ATMOSPHERE

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THE WAY AHEAD

By A. W. Brewer

On January 1, 1967, the Canadian Meteorological Society succeeded the Canadian Branch of the Royal Meteorological Society. The declared aim of the society is to advance the science of meteorology, but we must ask ourselves in what special way can the new society carry out these aims which are no different from those of the Royal Meteorological Society; and what special purpose, apart from national pride can be served by having our own Canadian Meteorological Society. Only if it serves a purpose will the society be a success.

Canada has very special needs for meteorological science. It behoves the society to examine these needs and to give itself an additional purpose, namely to advance the science of meteorology in the service of Canada.

The impact of the weather upon the lives of almost everyone in Canada is obvious, but atmospheric events also play a very large part in many aspects of Canadian affairs; as for example in forests and farms. Also the weather controls the water resources of the country. These will be of immense value in the future, both for power generation and for the water itself. But the same water can also cause disastrous floods. The winds disperse air pollution. In these fields and in many others, meteorologists are needed to help answer many important and difficult questions. Because of the importance of these matters some meteorology should be taught in schools. The means by which we can serve Canada is through these relationships.

In looking to the future, therefore, the society must aim at providing common ground on which <u>all</u> who are concerned with physical events in the atmosphere can meet to discuss their problems and draw on one another's experience.

At present, the membership of the society is mainly composed of professional meteorologists most of whom are concerned with the atmosphere alone. Only a few are concerned with the interactions of the atmosphere and our environment. The purpose then of establishing our own society is to widen the membership to include those whose main interest includes other matters and who see the significance of meteorology and who wish to advance both meteorology and their own special sphere of interest.

This, it seems to me, is the way we should advance. We, the professionals, cannot do this alone. I cordially invite all who have any interest in physical events in the atmosphere, in whatever connection, and at whatever level, whether erudite or seemingly common place, to join us and play their part in the progress and development of our new Canadian Meteorological Society.

AN ANALYSIS OF SMOKINESS AT REGINA AND SASKATOON

By R. E. Munn and D. Berengut*

ABSTRACT

An analysis is made of smoke data from two stations in each of Regina and Saskatoon for the period May 1961 to May 1965. The seasonal and daily cycles are determined, and the effect of wind speed and direction on air quality is studied.

* *Mr. Berengut is a student at McGill University and was a 1966 summer assistant with the Meteorological Service of Canada.*

1. INTRODUCTION

Ground level concentrations of pollution in a city depend upon

(a) the spatial distribution of the sources, their emission rates, and their variations with time;

(b) the wind and its turbulent fluctuations.

The source strength distribution in an urban area is complicated, e.g., it is different for different kinds of pollution, and is generally not known except in a very qualitative sense. Nevertheless, when large samples of pollution data are prestratified by season and time of day, meteorological factors will be the major cause of variations in air quality. It is evident, for example, that the concentration of pollution at a point downwind from an individual source will be higher than that at a point equidistant but upwind from the source.

In this study of Regina and Saskatoon, the effect of wind speed and direction on pollution is examined. In addition, daily and seasonal variations in air quality are studied in an attempt to relate these to variations in the principal meteorological factors, as well as to variations in emission rates. Since there are no data on vertical lapse rates, the importance of temperature inversions is not evaluated.

The pollution measurements are in the form of smoke data, i.e., Hemeon sampler observations of the soiling by suspended particulate matter in the air. Munn and Katz (1959) have shown that this is a useful index of urban pollution.

2. SOURCES OF DATA

The Occupational Health Branch of the Saskatchewan Department of Public Health operates two sampling stations in both Regina and Saskatoon. The locations of these stations, identified as A and B, are shown in Figs. 1 and 2. The A stations are representative of business areas and the B stations of residential areas. The wind roses on Figs. 1-2 will be described in Section 7.

A.I.S.I. samplers are used to obtain the smoke data. The sampler draws air at a constant rate through a tape of filter paper, thus depositing particulate matter on the tape in the form of a dark stain. The sampling time is two hours, after which the tape automatically moves along to a new spot. The per cent light transmittance of the spot relative to that of the clean tape is obtained, and the data are expressed in the form of a soiling index whose unit is "COH/1000 linear ft.". This is defined as the quantity of light-scattering solids producing an optical density of 0.01

Thus,

$$\text{COH/1000 ft.} = \frac{\text{Opt. Dens. x } 10^5 \text{ x A}}{\text{V}}$$

Where

$$\text{Optical Density} = \log_{10} \frac{100}{\text{\% light transmission}}$$

$$\text{A} = \text{area of spot on tape in ft.}^2$$

$$\text{V} = \text{volume of air sampled in ft.}^3.$$

Sampling times begin and end on the even-numbered hours in local standard time.

The hourly winds from the respective airports are also used. Regina airport is approximately $1\frac{1}{2}$ miles W of stations A and B; Saskatoon airport is about $2\frac{1}{2}$ miles NNW of A and B. Considering the reasonable proximity of the airports to the sampling stations, the flatness of the terrain and the absence of large lakes, the winds at the airports are considered to be fairly representative of those at the sampling stations, particularly because of the broad wind classes to be used in the analysis.

The period under study for Regina is from June 1961 to May 1965, with station B having the additional month of May 1961. For Saskatoon A, the period is from June 1961 to April 1965, and for Saskatoon B, from September 1962 to April 1965. There are occasional periods of missing information.

3. TABULATION OF DATA

The wind and smoke data are placed on I.B.M. punched cards, which are processed to yield frequency tabulations by the Data Processing Unit of the Meteorological Service of Canada. The data are grouped into four seasons: summer (June, July, August), fall (September, October, November), winter (December, January, February), and spring (March, April, May). Within these groups, the data are divided into 3 pollution concentration classes, (COH 0.0 - 0.9 light, 1.0 - 1.9 moderate, $\geq$ 2.0 heavy), and 3 wind-speed classes (0 - 4.9, 5 - 9.9, $\geq$ 10 mph). Within each of these nine divisions, the data are further subdivided into 8 wind direction classes and four time-of-day classes (00-05, 06-11, 12-17, 18-23 local standard time) (Emslie 1964).

Because of the relatively few occurrences of COH values $\geq$ 2.0 at all four sampling stations, the moderate and heavy pollution classes have been grouped together in many of the tables and figures to follow.

4. SEASONAL CYCLES

Figure 3 shows the seasonal percentage frequencies of COH values ≥ 1.0 at all four stations. High values occur rarely in the summer. In other seasons there is quite a variation from year to year; at Saskatoon A, for example, the winter percentages range from 11 to 76. The length of record is therefore too short to establish any long-term trends in air quality.

The frequency of high COH values is less at the residential than at the business area stations in both cities. In addition, pollution levels are lower at the Regina than at the Saskatoon stations.

Green (1966) has suggested an average monthly COH value of 0.9 as a desirable objective for urban areas. Average values at all four sampling stations are given in TABLE 1. Only at the two Saskatoon stations in winter is the suggested objective exceeded.

TABLE 1. Average COH values by season:

	Winter	Spring	Summer	Autumn
Regina A	0.5	0.6	0.4	0.5
Regina B	0.2	0.2	0.2	0.2
Saskatoon A	1.1	0.5	0.6	0.7
Saskatoon B	0.9	0.6	0.6	0.6

TABLE 2 shows the extreme COH value reported at each station for each month of the year. Values are generally higher in the heating than in the non-heating seasons, and at the business rather than at the residential area stations. However, there are a few exceptions, e.g., the B stations have higher values than the A stations in June. Such anomalies are not unexpected in analysis of extreme values over short periods of record.

TABLE 2. Extreme COH values by month at the 4 sampling stations:

	Month												Annual
	J	F	M	A	M	J	J	A	S	O	N	D	
Regina A	5.3	9.0	5.9	4.2	7.3	2.0	3.2	2.2	9.3	4.6	2.2	6.7	9.3
Regina B	1.3	1.5	1.6	1.4	4.8	2.8	1.0	1.2	1.3	1.0	2.1	3.2	4.8
Saskatoon A	6.0	6.0	2.9	3.1	2.5	3.7	4.9	2.3	2.3	8.3	3.0	12.8	12.8
Saskatoon B	4.4	7.1	3.1	3.2	2.1	5.0	3.5	2.6	4.2	3.9	3.6	5.1	7.1

Despite occasional very high peaks, the smokiness at the four sampling stations is generally low. If a COH value ≥ 2.0 is taken as a criterion of poor air quality, then this level is rarely reached, as can be seen from TABLE 3.

TABLE 3. Percentage frequency of COH ≥ 2.0:

	Dec.-Feb.	Mar.-May	June-Aug.	Sept.-Nov.
Regina A	1.8	1.7	0.1	1.4
Regina B	<0.1	<0.1	<0.1	0.3
Saskatoon A	4.5	0.0	0.5	2.2
Saskatoon B	5.9	0.0	0.2	1.1

5. DIURNAL CYCLES

Figure 4 displays diurnal cycles for Regina A and Saskatoon A and B. In this figure, the basic data have been limited to

(a) days for which there were a full 12 smoke observations at the station;

(b) days for which at least one COH value ≥ 1.0 at the station;

(c) days in the months of Sept. to May, inclusive.

When COH values are less than 1.0, a daily peak value is not particularly meaningful, and there are many such low values at the four stations, particularly in summer. For each day that met the conditions listed above, then, the hour of the maximum COH value was noted and the frequency distribution of these times was determined. There were insufficient occurrences of high COH values at Regina B for inclusion in Fig. 4.

In most urban areas that have been studied, e.g., Munn and Katz (1959), there is on the average a peak in pollution occurring between 7 and 10 a.m., caused by increased emissions and the breakup of a night-time inversion (the fumigation process). This peak is well defined in Fig. 4 at Regina A and Saskatoon B, but is not so evident at Saskatoon A.

In most cities there is also an evening pollution peak, the cause of which has not been adequately explained. This feature is well defined at all 3 stations in Fig. 4, occurring at 2100 LST at Saskatoon A and B and at 2300 LST at Regina A.

