flux, and instead the formula by Shuleikin was used This permits the determination of sensible heat flux independent of evaporation. The characteristic sensible heat flux curves are quite similar to the evaporation curves. The open water areas in the Polar Ocean show very high values for sensible heat flux. One percent open water , from October to May , would increase the heat flux from the

Central Polar Ocean from 3.7 to 5.2 K cal cm^{-2}, $year^{-1}$. Open areas must remain small as there is not sufficient energy available to maintain such fluxes.

Finally, a table gives the monthly values of the total heat loss for the various areas, by evaporation and sensible heat flux.

THE HEAT BUDGET OVER THE ARCTIC OCEAN

E. Vowinckel and S. Orvig

McGill University, Montreal

The energy budget of a climatic region is of prime importance for the understanding of its climatology and weather developments. Determinations of the energy budget have generally been restricted to particular locations. The Russian investigations (Budyko et al) have produced world-wide estimates of the various energy budget terms at the surface. Other authors have evaluated individual components of the energy budget but, apart from the Caribbean, it is difficult to find an area for which all terms have been evaluated and combined.

The present investigation attempts to do this for the Polar Ocean. The energy budget is discussed for the surface, the troposphere, and for the earth-atmosphere as a whole.

The energy fluxes for the surface and 300 mb were considered, and results were drawn from the evaluation of individual terms carried out previously in our study of the Arctic heat balance.

The annual energy budget at the surface is first discussed. An adjustment in the calculated annual ocean transport is necessary in order to obtain balance, but this error is quite insignificant on a monthly basis.

The monthly surface budget is discussed next. The radiative terms are far greater than all others, in all areas and months. The long wave components are the greatest. The predominance of long wave radiation towards the surface is far more significant in the Arctic than in other latitudes. A substantial portion of the incoming radiative energy in summer is put into storage, by absorption in the water and by warming and melting of ice. Such storage supplies from one half (Norwegian-Barents

Sea) to over ninety percent (East Siberian and Beaufort Seas) of the total energy expenditure from the ocean

Next , the tropospheric budget is discussed Here the importance of the non-radiative terms increases for the incoming side of the budget, and decreases on the expenditure side, where radiation becomes practically the only term.

Finally, the energy budget for the earth-atmosphere system is discussed. The energy streams at all levels are shown for the extreme areas. The general appearance of such figures is rather similar to global averages given by other authors, but certain peculiarities stand out. The absorbed solar radiation is proportionally smaller in the north,and the contribution of evaporation to the energy turn-over is also less than the global average.

ALTERNATIVE EXPLANATIONS FOR PRECIPITATION ANOMALIES

J. Maybank
Saskatchewan Research Council

and

M. Qureshi
University of Saskatchewan, Saskatoon

Since the publication by Bowen in Australia of data purporting to show a correlation between showers of meteoritic material and the occurrence, 30 days later, of an increase in daily precipitation at widely scattered observation points, numerous papers have appeared both in support of and in opposition to this hypothesis. While certain of Bowen's peaks have been found to be statistically significant with good correspondence between different geographical regions, the delay time between the meteor shower dates and the precipitation peaks has not been fully established and is open to serious objections on physical grounds.

A program has been carried out to investigate this problem along the following lines :

(a) Intercomparison of daily precipitation totals for 11 stations on the Canadian prairies between two twenty-year periods in order to determine if there are in fact any persistent anomalies.

(b) Comparison of the precipitation totals from forty years' records at the eleven stations with the median dates of known meteor showers.

(c) Five day precipitation forecasts have been obtained from three meteorological forecasters. These were based on long-term average pressure and pressure tendency maps compiled by the U.S. Weather Office, and after suitable numerical weighting were combined and plotted for comparison with the actual precipitation data.

The results may be summarised briefly as follows:

(a) Precipitation anomalies have been observed , some of which are statistically significant and persistent, as shown by their presence in the data of both record periods.

