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CLIMATOLOGICAL BULLETIN

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F O R E W O R D

During the past nine months steps have been taken within the Department of Geography at McGill University to consolidate and expand the programme in climatology which has grown up over the past fifteen years. One aspect of this expansion is the production of a Climatological Bulletin. The purpose of producing such a Bulletin is to provide information on current activities and opportunities within the climatology programme, and also to offer a facility for regular reports on the research being undertaken. With this in view, Climatological Bulletin will be published in January and July each year. Although the Bulletin is intended mainly as a publication medium for those associated with the climatological work of the Department of Geography at McGill University, relevant contributions and correspondence from those who are not direct participants are also invited.

B.J. GARNIER,

Professor of Climatology,
Department of Geography,
McGill University, Montreal.

January 1967.

CLIMATOLOGY AT MCGILL UNIVERSITY

B. J. Garnier*

The Department of Geography at McGill University has been known for its work in climatology for many years. Under the leadership of Professor Kenneth Hare, supported by Professor T. L. Hills, a network of field stations has been established providing opportunities for observations from sub-arctic to tropical locations.

The principal station in the former region is that at the McGill Sub-Arctic Research Laboratory at Knob Lake (55°N) near Schefferville in Labrador-Ungava. This station in its present form opened on October 1st, 1954, taking over the operation of weather observations from the Hollinger Ungava Transport Company which had maintained a station in the area since August, 1948 (Tout, 1964)[1]. Nearer Montreal, records of temperature and precipitation have been maintained since January 1960 by Colonel Baird at Gault House on the McGill University Field Station at Mont Ste. Hilaire (45°N). Observations in tropical environments are available from two stations established by Professor T. L. Hills in Barbados and in Guyana. The former is at Waterford, (13°N), two miles from Bridgetown, and the latter is at St. Ignatius (3°N) in the Rupununi Savanna area. The station at Waterford has been in operation since March, 1959, and that at St. Igantius since early 1962. Data from the former station have been published quarterly since 1959 and from the latter since its inception (Climatic Observations at Waterford, Barbados, Nos. 1 and 2, 1959; Savanna Research Project, Climatic Observations No. 1, 1962-3). An additional observation station connected with the Department of Geography is that operated on Axel Heiberg Island (80°N) by Professor Fritz Müller in connection with his glaciological research, the programme being particularly concerned with the micro-climatological observations necessary for understanding glacial ablation and movement.

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* B. J. Garnier is Professor of Climatology in the Department of Geography, McGill University.

1 Tout, David G. 1964: "The Climate of Knob Lake", McGill Sub-Arctic Research Paper No. 17.

The spatial spread of these field stations reflects the breadth of interest which has in general governed the climatological programme. Reference to the list of graduate theses in climatology given at the end of this article, however, shows that most graduate research within the Department of Geography has been concerned with arctic, sub-arctic, or northern locations, and that much of it has had a distinctly meteorological slant. Only in recent years have theses in tropical topics been presented, many aspects of applied climatology are as yet untouched, and the geographical opportunities for comparative studies provided by the existence of the field network remain to be exploited.

In 1959-60 an independent department of Meteorology was established in the University. Prior to this time preparation for degrees in Meteorology was undertaken either through the Department of Physics or through the Department of Geography. The potential co-operation between Geography and Meteorology which the existence of a separate Department of Meteorology encourages, enables the Department of Geography to concentrate more completely on microclimatological studies, both pure and applied, with emphasis upon their comparative (geographical) aspects and their relationship to prevailing weather characteristics. This is the direction which the climatological programme is now taking.