Air quality is usually best in the afternoon when both horizontal and vertical ventilation rates are greatest. However, this is not the case in the present study. Regina A has its largest daily frequency of peak values at 3 p.m. while both Saskatoon stations have well-defined afternoon maxima (1 p.m. and 5 p.m. at Saskatoon A and B, respectively). This interesting anomaly will be considered in Sections 6 and 7.

6. EFFECT OF WIND SPEED

The effect of wind speed on air quality is given in TABLE 4. For four wind speed classes and for four periods of day, the percentage of COH values $\geqslant 1.0$ is given (excluding the three summer months). It is necessary to separate the data into the 4 periods of the day because of the diurnal cycle in wind speed.

TABLE 4. Per cent frequency of COH $\geqslant$ 1.0 in each of 4 periods of the day and 4 wind speed classes; μ is the number of observations in each class; the months of June-July-August have been excluded from the table:

Wind Speed	Time of Day (LST)							
	00-06		06-12		12-18		18-24	
	%	μ	%	μ	%	μ	%	μ
REGINA A								
calm	26.5	49	24.6	61	17.1	41	30.0	40
1 - 4.9 mph	16.1	124	15.0	133	12.9	93	17.2	99
5 - 9.9 mph	11.7	573	15.3	529	9.7	382	10.3	526
$\geqslant$ 10 mph	8.8	1849	9.7	1880	12.0	2068	9.8	1910
SASKATOON A								
calm	30.0	70	38.3	60	38.0	50	27.6	58
1 - 4.9 mph	36.5	233	32.1	212	37.9	124	37.5	176
5 - 9.9 mph	28.4	947	29.0	778	31.4	659	30.4	841
$\geqslant$ 10 mph	25.1	1523	28.0	1721	28.4	1928	27.0	1714
SASKATOON B								
calm	21.4	42	21.6	37	32.4	40	36.7	49
1 - 4.9 mph	13.8	174	29.0	155	26.4	87	31.4	137
5 - 9.9 mph	14.7	638	13.8	499	22.6	424	19.5	553
$\geqslant$ 10 mph	10.6	962	11.0	1121	14.2	1277	14.4	1104

Examining first the vertical columns of the table, there is generally a trend towards improving air quality with increasing wind speed. One interesting exception (based on a relatively large sample of data) is Regina A in the afternoon; the percentage of high COH values is large in the wind speed class of $\geqslant$ 10 mph than it is in the 5 - 9.9 mph wind speed grouping.

Study of the horizontal rows shows that

(a) for Regina A:

(1) the evening peak of Fig. 4 is associated with winds of under 5 mph;

(2) the morning peak of Fig. 4 occurs with winds of 5 - 9.9 mph;

(3) the afternoon peak is associated with winds of 10 mph or greater.

(b) for Saskatoon A:

(1) in all wind speed classes, the percentage frequencies are at or near the daily maximum in the afternoon.

(c) for Saskatoon B:

(1) in all wind speed classes except 5 - 9.9 mph, the percentage frequencies are a maximum in the evening.

These time-of-day trends (variations along the horizontal rows) are caused by a combination of meteorological and source-strength factors. If source-strength variations were of primary importance, then wind speed should have little effect on the diurnal cycle; this is generally true at the two Saskatoon stations, and it is inferred that the peaks in Fig. 4 for Saskatoon A and B are caused by increases in emissions (or re-entrainment of dust from moving automobiles).

At Regina A, on the other hand, the changes in diurnal trends with wind speed class suggest that meteorological factors are of predominating influence. This will be discussed further in Section 7.

7. THE EFFECT OF WIND DIRECTION

Wind roses have been plotted in Figs. 1 and 2. The vertices of the solid-line octagons represent the 8 wind directions and the distances from the centre are proportional to the percentage frequencies of cases for which COH values were less than 1.0. A similar representation is given by the dashed-line octagons for cases when COH values were $\geqslant$ 2.0 at Regina A and Saskatoon A and B, and were $\geqslant$ 1.0 at Regina B (insufficient cases of COH $\geqslant$ 2.0 at Regina B). Calm winds and observations from June-July-August have been excluded from the frequencies. The number of cases in each data sample was:

	COH < 1.0	COH $\geqslant 1.0$	COH $\geqslant 2.0$
Regina A	8,930	1,098	162
Regina B	11,177	193	14
Saskatoon A	5,417	2,365	251
Saskatoon B	6,041	1,088	179

A comparison of these non-overlapping sets of data at each station is a good visual way of examining the effect of wind direction on air quality. Areas have been shaded where the dashed lines fall outside the solid lines. These represent sectors where smokiness is higher than would be expected if there were no association between wind direction and pollution levels. Similarly, the hatched areas indicate sectors where the air flow is relatively clean.

At Regina A, the shaded areas are in the western semicircle, while air quality is most likely to be high with NE, E and SE winds. There are sufficient data at this station to examine wind-roses in certain times-of-day and wind-speed groupings. Fig. 5 displays the wind-roses for

(a) the period 12-18 LST and wind speeds $\geqslant$ 10 mph (1819 and 249 observations of COH $<$ 1.0 and COH $\geqslant$ 1.0, respectively);

(b) the period 06-12 LST and wind speeds 5 - 9.9 mph (452 and 77 observations of COH $<$ 1.0 and COH $\geqslant$ 1.0, respectively).

The afternoon strong-wind wind-roses show relatively poor air quality with S and SW winds, probably caused by downwash from very local sources.

The morning moderate-wind wind-roses are quite different and are no doubt associated with the meteorological inversion break-up situations. In this case, there are inferred sources to the SE, SW and W of the station.

In Saskatoon, there is a very large surplus of high COH values with S and SW winds at Station B, and it is evident that smoke sources must exist in these directions. Station A shows a smaller but still significant surplus of high COH values with S and SW winds, as at Station B, but also with W winds. At both sampling locations air quality is relatively high with N and NE winds.

Wind-roses for sub-groupings of particular periods of the day and wind-speed classes (not displayed) are quite similar to those given in Fig. 2.

8. CONCLUSION

Air quality is usually good in both Regina and Saskatoon (TABLE 1), although there are occasional high COH values (TABLE 2). There is a seasonal trend (TABLES 1 and 3, Fig. 3) caused by the increased emissions in the colder half of the year.

The diurnal cycles are quite complex (Fig. 4 and TABLE 4). At the Saskatoon stations, the cycles are due mainly to variations in emissions or re-entrainment of dust by increased automobile traffic. At Regina A, because of the changing patterns with different wind-speed groupings (TABLE 4), meteorological factors must be important. For example, air quality is usually good with southeast winds; in the morning with moderate winds, however, smokiness is above average with winds from that direction (Fig.5).

Pollution levels generally decrease with increasing wind speed (TABLE 4). Wind direction is important, and the wind-roses give some indication of the orientation of local smoke sources.

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Green, M.H. (1966) An air pollution index based on sulfur dioxide and smoke shade. J. Air Poll. Cont. Assoc. 11, 703-706.

Munn, R.E. & M. Katz (1959) Daily and seasonal pollution cycles in the Detroit-Windsor area. Int. J. Air Poll. 2, 51-76.

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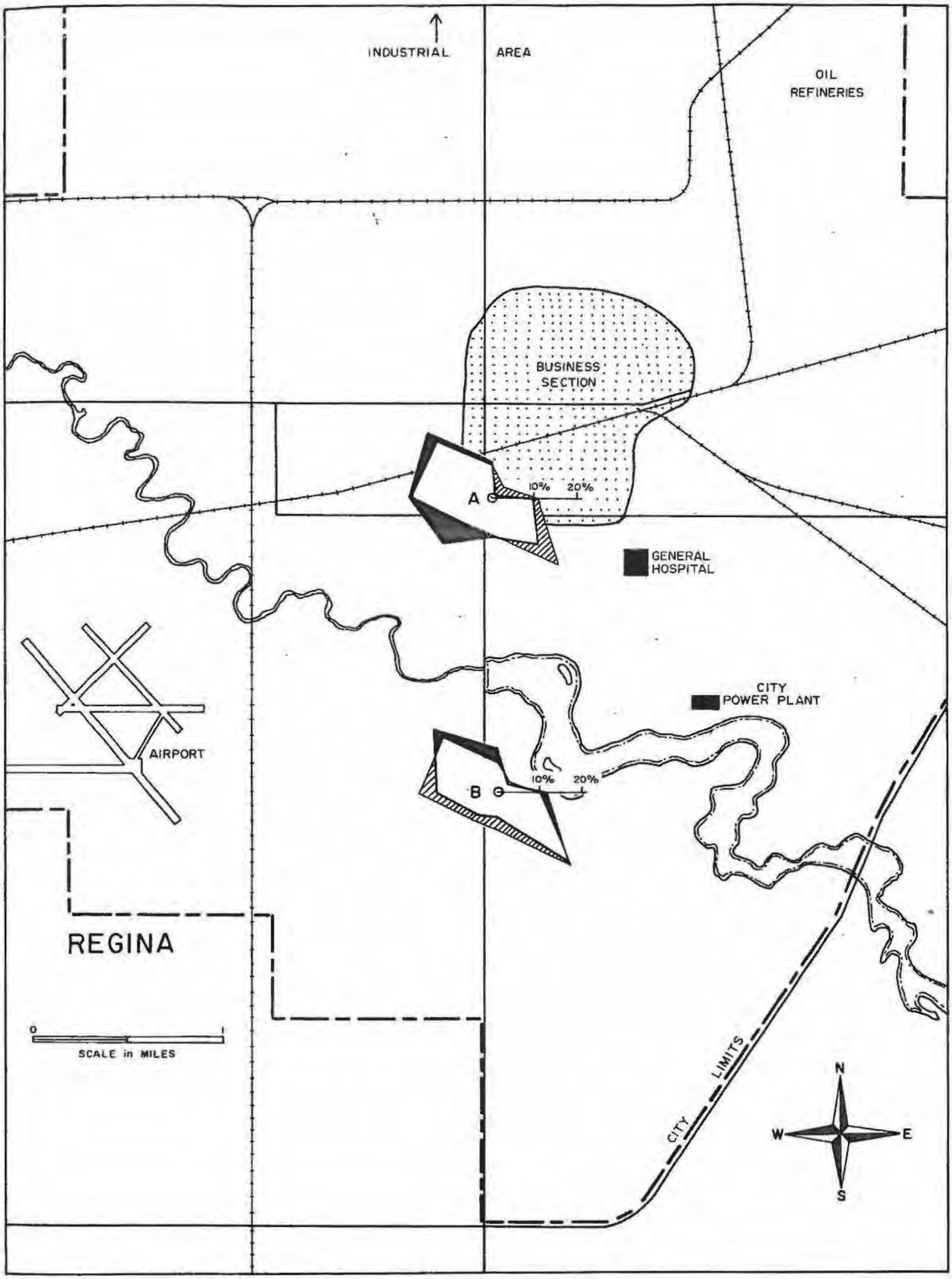