(b) Those peaks observed in January and February correspond fairly well with ones observed by Bowen for this period. The fact that they occur during the northern winter for a continental - type climate would rule out the suggestion that the meteoritic material , if responsible, acts by enhancing droplet coalescence within clouds rather than as freezing nuclei.

(c) The winter peaks and some of the summer ones correspond - with a 30 day delay time - to the mean dates of meteor showers . However, most of the summer meteor occurrences have lifetimes ranging from several days to two weeks so this correlation is not very surprising. More important, rainfall anomalies are present in April and early May, a period preceded by complete absence of meteor shower activity.

(d) Precipitation probability, based on forecasting from the long term pressure maps gives rise to peaks which correlate fairly well - but not, perhaps, as well as the meteor data - with the observed precipitation anomalies.

Despite this somewhat lower level of correlation, it is concluded that a more satisfactory explanation - from the physical standpoint at least - of precipitation anomalies may be found from these composite pressure patterns. These would presumably originate in world-wide radiation-temperature imbalances in the atmosphere, initiated during or following the solstices, and giving rise to periodic pressure fluctuations. From data on pressure, temperature and precipitation patterns it would seem that a frequency of around 18/year would be reasonable for these pressure cycles. The fact that there are approximately the same number of fairly reliable meteor showers in a year could easily result in the presence of a coincidental temporal relationship.

LARGE-SCALE VERTICAL MOTION AND THE OCCURRENCE OF SEVERE STORMS

J. Derome

McGill University, Montreal

The three-dimensional patterns of the large-scale divergence of the wind and of vertical motion are derived over North America for a one-week period beginning May 22, 1962, at twelve-hour intervals. The distribution of severe storms in central and eastern United States during that period is examined and related to the patterns of vertical motion.

The mean profile of large-scale vertical motion near early-morning storms is compared with that near late-afternoon storms; the two profiles are found to be quite different. The morning storms correlate highly with the dynamic patterns of upward motion; the afternoon storms do not, presumably because other factors such as local heating are of comparable importance.

SYNOPTIC PROBLEMS OF EASTERN NORTH AMERICA

R.A. Hornstein

Meteorological Service of Canada, Halifax

Weather prediction is notoriously difficult in the Canadian Atlantic Provinces, especially during the winter half of the year. The major factor responsible for the difficulties is the frequency of development of East Coast cyclones It is necessary to forecast the exact location of cyclogenesis, the subsequent speed and direction of motion and the degree of intensification of the new cyclone, the size and shape of the precipitation shield and the temperature pattern that controls the state of the precipitation. In this paper a review of the 1963-64 winter season will illustrate the magnitude of the forecasting problem.

VERTICAL MOTION COMPUTATIONS

D. E McClellan and D. E. Page

Meteorological Service of Canada, Montreal

The prediction of precipitation two days in advance is attempted by methods based on Sutcliffe's development theory. Prognostic thickness patterns for the layer 1000-700 mb are routinely prepared in 24-hour time steps at the Extended Forecast Unit as an aid in temperature prediction. These patterns are superimposed on the Numerical Prediction Unit 500 mb vorticity patterns. From each overlay, in less than a quarter of an hour, a diagnosis can be made of the amount of development and vertical motion. This knowledge permits an evaluation of precipitation rates. Limitations lie in the use of a model with a fixed level of non-divergence and in the lack of precision in the forecast patterns of thickness and vorticity. The vertical motion patterns obtained are compared with those deduced from observed precipitation rates and with those obtained from the Cressman three-level model.

THE APPLICATION OF A PREDICTION TECHNIQUE TO EAST COAST CYCLOGENESIS

E. C. Jarvis

Meteorological Service of Canada, Toronto

A simplified numerical prediction equation is adapted to the Wilson grid for forecasting the location and central pressure of east coast cyclones. Secondary displacements resulting from sensible heat exchange at the sea-air interface, terrain induced vertical velocity, and the variation of coriolis force with latitude, are accounted for by an adjustment of the initial 500-mb height field. Initial and forecast 500 -mb height fields are used to obtain estimates of central pressure. An example of a 24-hour forecast of east coast cyclogenesis is presented.