During 1966 the principal effort in respect of the current programme orientation has been to improve the observational facilities at Mont Ste. Hilaire in order to provide a well-equipped station to form a base near McGill University for graduate training and research. With the support of funds from the National Research Council, the Department of Transport (Meteorology Branch) and McGill University, a well-instrumented field station has now been established on the Gault Estate. Since funds for this station only became available in April, 1966, most of the past summer has been spent in obtaining instruments and preparing the site. Working with the co-operation of Colonel Baird, Director of Field Studies at Mont Ste. Hilaire, and the Mont Ste. Hilaire Committee of McGill University, a level area in an open orchard on the estate was prepared, grassed and fenced. Instruments, some of which were supplied by the Canadian Meteorological Service, and others bought under research grants, were installed during August and September, recording apparatus being connected by cable to the nearby Geophysics hut with the generous co-operation of Professor Geldart and his assistants. Thus, by the end of September regular observations were able to begin, the general supervision of which has been in the hands of Colonel Baird and Richard G. Wilson, a candidate for the M.Sc. degree in Geography (Climatology).

A plan of the station as currently equipped is given in fig. 1, while figs. 2 to 5 provide a selection of photographs to illustrate the site and its surroundings, and also some of the equipment being used. These illustrations show that, in spite of the apparently unique and hilly character of Mont Ste. Hilaire, the station itself is on relatively level land with open surroundings. Its elevation is 680 feet which is approximately 400 feet above the level of the surrounding St. Lawrence plain.

Situated as it is the station can serve the double purpose for which it is intended: a base for field demonstrations and student training, and a location from which to develop specific research activities. Operations in the first of these categories are facilitated not only by the fact that Mont Ste. Hilaire is only 25 miles from Montreal but also by the existence of dormitories and laboratories on the Gault Estate where students can be accommodated and work during field camp periods, at weekends, and other suitable times. The research potential of the station is considerable. Wide topographic variety is found at Mont Ste. Hilaire which provides an excellent opportunity for various forms of microclimatic investigation, while hydrological and related studies may be undertaken at Lac Hertel within the Gault Estate and a short distance from the station. In a wider context the station can act as a bench mark station and basic experimental site for work in the microclimatology and topoclimatology of this part of the St. Lawrence lowland environment. Finally, it is hoped that the presence of the station will be found useful to workers in biological and field sciences who wish to use microclimatic data in connection with their work.

The facilities for field work now available to the climatological programme not only at Mont Ste. Hilaire but also at Knob Lake, Barbados, and elsewhere, provide first-hand information on a number of different climatic environments. These facilities provide a unique opportunity both for basic research investigations within the field of microclimatology and also for comparative studies. They also ensure that the training programme

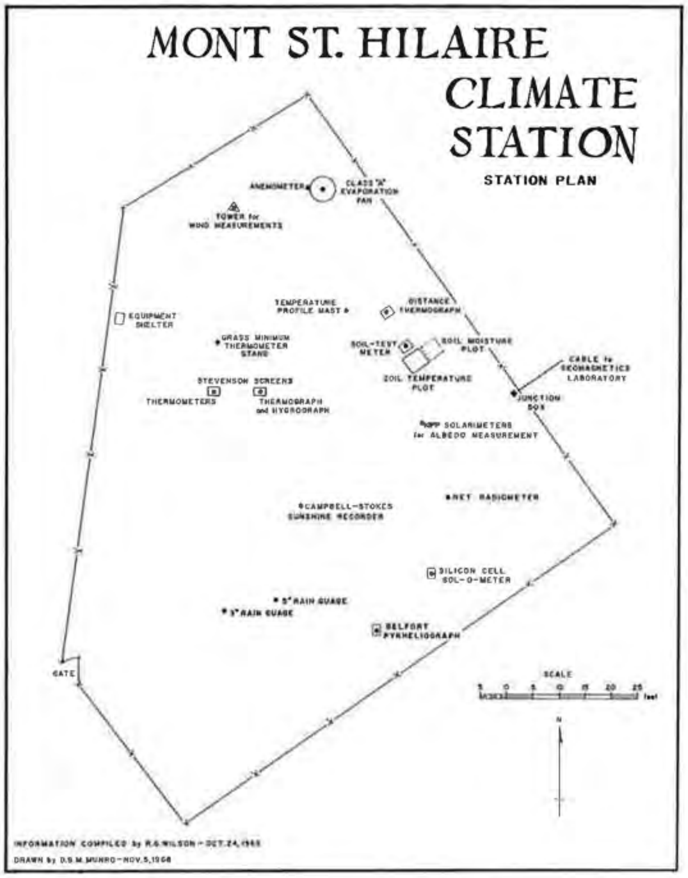

Fig. 1. Map of Mont Ste. Hilaire Observation Site.