INDUSTRIAL AREA
OIL REFINERIES
BUSINESS SECTION
A
10%
20%
GENERAL HOSPITAL
CITY POWER PLANT
AIRPORT
B
10%
20%
REGINA
0
1
SCALE in MILES
CITY LIMITS
N
W
E
S

FIG. 1

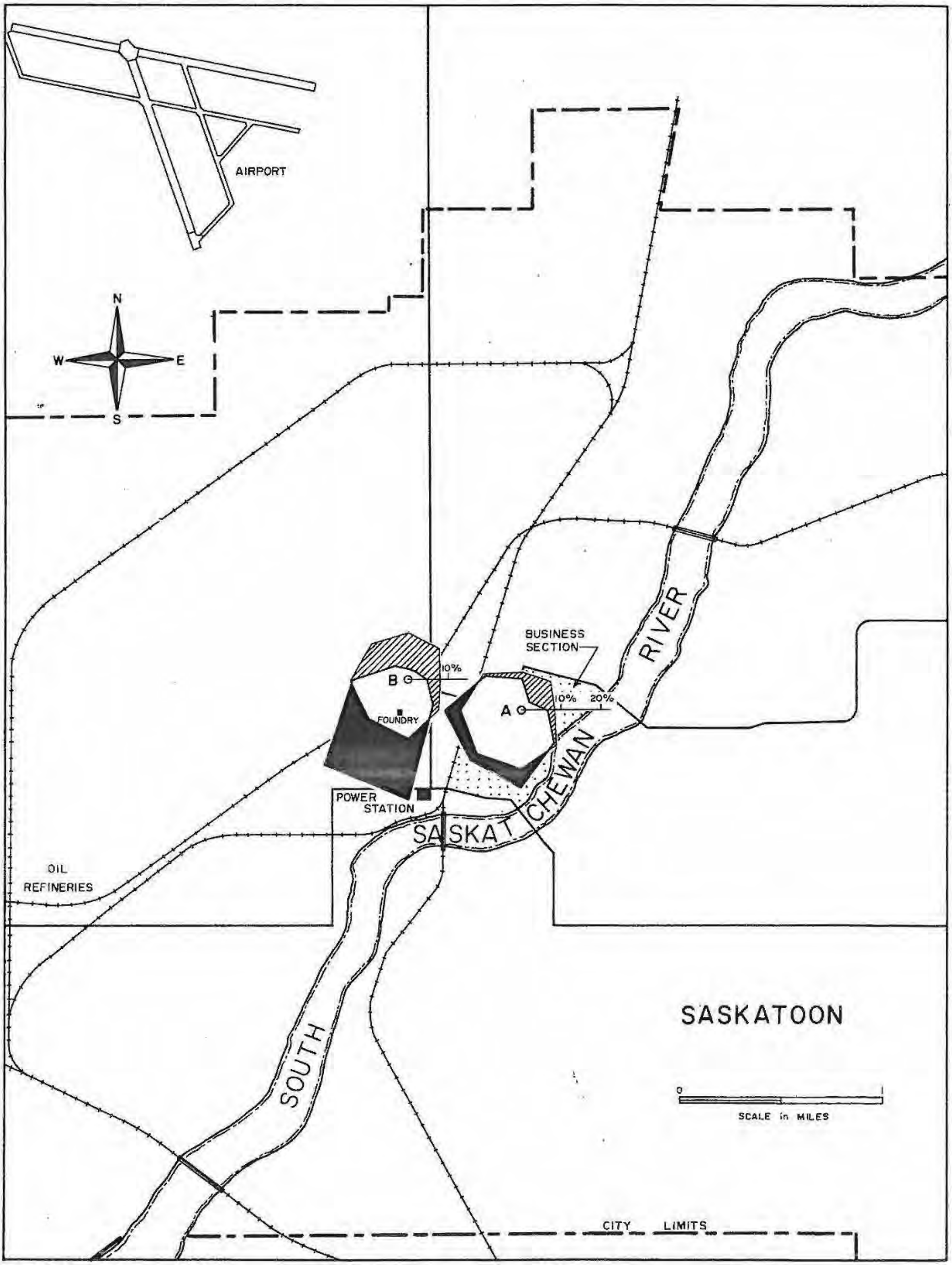

AIRPORT
N
W
E
S
BUSINESS SECTION
10%
B
FOUNDRY
10%
20%
A
RIVER
POWER STATION
SASKATCHEWAN
OIL REFINERIES
SOUTH
SASKATOON
0
1
SCALE in MILES
CITY LIMITS

FIG. 2

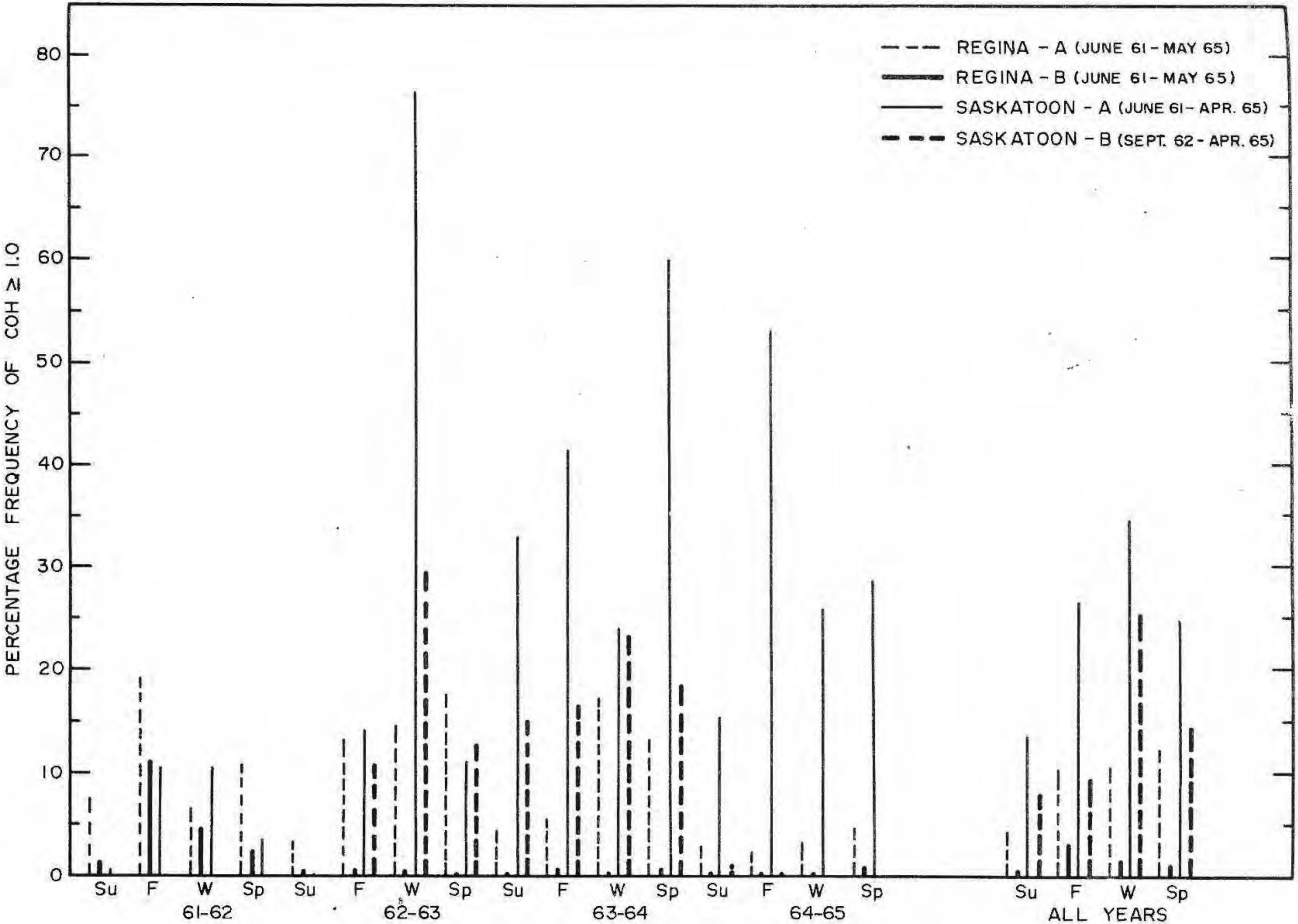
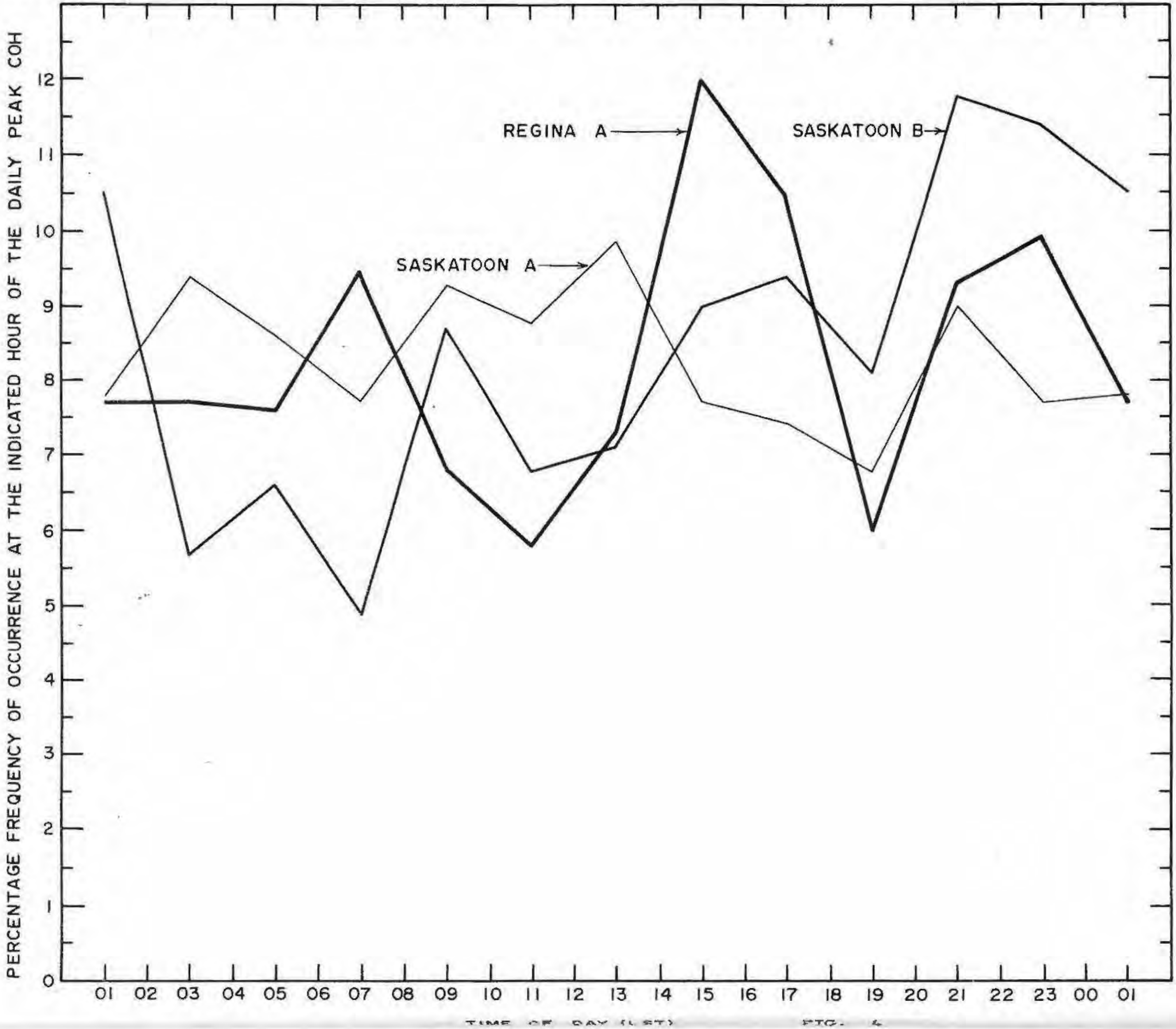