THE PROBLEM OF SHORT-WAVE RESOLUTION IN NUMERICAL FORECASTS

D. Davies

Meteorological Service of Canada, Montreal

A subjective assessment of predicted charts from an experimental four-level model at the Central Analysis Office, over a 342 -point grid, suggests that a major weakness is the inability to handle developments smaller than about eight grid-lengths in dimensions. Superficially, this is not unexpected in view of the many simplifications incorporated into the basic meteorological equations. Attempts are being made to improve the quality of the predicted charts by making secondary passes at each time-step , in which values in the neighbourhood of such developments are adjusted or "patched". This is essentially being done by performing short-wave biased integrations in the secondary pass, using the primary pass to provide boundary conditions. On the initial chart suitable objective criteria for locating the centre of the area to be patched, with 37-point octagonal patches, are :

a) A maximum 700 mb vertical ascending motion (or possibly some feature of the vorticity advection fields) ;

b) A 500 mb mean flow from the south-west quadrant;

c) A nearby significant front, i.e. a nearby region of intense 1000-500 mb thickness gradient.

Unfortunately, these criteria do not seem to be applicable to time-steps subsequent to the first few. The reasons for this difficulty are being investigated.

EFFECT OF DIFFERENT WIND APPROXIMATIONS ON BAROTROPIC FORECASTS

J. Simla and R. Asselin

Meteorological Service of Canada, Montreal

Operational forecasts using a linearized balance stream function in the barotropic model at the Central Analysis Office revealed a tendency for excessive anticyclogenesis. Corrective action in the form of improved objective analysis and elimination of negative absolute vorticity was only partially successful. It was found that spurious anticyclogenesis was alleviated by the use of a stream field obtained from the solution of the complete balance equation. Results from a series of forecasts are presented and a typical case illustrates the behaviour of forecasts when a linearized stream function (with and without the application of the ellipticity criterion) is used and when the balance stream function is used. It is suggested that the reason for anticyclogenesis in geostrophic wind approximations is due to the characteristic overestimate of the winds in troughs.

THE OPERATIONAL USE OF BOGUS DATA IN OBJECTIVE ANALYSIS

W.S. Creswick and H.B. Kruger

Meteorological Service of Canada, Montreal

Bogus data are counterfeit or synthetic observations provided to an objective analysis routine to compensate for deficiencies in actual observations. The machine analysis program in use at the CAO permits bogus data either to modify the trial field prior to the commencement of objective analysis (repair bogus) or to be treated simultaneously with real data and subject to the same rejection criteria (analysis bogus data). While the primary purpose of bogus data is to fill gaps in the observational network it is also useful in eliminating peculiarities which might otherwise be introduced into the analysis by isolated observations or by strong winds at the edge of the data area. Irregularities which tend to develop near the borders of the grid can be removed through the use of bogus data . Operationally , a major problem is that the monitoring analyst does not know precisely what real observations will be available and may accidentally introduce spurious vorticity centres through incompatible bogus values. Examples of the use of bogus data and some common errors are shown.

A MODEL OF CONVECTION
(WITH ENTRAINMENT AND PRECIPITATION)

R. C. Srivastava

McGill University, Montreal

A numerical model of cumulus convection has been formulated, on the assumption of steady-state conditions and a horizontally uniform cross-section of updraft. Entrainment of environmental air is considered to follow Morton, Taylor and Turner's hypothesis , namely, that the fractional increase in the mass flux over unit depth is inversely proportional to the jet radius, the constant of proportionality being 0.2

The entrainment hypothesis together with the conditions of conservation of water substance, energy and vertical momentum are used to calculate the cloud properties for a variety of initial and environmental conditions. The initial radius of the jet is found to be an important parameter determining the behaviour of the cloud. After slight initial contraction, the jet spreads rapidly near the top; thus an updraft column of 1 km in radius at base, might typically contract by 30% at first, but reach 1.4 km radius at a height about 5 km above base where the cloud liquid water content is about 2.2 g m^{-3}. (Without entrainment, a similar cloud would contract by 60% , and reach 1 km radius only 9.5 km above base, with a liquid water content of about 4g m^{-3}.)