REGINA - A (JUNE 61 - MAY 65)
REGINA - B (JUNE 61 - MAY 65)
SASKATOON - A (JUNE 61 - APR. 65)
SASKATOON - B (SEPT. 62 - APR. 65)
PERCENTAGE FREQUENCY OF COH ≥ 1.0
0
10
20
30
40
50
60
70
80
Su F W Sp
61-62
Su F W Sp
62-63
Su F W Sp
63-64
Su F W Sp
64-65
Su F W Sp
ALL YEARS

FIG. 3



TIME OF DAY (LST) FIG. 4

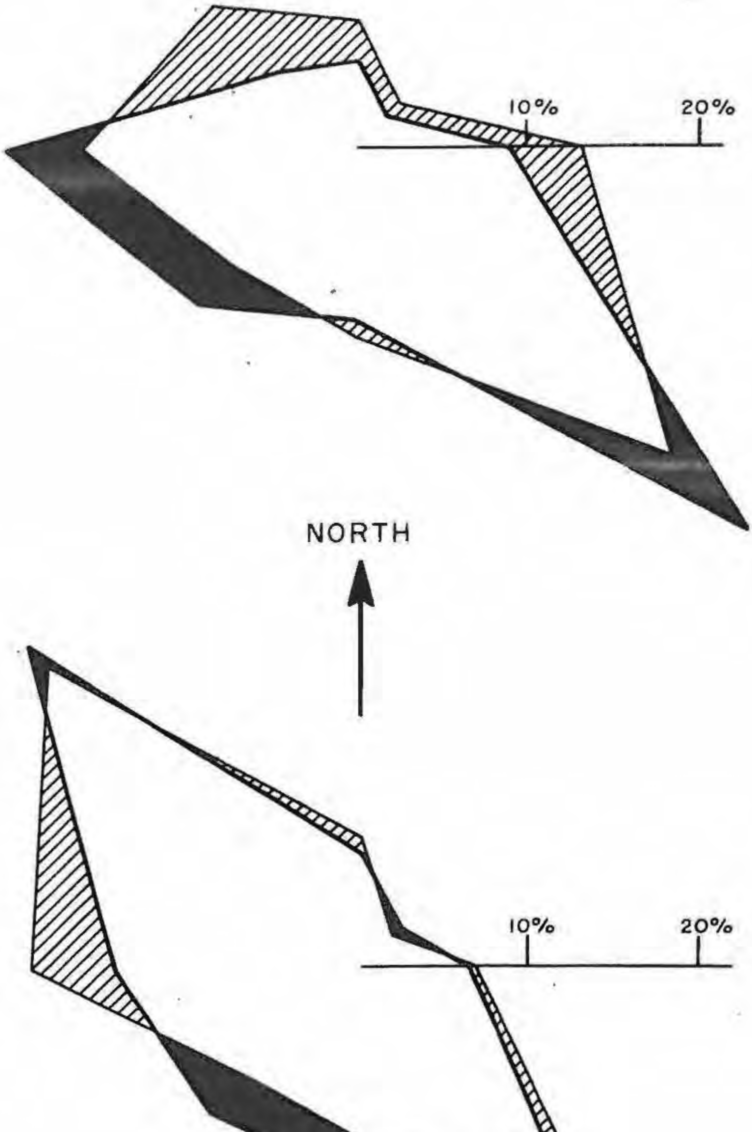
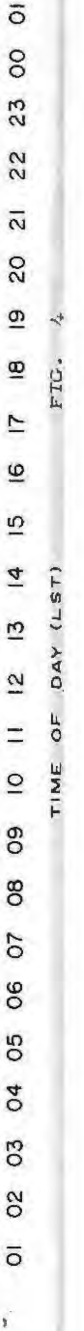


FIG. 5



"PILOT CHIMNEY" ON THE WATERLOO CAMPUS

by G. T. Csanady

University of Waterloo

An active programme of research in the application of fluid dynamics to natural phenomena involved in air and water pollution has been pursued in the Faculty of Engineering, University of Waterloo, since 1963. One phase of the work has dealt with the dispersal of heavy particles suspended in hot chimney plumes and involved field observations on full-scale chimney plumes, e.g. at the Lakeview (Toronto) power station.

One of the main difficulties in full-scale observations was that at large distances the plumes were no longer visible. In order to overcome this difficulty while retaining the advantage of observations in the natural environment, a "pilot chimney" has been constructed on the "North Campus" of the University of Waterloo. The chimney is 20 feet in height (i.e. just one order of magnitude smaller than full scale) and is situated in the middle of flat terrain, with observations possible for several thousand feet downwind. In order to avoid disturbing the air flow, all auxiliary equipment has been housed in underground pits. In one pit at the base of the chimney a furnace and an oil-fog generator are arranged. The output of the furnace is such that the "buoyancy length scale":

$$\ell = \frac{F}{U^3}$$

with F = flux of buoyancy, U = wind speed,

is also scaled about 1:10 to 1:25 as compared to typical industrial stacks. It is reasonable to assume that the atmospheric eddies effective in dispersion have a scale proportional to chimney height. Therefore, if the buoyancy-scale is reduced in the same proportion as the chimney height, similarity of plume behaviour should result under neutral conditions, excepting the region of the plume in the immediate neighbourhood of the chimney (because chimney diameter cannot be scaled accurately, if the flux of buoyancy is scaled).

Figure 1 shows a photograph of the installation. Wind and temperature profiles will be measured by instruments located on a light TV mast, near the pilot chimney, not yet erected. The whole installation is expected to be in service by 1 April 1967 and will enable studies to be made during the next summer on the mean path of the plume at relatively much larger distances than has been possible at full scale, on the flow pattern within the plume, and on the fall-out of heavy particles (glass beads) from the plume.