Important changes occur when coalescence among cloud droplets takes place : concentrations of rain as high as 10g m^{-3} can develop in the middle and upper levels of the cloud while the concentration of cloud water is reduced to a small fraction of 1g m^{-3} The great weight of this rain concentration reduces the updraft speed and height of cloud top , but only by relatively small amounts.

AREA RAINFALL FREQUENCIES FOR NOVA SCOTIA

J. P. Bruce and U. Sporns

Meteorological Service of Canada, Toronto

A major co-operative study of flood flows of Nova Scotia rivers is being conducted by the federal Water Resources Branch, the Meteorological Branch and the Nova Scotia Power Commission. As a first part of the study, depth-area duration analyses have been undertaken of the rainfall of more than 60 severe storms which occurred over Nova Scotia in the period 1921-63. Using these analyzed data, frequency analyses have been completed of heavy rainfalls over Nova Scotia, averaged over areas ranging from 500 to 5,000 sq. mi. The question of the probability of a severe Nova Scotia storm occurring over a specific drainage basin within the region is also discussed.

AVERAGE VERTICAL PROFILES OF TEMPERATURE AND MIXING RATIO AT SUFFIELD, ALBERTA IN MARCH, 1946

R. E. Munn and E. J. Truhlar

Meteorological Service of Canada, Toronto

As part of a radio-wave propagation study at Suffield, Alberta in March, 1946, hourly vertical profiles of temperature and mixing ratio were obtained at 10-feet intervals from a 100-feet tower. Vertical profiles of humidity are relatively rare in the lowest 100 feet of the atmosphere; the Suffield data are therefore of some interest.

Mean hourly temperatures and mixing ratios have been computed to show the diurnal trends. The mean values have then been used to calculate the vertical flux divergences of sensible and latent heat. Finally, an estimate of radiative flux divergence has been made from which it has been possible to infer the relative contributions of radiative and turbulent flux divergences in determining the diurnal temperature cycle.

ATMOSPHERIC POLLUTION AT SAINT JOHN, N.B.

H. J. Wilson

Meteorological Service of Canada, Toronto

The data from two smoke sampling stations at Saint John, N.B. for the period July 1961 - February 1963 are analysed. The dependence of air quality on wind speed , wind direction and time-of-day is shown. A case study of the largest smoke values for the period of record demonstrates the meteorological parameters contributing to poor air quality.

LOW LEVEL INVERSIONS NEAR LAKE ERIE

H. F. Cork

Meteorological Service of Canada, Toronto

Temperatures at 100 feet and 20 feet and wind at 100 feet for summer nights near the north shore of Lake Erie are examined to explore some relationships between wind and night-time inversions. It is shown that if the dividing line between "inversion" and "non-inversion" is chosen to be the isothermal condition, that there was little relationship between wind strength and time of inversion formation; however, strong winds delayed or prevented formation of strong inversions. Median inversion intensities varied little for the nine hours between 2000 and 0500 EST, although they fluctuated widely on individual nights. Wind speed greatly affected the range of inversion intensity, and it is found that the run of the wind for the night time hours was related to an upper limit for a mean inversion intensity. Winds from the lake are shown to have affected inversion intensity in a somewhat different manner than winds from the land, but differences in wind direction affected inversion intensity less than differences in wind speed.