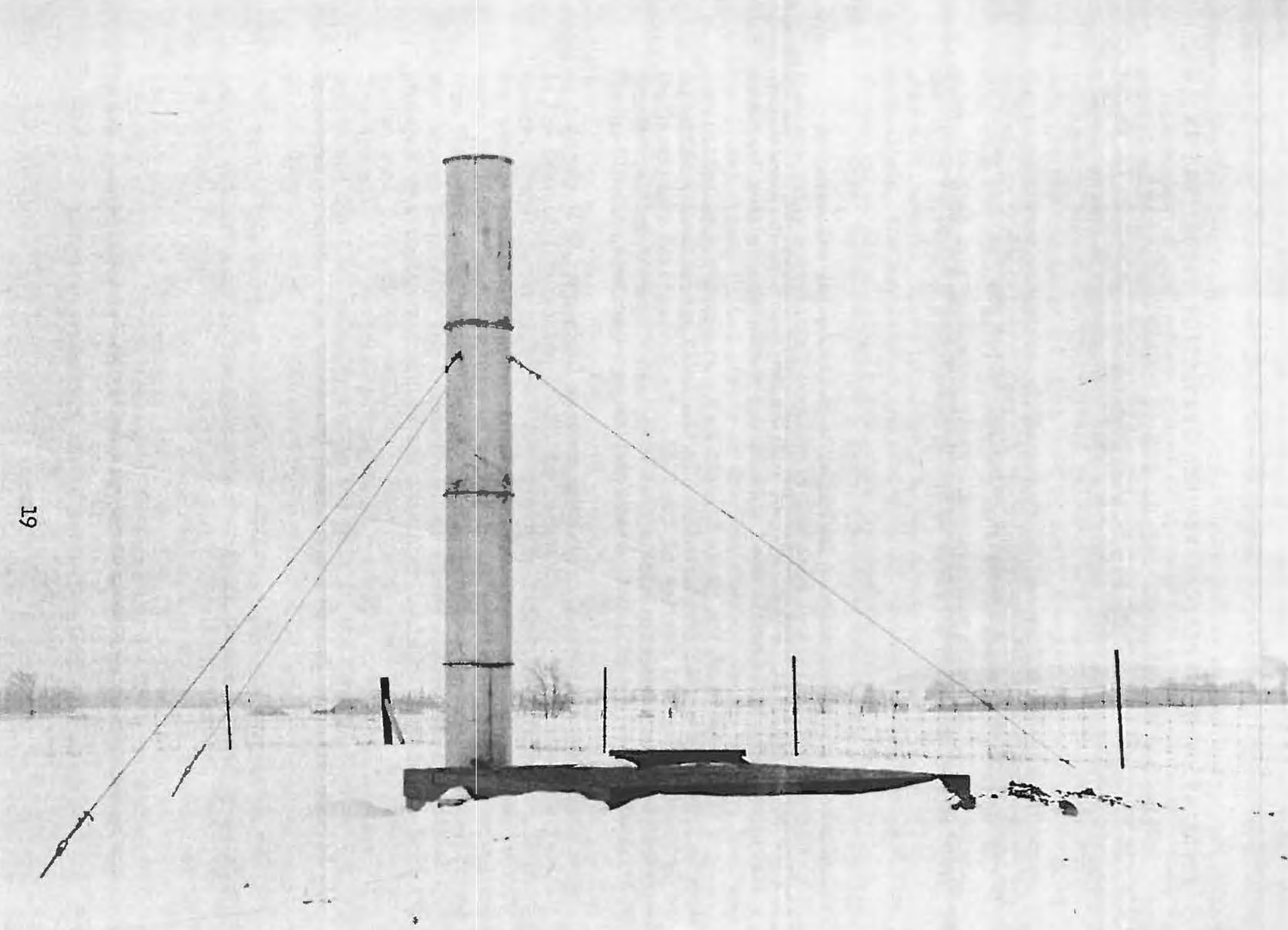


Figure 1 - Pilot chimney with cover of underground
pit visible in foreground

APPLICATION OF NUMERICAL WEATHER PREDICTION TECHNIQUES IN THE OPERATIONAL ROUTINE OF THE HYDROMETEOROLOGICAL SERVICE OF THE USSR*

By V. A. Bugaev, Academician, Acad. Sci. Uzbek SSR
and S. L. Belousov, Candidate of Physical-Mathematical Sciences.

(Translated by A. Nurklik from Meteorologia i Gidrologia, #8, 1966)

The purpose of the present paper is to review the application of numerical weather prediction techniques in the daily operational routine of the Hydrometeorological Service of the USSR. The theoretical aspects of numerical weather prediction models used have been discussed by the authors in original papers and will not, therefore, be repeated here.

* *A summary of two papers read by the authors at the Meeting of the Scientific and Technical Council of the Main Administration of the Hydrometeorological Service of the USSR.*

A review of the present status of the application of numerical weather prediction techniques in our Service seems to be necessary not only to inform the wide circle of professionals of the Service, but also to dispell a deeply rooted erroneous view that these techniques have not advanced in our country beyond the theoretical research and experimenting stage and have not yet become an integral part of daily forecasting routine, or that the earnest reorganization of technology of the entire forecasting procedures, on the basis of numerical techniques is rather a promising future plan than the actual reality. This view must be abandoned once for all since the fact that numerical prediction techniques come into operational use on an increasing scale compels one to consider problems arising from this development. These problems are, the training of new types of specialists, the acquisition and mastering of computer technology, and the automation of all steps of operational forecasting procedures, etc.

An extensive introduction of numerical weather prediction techniques into the daily operational routine is the main feature of the present developments in both our own and the foreign weather services. Operational numerical weather prediction has already been effected in many countries: the Soviet Union, United States of America, Sweden, Japan, Norway, England, Canada, France and Belgium. Extensive theoretical research on and experimentation with numerical weather prediction techniques for the purpose of their operational application is carried out in many other countries: in the Federal Republic of Germany, Australia, New Zealand, Israel, Finland, Czecho-Slovakia, Poland, Romania and others.

In the USSR, numerical weather prediction techniques were first used in the Central Forecasting Institute (presently the Hydrometeorological Centre, Transl.), in 1947-1949 for preparing long-range weather forecasts. Short-range numerical weather prediction was introduced on an experimental basis in 1961. In the course of experimental prediction, it was established that the prognostic contour height charts, prepared by numerical techniques for various levels of the troposphere, were more successful than these prepared by synoptic techniques and that they could be produced to meet the operational forecasting deadlines. In connection with this, a change-over from synoptic to numerical techniques of producing prognostic contour height and vertical velocity charts was made in the Central Forecasting Institute in 1963. The necessary prognostic computations were carried out on the computer of the World Meteorological Centre.

At the present time, operational numerical weather prediction is carried out not only in the Hydrometeorological Centre (formed by merging the Central Forecasting Institute and the World Meteorological Centre in Moscow), but also in a number of other regional centres: at Novosibirsk by the West Siberian Hydrometeorological Service in co-operation with the Siberian affiliate of the Academy of Sciences of the USSR; at Tashkent by the co-operative effort of Weather Services of the Central Asian and

Uzbek SSR and the Central Asian Sci/Res. Hydrometeorological Institute; in Leningrad by the North West Region Hydrometeorological Service in co-operation with the Arctic and Antarctic Sci/Res. Institute; at Rostov on Don by the North Caucasus Hydrometeorological Service, and in other regional offices.

The Operational Numerical Weather Forecasts Produced by the Hydrometeorological Centre of the USSR

In the field of long-range weather forecasting aerodynamical methods were, for the first time, applied in the USSR in theoretical studies on this problem as well as in operational forecasting. This is evidenced by a large number of papers on this subject by E.N. Blinova, Corresponding Member of the Academy of Sciences, USSR and her collaborators. At the present time, models based on these studies are used for operational long-range and medium-range numerical weather predictions. Let us briefly review these models.

Long-range forecasts of monthly mean temperature departures from normal values for the northern hemisphere are prepared on the basis of the numerically predicted circulation at the mid-tropospheric level by a model which incorporates the climate forming factors: the radiative heat transfer and the atmospheric and moisture circulations. These forecasts are issued by the Planetary Atmospheric Dynamics and Hydro-dynamic Long-range Forecasting Section of the Hydrometeorological Centre forty days before the effective date. Long-range weather forecasts with such a long advance time are produced nowhere else at the present time. The success of these forecasts is such that they can be relied upon by users. Since 1964, these forecasts are supplemented by prognostic 500 mb. contour charts for the forecast periods.

The above section produces operationally also the medium range (up to 6 days) prognostic hemispheric charts for the 700 and 300 mb. levels. These forecasts are made by a two-layer model based on the vorticity and heat transfer equations linearized with respect to the westerly flow. The numerical medium range forecasts are produced twice a week; the machine time required for their computation does not exceed 10 minutes.

Three times a week, the prognostic 500 mb. and 700 mb. contour and the sea-level pressure charts are prepared for the northern hemisphere for periods up to 5 days by a non-adiabatic three-layer model. This model takes into account the eddy exchange and the prognostic equations are linearized by considering the observed temperature stratification in the atmosphere. The prognostic surface pressure charts produced by this model are used for forecasting the wave height in the Atlantic by a corresponding technique. In turn, the latter forecasts are used for issuing the most favourable sailing route forecasts for ships crossing the Atlantic. It should be noted here that the numerical prediction of most favourable sailing routes has been extremely promising. Already at the present, the saving in the Atlantic crossing time of ships using these forecasts is 5 per cent and more.

The experience gained in this work indicates that there is a real need for the further improvement of numerical models for the prediction of sea-level pressure in the northern hemisphere several days ahead. Efforts to improve our corresponding prognostic models are already under way.

The computation of prognostic charts with the models mentioned above is performed with data obtained from the objective (numerical) analysis of contour charts for the northern hemisphere. The objective analysis technique is also used in daily computations of some parameters of the Northern Hemisphere circulation. The observational data necessary for the objective analysis are fed directly into the computer by means of paper tapes produced by teletypes on the main information traffic lines. The processing of Northern Hemisphere upper air data requires about 15 min., the objective analysis about 20 min. machine time.

The daily program of operational numerical short-range prediction consists in computing a series of prognostic charts which differ in form, in the size of forecast area and in the complexity of the models used.

In the first place, the prognostic chart is produced for the smallest forecast area and by the simplest model. A minimum number of observational data is required for such forecasts. Due to this, it may be issued in a relatively short time after the acquisition of necessary observational data. For instance, the prognostic upper level and the vertical velocity charts for the European area are already available 5 hours after the upper air observation times.

During the later "reruns", prognostic charts are prepared for larger areas or with more complex models. The preparation of the later prognostic charts requires a greater number of initial data and a longer machine time. All prognostic computations are preceded by automatic checking and objective analysis of the input data.

The prognostic chart production schedule of the Hydrometeorological Centre is shown in TABLE 1 and the areas to which the forecasts apply in FIG. I.