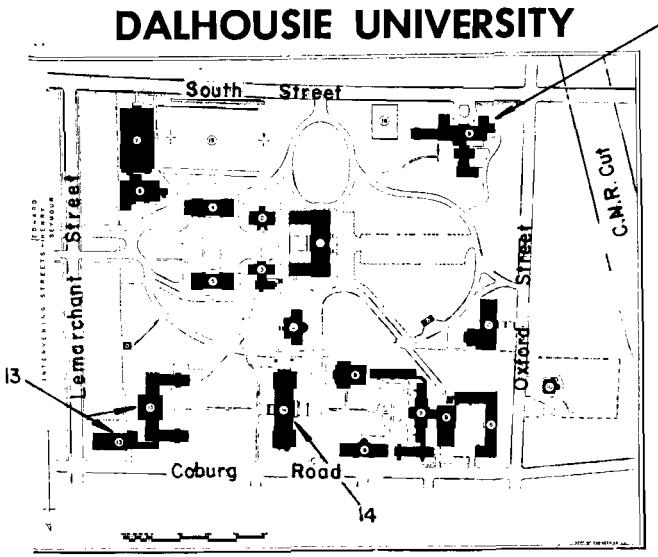
MEDIUM RANGE TRAVEL AND DIFFUSION OF AEROSOL CLOUDS

O. Johnson

Meteorological Service of Canada
and
Defence Research Board
Suffield Experimental Station
Ralston, Alta.

While there are considerable data on the travel and diffusion of gases or aerosols from ground level sources to distances of several hundred metres, relatively little experimental work has been done on travel over longer distances. Results of an analysis of sampling data to distances of five to ten miles from instantaneous ground level aerosol sources will be presented. The ground level concentration as a function of distance down wind has been determined and compared with values computed from diffusion theory. Data on the width and length of the cloud have also been obtained.

DALHOUSIE UNIVERSITY



1—Arts & Administration Building.
2—Law Building
3—MacDonald Memorial Library
4—Arts & Administration Annex
5—Chemistry Building
6—Gymnasium
7—Memorial Rink
8—Education Building
9—Shirreff Hall (Women's Residence)
10—President's House
11—Seismograph Building
12—Garage
13—Men's Residence
14—The Sir James Dunn Science Building.
15—Football Field
16—Tennis Courts Laboratories
A—Provincial Archives Bldg.
B—University of King's College.
C—National Research Council Laboratories

****

14 : Location of Meetings
13 : Residence
9 : Residence (will accommodate any overflow from 13)

****

Lord Nelson Hotel : 3/4 mile to left on Coburg Road (which becomes Spring Garden Road).

FIFTH NATIONAL CONGRESS OF THE CANADIAN BRANCH OF THE ROYAL METEOROLOGICAL SOCIETY

For the fifth year in succession the Canadian Branch joined the Learned Societies in their annual meetings which conclude the academic year in Canadian Universities. On this occasion Halifax was the venue. Distance from the main centres of population in Canada did not appreciably affect the attendance - there were 65 registrations - but in contrast with the sunny skies of previous locations, Halifax will be remembered for its wind and rain and 40 degree temperatures. Meetings were held on two days, 11th and 12th June, in the Sir James Dunn Science Building, Dalhousie University and in the Chemistry Building.

The chairman of the Programme Committee was H.M. Hutchon. Nineteen papers were read in all, the first day being a "University day", the second a "Meteorological Service day".

Local arrangements were in the hands of Lyall Swansburg.

FIRST DAY - Morning Session

Prof. B.W. Boville, McGill University, retiring President of the Branch, took the chair for the first session, which was held jointly with the Canadian Association of Physicists. His own work on the general circulation formed the first subject. Prof. Boville opened with an historical introduction and a general statement of the three main aspects of the problem as they appear today. These were then dealt with in detail by members of his group. Using a series of colour slides Mr. B. O'Reilly summarized the methods of exchange of energy from available potential to kinetic and back and between the various types of kinetic energy, e.g. that contained in meridional motion, the zonal current and in the stationary and travelling eddies - cyclones. He emphasized that it is the synoptic scale eddies which play the predominant part in the conversion of potential energy into air motion - sending energy up the spectrum to maintain the zonal current and planetary waves and down the spectrum into turbulent and frictional dissipation. Mr. Andre Robert dealt with the effects of convection and heat transfer in the meridional circulation and suggested that the interactions between eddies on different scales was a feature of importance. Mr. Merilees showed that the effects of non-linear interaction had been seriously underestimated in the past and that non-linear wave growth required careful investigation. He presented graphs showing the growth of a wave at the expense of the zonal flow. Linear growth was shown to proceed without limit while non-linear growth ends after most of the available energy has been taken out of the flow. The stabilization of the long waves by the short waves was also discussed.