TABLE 1. The production schedule of operational short-range prognostic charts of the Hydrometeorological Centre

Model	Initial input information	The area to which forecasts apply (FIG. I)	The availability of forecasts (in hrs. after observation time)	Prognostic charts	Required machine time (in min.)	Frequency of prognostic charts & time of initial data
Non-linear quasi-geostrophic three-layer model of S.L. Belousov	H_{850}, H_{500} H_{300} at 250 stations	1	5	H_{850}, H_{700} H_{500}, H_{400} & H_{300} for 12, 18, 24 & 36 hrs.	15	Twice a day: 00 & 12 GMT
Non-linear quasi-geostrophic three-layer model of S.L. Belousov	H_{850}, H_{500} H_{300} at 300 stations	2	6.5	H_{1000}, H_{850} H_{500} & H_{300} for 48 and 92 hours	40	Once a day: 00 GMT
Non-linear quasi-geostrophic model of I.Z. Lutfulin incorporating the surface pressure tendencies	H_{1000} H_{500} & H_{300} at 200 stations and the surface pressure tendency field	1	7	H_{1000}, H_{850} H_{700} & H_{500} and the streamline pattern at these levels for 24 hrs.	15	Once a day: 00 GMT
The primitive equation models of S.A.Bortnikov and V.M.Kadyshnikov	H_{1000} H_{850} H_{700} H_{500} & H_{300} at 200 stations	1	8	H_{1000}, H_{700} H_{500}, H_{300} for 24 hrs.	60	Once a day: 00 GMT
Non-linear quasi-geostrophic three-layer model of S.L. Belousov	H_{850} H_{500} & H_{300} at 200 stations	3	7	H_{850}, H_{500} & H_{300} for 36, 48 and 78 hrs. (transmitted also to Khabarovsk)	50	Once a day: 12 GMT

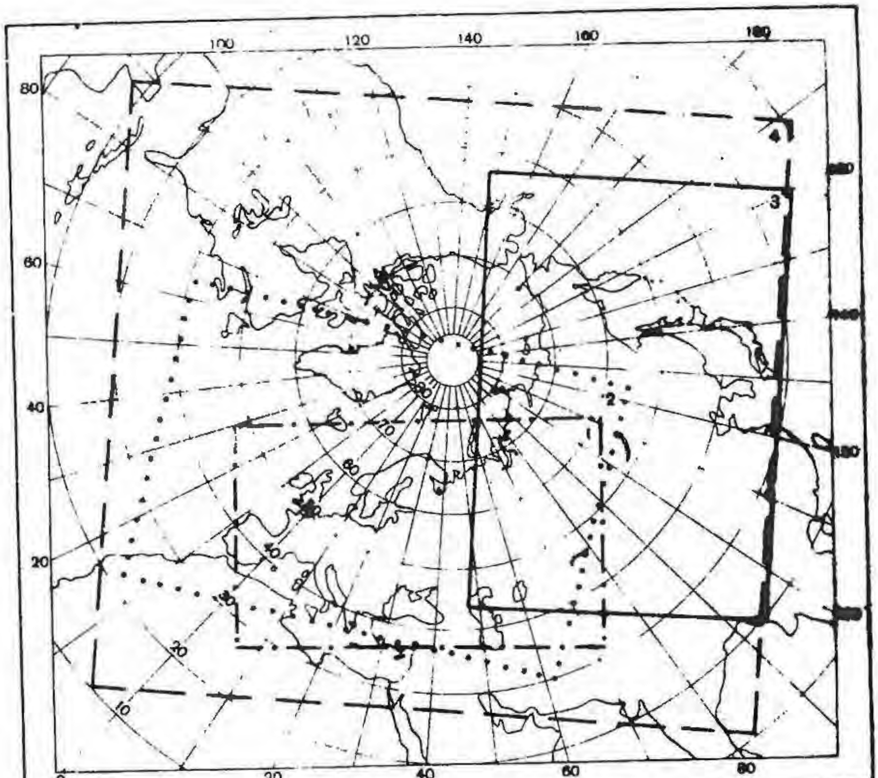


FIG. I. The areas for which the Hydrometeorological Centre of the USSR issues operationally numerical weather predictions

Most of our prognostic charts are produced by quasigeostrophic models, which, from the theoretical point of view, are considered not to be the most perfect models of numerical prediction. Their assumption that the actual wind can be approximated (but not equated) with the geostrophic wind, enables one to use the contour heights as the only initial input information. Also the smaller volume of initial data required by quasigeostrophic models is advantageous from the standpoint of operational forecasting.

At the end of 1965, two more up-to-date numerical weather prediction models, based on the primitive (or complete) hydrodynamic equations, were introduced into the operational schedule. As is known, these models are free of the geostrophic wind assumption and must, therefore, be considered more promising than the quasigeostrophic models. At the present time, the advantage of our primitive equation models is most perceptible in predicting the 24-hour surface pressure patterns. The numerical weather prediction models in our country are designed under the guidance of I.A. Kibel, Corresponding Member of the Academy of Sciences of the USSR.

The total number of prognostic charts produced daily by models mentioned above amounts to 50. Several of these are produced in plotted form. Most of the prognostic charts produced are transmitted over facsimile to local forecast offices. However, a number of prognostic charts are used only by the Short-range Forecasting Section of the Hydrometeorological Centre for forecasting the synoptic situation and weather for Moscow and the Central European region of the USSR. They are also used for predicting the amount of precipitation at selected points in this region.

Owing to the utilization of machine produced prognostic charts, the quality of weather forecasts has risen in recent years. In addition, the machine methods have made it possible to accelerate the dissemination of meteorological information to users, and to free forecasters from a considerable amount of non-creative work and from making a number of subjective judgements.

The technical capabilities of computers at the disposal of the Hydrometeorological Centre do not yet allow us to produce daily multi-level prognostic charts for the northern hemisphere with a non-linearized model. Therefore, prognostic charts are produced for several limited areas using a universal objective analysis technique for any region of the northern hemisphere.

In 1965, the production of prognostic charts for the Far East* by a three-layer model was initiated. Prognostic models are also available for other regions. In 1966, preparation of prognostic charts for the extratropical area of the northern hemisphere (area 4 in FIG. I) by a three-layer model was initiated on an experimental basis. The preparation of a 72 hr. forecast for this area on our computer requires 1 hr. 30 min. and it becomes available 9 hours after the standard upper air observation time.

The success of machine forecasts is evaluated regularly. The most complete verification data are available for forecasts produced with our three-level model. The magnitude of relative errors of forecasts in 1964 and 1965 are shown in TABLE 2.

TABLE 2. Relative errors of operational forecasts in 1964 and 1965

Forecast period	Prognostic charts	Error in 1964	Error in 1965
24 hours	850 mb	0.82	0.81
	500 mb	0.70	0.68
	300 mb	0.63	0.66
48 hours	500 mb	0.86	0.77
	300 mb	-	0.74
72 hours	500 mb	0.95	0.86

*Prognostic maps are transmitted in coded form to Khabarovsk where they arrive at 07-08 o'clock local time. The computer output on a paper tape is automatically fed into the teletype.

The errors of 24-hour forecasts refer to area 1 and these of 48 and 72-hour forecasts to area 2 in FIG. I.

The basic deficiency of our numerical forecasts is that they underestimate the displacement speed and the development rate of disturbances. Undoubtedly, the quality of our numerical forecasts suffers also from the fact that they are produced for limited areas and not for the entire hemisphere. This becomes particularly evident with the extension of the forecast period to 72 hours.

We compare regularly the verification of our operational prognostic charts and these of the foreign weather services for the same areas. This has been made possible by a recommendation of the Working Group for numerical prediction in the Aerological Commission of the WMO which urges an exchange of current information on results of scientific research in the field of numerical prediction and on the operational routines of numerical prediction between countries engaged in these activities. In particular, to disseminate operational experience, an exchange of the objective analysis and prognostic charts prepared on the 15th of each month has been established between countries engaged in numerical forecasting. Our country participates in this exchange. It permits us to be informed about the state of numerical weather prediction in other countries and to evaluate the success of our own forecasts on the basis of the world level.

The foreign forecasts received by us are regularly evaluated for Europe and West Siberia. This evaluation is carried out by means of an index ρ_Σ which characterizes the geometrical similarity of prognostic and actual charts. This index is extensively used in verifying the long-range weather forecasts. If the prognostic and actual charts are completely similar $\rho_\Sigma = 2$. If the contour pattern on comparable charts bear no similarity, $\rho_\Sigma = -2$. However, when $\rho_\Sigma \geq 1.2$ the prognostic charts have already practical value. The values of ρ_Σ for the prognostic H_{500} charts, produced in various countries in 1964-65 are shown in TABLE 3.

TABLE 3. Values of ρ_Σ for H_{500} forecasts produced in different countries in 1964-1965

Country Forecasting Centre	24-hour forecasts	48-hour forecasts	Number of forecasts
USSR, Moscow	1.51	1.32	24
U.S.A. Washington	1.49	1.35	14
Japan	1.53	1.34	23
France	1.52	1.30	17
Belgium	1.58	1.32	14
Sweden	1.54	1.39	2

It should be pointed out that these indices characterize not only the quality of various prognostic models of the atmosphere, but also the success of the entire operational numerical prediction procedures including data collection, objective analysis and forecasting.

In 1964, our activities in the field of operational numerical forecasting went, in a certain sense, beyond our territorial boundaries. Reference is here made to the establishment of an exchange of operational meteorological information between Moscow and Washington via a direct communication line. The exchange encompasses the surface and upper air data for the USSR and USA territories and the short and long-range prognostic charts amounting to 20 in a day in both directions.

The operational data received over the direct line from the National Meteorological Center of the U.S.A. at Washington are of considerable scientific and practical interest to us. In particular, we compare regularly our own and the American short-range forecasts for the same areas. The verification percentage of our short-range forecasts is rather close to these of the USA, although the USA uses a numerical prediction model which, from the theoretical point of view, is more precise than ours. Some results of the verification of these forecasts are presented in TABLE 4.

TABLE 4. Relative errors of operational numerical prediction issued by Washington and Moscow for European areas in November and December 1964 and in March and June 1965 (according to W.F. Chernovoi)

Forecast Period	Contour Height of	Moscow	Washington
24 hours	500 mb	0.65	0.61
	300 mb	0.64	0.68
36 hours	500 mb	0.75	0.80
	300 mb	0.68	0.74

Operational Numerical Forecasts in the Future Regional Centres

At the present time, operational numerical predictions are produced not only in Moscow, but also in a number of regional forecast offices which will serve as regional centres in the future.

The Novosibirsk regional weather office utilizes prognostic charts produced by a 5-layer quasigeostrophic model devised by G.P. Kurbatkin, staff member of the Siberian affiliate of the Academy of Sciences of the USSR. The prognostic charts of H_{850}, H_{700}, H_{500} and H_{300} are produced here for the Asian territory of the USSR. The success of these prognostic maps is about the same as for the quasigeostrophic model of the Hydrometeorological Centre. However, an essential feature of Kurbatkin's model is that it also produces the prognostic chart of the surface pressure. It is planned to extend the prognostic chart coverage over the hemisphere.

In Tashkent the prognostic charts are produced with S.L. Belousov's model used in the Hydrometeorological Centre in Moscow. The forecast area encompasses Central Asia, Kazakhstan, East Europe and West Siberia.

The Leningrad Regional Forecast Office produces 24, 48 and 72 hour prognostic charts of H_{500} by I.G. Sitnikov's non-linear one-layer model. (In the past this model was used operationally in the Hydrometeorological Centre). The forecast area encompasses the North Atlantic, Europe and parts of West Siberia. The Leningrad Forecast Office also produces prognostic charts by I.Z. Luftfulin's model (TABLE 1). The prognostic surface pressure and upper air charts are also produced here on an experimental basis, by L.V. Rukhovet's model based on some statistical relationships between the vertical structure of the atmosphere and the future pressure (contour height) fields.

The Rostov on Don Forecast Office produces prognostic maps on an experimental basis utilizing I.Z. Lutfulin's model.

A number of other regional forecast offices are making preparations for going over to numerical weather prediction. However, before taking this step, one must have a clear picture of the difficulties associated with this and realistically evaluate all the existing possibilities. It must be pointed out that basing operational numerical weather prediction on computers belonging to other institutions holds no great promise. Successful operational numerical weather prediction is possible only when the corresponding regional office has a qualified staff and its own computer. The establishment of operational numerical weather prediction is expedient only at regional forecast offices which will not, in the near future, be supplied with facsimile maps by the regional centre, or at forecast offices where the facsimile maps cannot be received before the operational forecasting deadlines. The non-observance of these limiting conditions may lead to an unwarranted splitting of manpower and financial resources without a benefit to the quality of forecasts.

Future Prospects in the Field of Operational Numerical Forecasting

Simultaneously with the application of the present numerical forecasting models in operational routine, designing of new and more promising models is in progress. Let us point out the basic directions in this activity.

In the field of long-range forecasting, efforts are directed to designing:

(1) a model for the numerical prediction of circulation index for different time periods. The prediction of this parameter is necessary for the improvement of some presently applied linear models in which the magnitude of the initial circulation index is considered to remain constant for the entire forecast period.

(2) a numerical medium range weather prediction model which incorporates the radiative and eddy heat transfers.

(3) a hemispheric non-linear multi-level medium range weather prediction model based on the primitive equations.

In the field of short-range forecasting efforts are concentrated:

1. On the improvement of existing and designing of new, more complete primitive equation models incorporating the wind velocity and the non-adiabatic heat transfer. These efforts are carried out in the Hydrometeorological Centre and also in the Siberian affiliate of the Academy of Sciences, USSR where a hemispheric primitive equation model is being developed under the guidance of G.I. Marchuk, Corresponding Member of the Academy of Sciences, USSR.

2. On designing a model for the prediction of non-convective precipitation amount, this model, using the objective analysis data of temperature and dewpoint at two levels of the atmosphere as initial data, predicts the instability energy, the height of the condensation level and the time of the arrival of saturation.

3. On designing models for the numerical prediction of mesoscale meteorological phenomena, including the convective clouds and precipitation amounts.

Simultaneously with this we must carry out basic research on problems which are important from the standpoint of anticipated future developments in the field of numerical prediction. These problems are: the hydro-dynamics of the general circulation of the atmosphere, the atmosphere-ocean interaction, the application of the primitive equations in forecasting and the problems of mesometeorology. Certain difficulties exist in all these directions, the discussion of which is, however, beyond the scope of this article.

It is also necessary to dwell on the role that automation and new computational techniques play in the introduction of numerical prediction models into the operational routine. The adoption of numerical prediction techniques has made automation one of the most paramount scientific and technical problems of our Service.

In speaking of new and more sophisticated numerical weather prediction models, one must bear in mind the exceptionally heavy demands they make on computational technique and to other aspects of automatic data processing. For instance, the computation of a 3-day prediction for the hemisphere, including the objective analysis of initial data even with the simplified (quasigeostrophic) non-linear model requires already $1\frac{1}{2}$ hours machine time instead of the 15 min. required at present in predicting for a limited area for the same period. This time will be considerably longer for a multi-layer long-range prediction model based on the primitive equations. The requirements for the reliability of the computer increase correspondingly. Consequently, a further progress in operational numerical forecasting is possible only when more efficient and reliable computers, with a speed of several hundred thousand operations per second, become available.

In addition, the introduction of hemispheric and primitive equation models into operational routine is impossible without an automatic system that feeds the observational data from the communication lines directly into the computer, since the manual preparation of the great volume of required initial data in acceptable time is completely unfeasible. Finally, in order that effective use can be made of the prognostic charts produced, they must come out of the computer in plotted form and must be transmitted in this form over the communication lines. The first experiments of the Hydrometeorological Centre in producing operationally computer plotted charts have given encouraging results. The Hydrometeorological Centre is also engaged in designing devices which will automatically transfer the data from communication channels into the computer.

INTER ALIA

SPECIALISTS MEETINGS

The week of September 11 to 15 will see two meetings on highly specialized subjects held less than 200 miles apart. The fields are so specialized that attendance is by invitation only.

An "International Research Seminar: Wind Effects on Buildings and Structures" will be held in Ottawa. It will cover recent experimental and theoretical studies in meteorology, aerodynamics and structural engineering pertaining to that subject.

Simultaneously at Chalk River, a meeting of participants of the Atomic Energy Commission (U.S.) micrometeorology research program, and representatives of closely related programs of Canadian and other U.S. agencies will take place. Among the subjects discussed will be dry deposition of pollutants, rise of exhaust plumes from chimneys, and effects of boundary parameters, such as roughness, on the diffusion of pollutants.

CALL FOR PAPERS

The first annual Congress of the Canadian Meteorological Society will be held at Carleton University, Ottawa, on May 24-26. As was the case with the Canadian Branch, Royal Meteorological Society, the Congress will be held with the Conference of Learned Societies.

Papers have been invited in all fields of Meteorology and Atmospheric Physics, but particular consideration will be given to these four general topics:

(a) Upper Atmosphere
(b) Weather Forecasting and Applied Meteorology
(c) Dynamic Meteorology - N.W.P.
(d) Tropospheric Physics

The deadline for receipt of titles and abstracts is March 27, 1967. If you have not already acted, it may be too late. Let us make this first Congress a resounding success. Submit titles and abstracts to:

Dr. J. Clodman
Program Chairman
First Annual Congress, C.M.S.
315 Bloor St. West, TORONTO 5, Ontario

STANSTEAD SEMINARS

Every second year, two weeks of seminars, dealing primarily with topics in the stratosphere and mesosphere, are held at Stanstead College, Stanstead, Quebec. The joint sponsors are McGill University, and the U.S. Air Force Cambridge Research Laboratories. This is the year for them and they will be held the last two weeks of July. Information on the seminars may be obtained from Prof. B.W. Boville, McGill University.

THE PRESIDENT THANKS THE PRESIDENT

Reproduced below is the text of a letter written by Prof. A.W. Brewer, the president of our society, to Dr. G.D. Robinson, President of the Royal Meteorological Society.

"Dear Mr. President:

I write on behalf of the Canadian Branch of the Royal Meteorological Society, which will soon be dissolved, to thank you and Council, and all the Fellows of the Royal Meteorological Society, for the help which Canadian meteorology has received through the existence of the Branch. We are very grateful.

You will recall that at its foundation the Canadian Meteorological Society was acclaimed to be the successor of the Canadian Branch of the Royal Meteorological Society. We expect it to benefit very considerably from this historic connection and in the future we look forward to a long period of co-operation between the two Societies.

I would be glad therefore if you would convey this message of thanks for the past, and hopes for the future, to all concerned. Thank you also for your presence at our annual congress last summer.

Yours very sincerely,

A.W. Brewer."

NEW JOURNALS

Pergamon Press has announced that the JOURNAL OF AIR AND WATER POLLUTION will be divided into two separate publications, one dealing with air pollution and the other with water pollution. The air pollution journal will be entitled ATMOSPHERIC ENVIRONMENT, and will publish papers on all aspects of air pollution research which are of "other than purely local interest".

GREAT LAKES CONFERENCE

The Tenth Conference on Great Lakes Research will be held at the University of Toronto April 10-12, 1967.

As in past conferences, concurrent sessions on physical and biological limnology will be held. This means that the meteorologists will not be subjected to papers on the flora and fauna of the Great Lakes waters. By the same token, the biologists need not fear the spectre of lake-effect storms.

This will be the first conference under the aegis of the newly formed Society for Great Lakes Research. Proceedings of the Conference will be supplied to all members. Non members may purchase copies when they are printed.

CONGRESS ARRANGEMENTS

The chairman of the Arrangements Committee for the Congress, Michael Webb, has advised the Council that:

(a) sessions will be held in Alumni Theatre B in Southam Hall. This theatre seats 225 and is most suitable;

(b) registration will take place in room 300 of Southam Hall;

(c) Campus billetting will be handled by the University. All rooms must be vacated no later than noon, Saturday, May 27;

(d) the banquet-luncheon will be held in the University Dining Hall at 1330, May 25. The cost will be $2.50 per person.

DR. R.R. ROGERS

Dr. R.R. ROGERS has been appointed Associate Professor in the Department of Meteorology at McGill University, Montreal. Until recently a research meteorologist at Cornell Aeronautical Laboratory, specializing in the application of radar to meteorology, Dr. Rogers holds degrees from U of Texas, MIT and NYU. At McGill he takes over teaching responsibilities in physical meteorology in succession to Dr. R.H. Douglas. (Professor Douglas, of course, became Chairman of the Department of Agricultural Physics at Macdonald College of McGill University in 1965, but retains his research interests in the meteorology of severe storms.)