Papers by Mr. C. Quon of the Bedford Institute of Oceanography, Dartmouth, Nova Scotia, and Prof. A.W. Brewer, Toronto University, were then taken up. Mr. Quon explained the problems facing a wave forecaster, who is handicapped by lack of observations and who must forecast such an erratic element as wave height, dependent on such diverse factors as the air-sea temperature difference, air turbulence, the angle of the wind direction to the running sea, in addition to depth and fetch. Wave refraction is of particular importance in coastal waters because of the rapid change in depth: this was illustrated by slides showing two wave trains entering the Gulf of St. Lawrence: although coming from the same direction a moderate difference in wave-length produces markedly different travel in the Gulf. Prof. Brewer described a new technique for the measurement of ozone in the stratosphere. The platinum element was baked: the sonde is launched so that one radiometer is so close below the balloon that it is constantly in its shadow and a second so far beneath that it is clear. It was possible to obtain the ratio between direct and scattered radiation. The technique could be particularly successful in the tropics and three ascents made in Jamaica this spring had given entirely compatible results.

Afternoon Session.

The afternoon session carried the title "Physical and Dynamical Meteorology" and was under the chairmanship of Dr. D.P. McIntyre, a past President of the Branch.

Two papers were presented by members of Prof. Orvig's McGill Arctic Group. Miss Bea Taylor was concerned with evaporation and sensible heat flux over the Arctic Ocean. Her tables and graphs indicated that both these elements are very sensitive to the amount of open water and, in fact, that there is not enough energy available to maintain the fluxes if substantially greater areas of open sea were to exist. In spite of this the studies indicated that the Arctic sea ice is becoming progressively thinner, a result confirmed by a comparison of current values of the ice thickness with those made at the end of the nineteenth century. Prof. Orvig then went into the question of the heat budget over the Arctic Ocean: this had been investigated for the surface, the troposphere and the earth-atmosphere as a whole. It emerged that in the approach to the studies a cloud atlas had been prepared which gave average type and amount of cloud for each month of the year for different regions of the Arctic. The predominance of longwave radiation towards the surface is far more significant in the Arctic than in other latitudes. A substantial portion of the incoming radiation energy in summer is put into storage by absorption in the water and by warming and melting of ice. In the case of the tropospheric budget the importance of the non-radiative terms increases for the incoming side of the budget and decreases on the expenditure side, where radiation becomes practically the only term. In the case of the earth-atmosphere system as a whole the absorbed solar radiation is proportionally smaller in the north and the contribution of evaporation to the energy turn-over is also less than the global average. Dr. J. Maybank of the Saskatchewan Research Council had been investigating Bowen correlations in respect of rainfall in the Canadian prairies. Reasonably good agreement had been found but time intervals other than the 30-day period appeared to give equally good results. Dr. Maybank was attempting to link the precipitation anomalies with pressure cycles dependent on extra-terrestrial influences. Mr. J. Derome, McGill University, in a study of the relationship of large scale vertical motion with the occurrence of severe storms, in a week in May, 1961, in eastern North America, had found a good correlation with morning precipitation only.

SECOND DAY - Morning Session

On the second day Mr. J.M. Leaver, a past President of the Branch, was in the chair for a session of six papers on synop-

tic analysis and prediction, contributed by staff members of the Canadian Meteorological Service.