DR. N.H. THYER

Dr. N.H. THYER, a graduate of the Universities of Birmingham and Washington (Seattle), joins the Department of Meteorology at McGill University in Montreal as a Research Associate, with teaching responsibilities in the Graduate Faculty. His major concern is the measurement of winds in the vicinity of severe storms, a field in which he acquired considerable experience in the Coastal Mountains while on the staff of the Institute of Oceanography at the University of British Columbia.

MET. L. RETURNS

GEORGE LEGG, who has acted as Liaison Meteorologist to the Assistant Deputy Minister for Air in Ottawa for the last two years, will be returninto to the Toronto Headquarters about July 1, 1967. His replacement, for the next two years, will be Alec MacVicar.

E.R. WALKER

TED WALKER, who has been associated with the Meteorological Branch since 1943, is leaving to join the Marine Sciences Branch of the Department of Energy, Mines and Resources.

After the Introductory Course and a tour of duty at Whitehorse, TED returned to Toronto for the M.A. Course, and graduated in 1948. After further service at Vancouver, he spent some time at U.C.L.A., and subsequently completed his doctoral studies at McGill. In 1961, he was assigned to the Suffield Experimental Station as a research meteorologist.

His friends and formal colleagues all wish TED a successful second Career in Oceanography.

DR. P.J. BARRY

Dr. P.J. Barry of Atomic Energy of Canada, Ltd., at Chalk River, is going on leave of absence March 4 to join the Scientific Secretariat of the United Nations Scientific Committee on the Effects of Atomic Radiation. He will be in New York until the end of June, and will be returning for three other periods between then and the summer of 1968.

SPOTLIGHT ON THE SOMAS ACGG NRC

The title of this note could have been "Spotlight on the Sub-committee on Meteorology and Atmospheric Sciences of the Associate Committee of Geodesy and Geophysics of the National Research Council". However, the above is a bit mysterious to those who are not "in" and will also fit into the table of contents.

Almost from its beginning, N.R.C. has appointed advisory groups to deal with special problems in various fields. According to their terms of reference, these Advisory Committees "outline the researches, recommend the laboratory in Canada in which they should be conducted, and assess the results." Further, they advise the Council on Canadian participation in the appropriate international unions (e.g. for A.C.G.G., the International Union of Geodesy and Geophysics - I.U.G.G.), and act as channels of communication between Canadian Scientists and the Union.

The Associate Committees have set up sub-committees on individual fields under the chairmanship of a member of the main committee. The Sub-committee on Meteorology and Atmospheric Sciences of A.C.G.G. has two tasks. First, it is Canada's contact with the International Association of Meteorology and Atmospheric Physics (I.A.M.A.P.). Secondly, it examines the current position of meteorological research across Canada, and makes recommendations to the A.C.G.G. regarding such research.

As of April 1, 1967, the Sub-Committee will be made up as follows:

Chairman	:	Prof. W. Hitschfeld, McGill University
Secretary	:	Prof. B. Boville, McGill University
Members	:	J.P. Bruce, Meteorological Service of Canada Prof. R.W. Burling, University of British Columbia Prof. J. Gregory, University of Saskatchewan Prof. K. King, University of Guelph Prof. R. Magarvey, Acadia University Dr. R.E. Munn, Meteorological Service of Canada Dr. P.W. Summers, Alberta Research Council M.K. Thomas, Meteorological Service of Canada Dr. O. Villeneuve, Meteorological Service of the Quebec Department of Natural Resources
by invitation	:	Dr. D.P. McIntyre, Meteorological Service of Canada
ex officio	:	Dr. W.L. Godson, Meteorological Service of Canada

Each year, the Sub-committee arranges for the preparation of the meteorological portion of the N.R.C. "Geophysical Bulletin", a survey of accomplishments and publications in all fields of Geodesy and Geophysics during the past year. As well, it has played a useful role in maintaining liaison between the Universities and the Meteorological Branch. Among its major achievements is the sponsoring of symposia such as the "First Canadian Conference on Micrometeorology".

The upcoming event of most interest is the XIVth General Assembly of I.U.G.G. and of I.A.M.A.P. in Switzerland, September 25 - October 7, 1967. The meteorological sessions will be held in Lucerne and will feature both survey and specialist symposia on a wide range of subjects. Prof. Hitschfeld, as chairman of the Sub-committee, is the I.A.M.A.P. Canadian Correspondent and would be delighted to hear immediately from anyone desiring to present a paper. Program information can be obtained from Dr. W.L. Godson (315 Bloor St. W., Toronto 5), who is secretary of I.A.M.A.P.

MEETINGS

The first meeting for the 1966-67 season of the Toronto Centre of the Royal Meteorological Society was held at 147 Davenport Road on October 5, 1966. The chairman, George Pincock, introduced the new executive and moved a vote of thanks to the last year's executive.

The program for the evening consisted of a panel discussion on the topic "Designing and Using a Meteorological Observing System". The members of the panel were:

Dr. J. Clodman	- Supervisor of Synoptic Research, Research and Training Division
R.E. Vockeroth	- Superintendent, Engineering and Research, Instrument Division
F.B. Muller	- Research Division, Research and Training Division
T.L. Wiasek	- Officer-in-Charge, Toronto Weather Office
B.S.V. Cudbird	- Officer-in-Charge, Data Processing, Climatology Division, Moderator

Following an active discussion of the subject, H. Cameron moved a vote of thanks to the panel and their capable moderator.

Dr. A. Thomson took this opportunity to recall that October 5 is the anniversary of the greatest disaster in British aviation history. On October 5, 1930, the R101 crashed in a heavy rainstorm at Beauvais, France, bringing an end to the development of lighter-than-air aircraft.

At its second meeting of the 1966-67 season, held November 23, at 147 Davenport Road, the Toronto Centre was privileged to hear one of its own members, Dr. R. List, speak on the subject of "New Developments in Hail Research". Prof. List, educated in Switzerland, has been on the staff of the University of Toronto since 1963, where he has directed an energetic program of research on hail with graduate students.

Prof. List indicated that the importance of hail research had been well recognized at international level by the establishment of several committees and sub-committees on this subject, and carrying out of a first project in the U.S., termed Hailswath I; other groups are active in Switzerland and Australia. However, Prof. List indicated that committee reports were as yet unavailable and that scientific publication on this topic has been rather lean in the last two years. He therefore confined his discussion mainly to the research studies in progress at the University of Toronto.

One of the principle studies is an investigation into hailstones themselves. With an excellent set of slides, Prof. List demonstrated how hailstones are constituted; their crystallographic structures, their composition of clear and spongy ice related to density and determined by mean surface area and heat exchange. Included was an ingeniously designed analytical diagram which considered temperature or height against stone diameter, yielding percentage ice content, water availability, the contribution of conduction, convection and evaporation heat in the formative process etc.

A second important study deals with the dynamics of hailstone formation. A single cell theoretical model has been developed and computer-studied using updraft velocities and a distribution of liquid water content with height. It has been shown that maximum hailstones derive from critical sized embryos in the initial low position within the cell. They must be just large enough and no more to assure they will be transported through the water-laden zones higher in the cell. Also, too dense a concentration of embryos will deny large stone development because of too much sharing of the water content. Considering all factors, it has been shown that a most favourable updraft velocity exists for largest growth. This is a departure from belief heretofore that the largest updraft produced largest stones, out of buoyancy considerations.

A third major study underway involves the possibility of modification of hail storms by changing embryo concentration through the introduction of silver iodide.

Active discussion followed Dr. List's talk, with questions on the model relating to assumed limits of supercooling, the part played by re-cycling of stones, and the relationship of hail and lightning.

On behalf of the gathering, Mr. Penner thanked the speaker for his stimulating address.

NOTES FROM COUNCIL

1. The Taxation Division has been approached, but were not encouraging about having C.M.S. fees registered as tax-deductable. They have promised to give the matter further study.

2. At the January 24th meeting, the following were accepted as new members:

J.L. Hegbin	D.G. Massey
N.G. Macphail	F.H. Woodford
F.D. Manning	

3. At the February 22nd meeting, the following were accepted as new members:

C.B. Adamson	R.G. Chapil
C.J.F. Anderson	H.F. Cork
S.R. Anderson	R.W. Drozdiak
P.J.S. Barry	L.J. Klump
J.L. Bergsteinsson	W.G. McKay
Bhartendu	J.E.D. Reid
E.W. Brandon	L.F. White
D.A.F. Carr	G.L. Wolfe

4. The results of the questionnaire that was sent to all members of the Canadian Branch of the Royal Meteorological Society last fall are, up to March 7, as follows:

Questionnaires sent out	-	430
Remaining with R. Met. S.	-	220
Joining C.M.S.	-	315

5. A tentative reprint policy for ATMOSPHERE has been developed. The following will apply until enough experience has been gained to ensure that the service is paying for itself. These rates are lower than those for most other periodicals consulted.

(a) Each author will receive fifty reprints free of charge.

(b) Additional reprints will be available at the following rates provided the order is placed prior to the press run:

(i) the first five-hundred pages cost 4 cents per page

(ii) the next five-hundred pages cost 3 cents per page

(iii) the next five-hundred pages cost 2 cents per page

(iv) all additional pages cost 1 cent each

(v) cover pages cost 3 cents each

(vi) reprints must be ordered in units of fifty

For example, 250 reprints of a seven page article would be

$250 \times 7 = 1750$ pages. The cost would be:

1st 500 pages	-	$20.00
2nd 500 pages	-	$15.00
3rd 500 pages	-	$10.00
remainder	-	$ 2.50
cover page	-	$ 7.50
		$55.00

After some experience, the scale of charges may be modified.

LETTERS TO THE EDITOR

The Editors, "Atmosphere"
Canadian Meteorological Society
315 Bloor St., W.,
Toronto 5, Ont.

Feb. 3, 1967

Dear Sirs:

I would like to suggest that part of each issue of "Atmosphere" be devoted to a general weather summary along the lines of the "Weatherwatch" section of the A.M.S. publication "Weatherwise" - surely now is an ideal time to bring "Canadian Briefs" back home to Canada. In addition, I think that consideration should be given to emulating our wealthy sister society to the south in the production of an annual "almanac" issue in which the most interesting weather events in the previous year are described.

Yours truly,

H.B. Kruger