Mr. R.A. Hornstein, chief forecaster of the Atlantic Weather Central, this year a winner of a Patterson Medal, reviewed the weather of the past winter in the Maritime Provinces of Canada. This was a period of exceptional cyclonic activity in the area: taking as a measure of "explosive deepening" Gen. J.J. George's criterion given in his book "Weather Forecasting for Aeronautics", of a central pressure fall of 20 mb in 24 hrs, this one winter had provided as many such storms as noted by George in the three-year period studied by him. Mr. E.C. Jarvis of the Research Section, had been working on a refinement of the Wilson grid method of forecasting displacement by the introduction of standard monthly sea surface temperatures. The remainder of the session was taken up by work from the Central Analysis Office. Mr. D.E. Page described a quick method for the prediction of precipitation two days in advance. Prognostic thickness patterns for the layer 1000 - 700 mb, prepared in 24-hr time steps, are superimposed on the NWP prognostic 500 mb vorticity chart. In less than a quarter of an hour a diagnosis can be made of the amount of development and vertical motion to be expected and therefrom an evaluation of rates of precipitation. Mr. D. Davies reported on attempts to improve the routine computer prognoses by "patching", i.e., carrying out secondary calculations in regions of strong activity. Unfortunately the patching has to be done before the integration of the equations, necessitating the introduction of more complicated methods of relaxation. Mr. R. Asselin reviewed work on the elimination of spurious anticyclogenesis persisting despite improved objective analysis . The use of the complete balance equation in place of the linearized form met requirements, apparently due to an improved estimate of wind speeds in the troughs. Mr. W.S. Creswick described the many pitfalls resulting from the introduction into the computer of estimated data in the silent areas of the chart.

Afternoon Session

The incoming President, Dr. R.E. Munn, of the Meteorological Service, was in the chair for the final session.

Prof. Hitschfeld read a paper by R.C. Srivastava of McGill University, who was putting forward a numerical model of cumulus convection which could take care of both the jet and bubble theories of cloud growth. The initial radius of the jet is found to be an important parameter. Criticism of the jet-cum-entrainment mechanism has often been based on the assumption that the weight of condensed water would kill the jet. However, Mr. Srivastava finds that concentrations as high as 10 gm/m^3 can occur with only a small reduction of jet speed.

The author hopes to continue this investigation by considering the effect of a partially mixed collar between the rising jet and the ambient air. Members of the Meteorological Service made up the balance of the session. Mr. U. Sporns reported on a major cooperative study of flood flows being conducted on a joint basis with the federal Water Resources Branch and the Nova Scotia Power Commission. The work was so far forward that it was considered that a reliable estimate could be given of the probability of any given rainfall over any of the river valleys in the province. Mr. H.J. Wilson had been investigating pollution at Saint John, New Brunswick; he also read a paper by H. F. Cork on low level inversions near Lake Erie, where two types had been found. One, occurring on clear nights with light winds, persisted for about 12 hours: the other, on cloudy nights with strong winds, for less than half as long. The Chairman and President then took up the first of two papers from the Suffield Experimental Station, Alberta. Some 20 years ago, as part of a radio-wave propagation study, hourly vertical profiles of temperature and mixing ratio had been obtained at 10-foot intervals from a 100-foot tower. As vertical profiles of humidity are relatively rare in the lowest 100 feet of the atmosphere, these had been worked up and it had been possible to infer the relative contributions of relative and turbulent flux divergence in determining the diurnal temperature cycle. In the final paper Mr. O. Johnson summarized experiments to measure the concentration of smoke up to about 15 km from the source. The trials were made at night and it had been found that where the conditions were slightly unstable agreement with standard diffusion theory was better: where the conditions were stable concentrations at ranges above about 3 km were less than predicted.

In a large country like Canada not the least fringe benefit of these Congresses is the opportunity they afford for a meeting of meteorologists who would otherwise never get together. A notable regular attender in his retirement is Dr. Andrew Thomson, a former Director of the Meteorological Service. Fellows, who gathered for luncheon at the Lord Nelson Hotel on the first day, enjoyed the hospitality of a reception by Dalhousie and a trip across the harbour to the National Oceanographic Institute as its guests. Next year Fellows will experience the "coast to coast" nature of the country when the Learned Societies gather at Vancouver.

J.A. McCallum