Fig. 2. A General View - Mont Ste. Hilaire Observation Site.

Fig. 3. Kipp Solarimeters measuring downward and upward radiation fluxes.

Fig. 4. Temperature Sensing Mast for Distance Thermograph. →

Fig. 5. Class A Evaporation Pan.

at both the graduate and undergraduate levels can made use of research results closely associated with the department, and that students trained in climatology at McGill will have had the opportunity to participate actively in the investigations related to this research.

Within McGill University various roads may be followed by those wishing to undertake graduate work in climatology. The most satisfactory undergraduate preparation consists of either a B.Sc. (Hons.) course in geography or meteorology, or a combination course in meteorology and geography leading to a B.Sc. degree. Although different in detail, each degree course ensures adequate undergraduate training in mathematics and physics as well as in the appropriate coverage of biological work necessary to successful microclimatological specialisation. Within the Geography Department two undergraduate courses are devoted entirely to climatology: a third-year course dealing with the principles of physical climatology and the world climatic pattern, and a fourth-year course centering upon material contained in books such as Geiger: "The Climate near the Ground"; Budyko: "The Heat Balance of the Atmosphere"; and Sellers: "Physical Climatology". At the graduate level there is a seminar in advanced climatology dealing in depth with appropriate aspects of microclimatology, including bioclimatology. Students at this level are also advised into other appropriate graduate courses available in the Geography Department, such as glaciology, geomorphology, biogeography and map and air-photo interpretation, as well as into courses in meteorology, botany, zoology, or physiology according to the intended specialisation and background of the student.

The purpose of this article is to make known the aims and facilities associated with the particular orientation towards microclimatology within the climatology programme of the Department of Geography at McGill University, and to outline the course work leading to degrees with specialisation in the climatological fields. A unique aspect of the programme consists of the opportunity for first-hand investigation in different climatic environments. This facility provides valuable experience essential to the production of high quality climatologists and ensures that a sound basic training in Canadian conditions may be seen in the perspective of a wider framework.

List of Graduate Theses in Climatology

presented in the

Department of Geography, McGill University, since 1960

(Note: Theses presented through the Department of Geography prior to 1960 for degrees in Meteorology are not included).

Montgomery, Margaret R.	The climate of Labrador and its effects on settlement. M.A. 1950.
Bubridge, F.E.	The modification of continental polar air over Hudson Bay - Eastern Canada. M.Sc. 1950.
Orvig, S.	The Climate of the ablation period on the Barnes Icecap in 1950. M.Sc. 1952.
Orvig, S.	Glacial-meteorological observations on icecaps in Baffin Island. Ph.D. 1954.
Gerard, R.D.	Some aspects of Pleistocene and Post-Glacial climatic change in Central Alaska. M.Sc. 1955.
Butzer, K.W.	Some aspects of the Post-Glacial climatic variations in the Near East as considered in relation to movements of population. M.Sc. 1956.
MacFarlane, M.A.	Pressure contour variance and kinetic energy over the Arctic. M.Sc. 1958.
Nebiker, W.A.	Evapotranspiration at Knob Lake, Quebec. M.Sc. 1958.
Wilson, C.V.	Synoptic regimes of the lower arctic troposphere in 1955. M.Sc. 1958.
Barry, R. G.	A synoptic climatology for Labrador-Ungava. M.Sc. 1959.
Powell, J. M.	Climatic conditions affecting the vegetation of the Lake Hazen area, Ellesmere Island, N.W.T. M.Sc. 1959.
Sagar, R.B.	Glacial-meteorological observations in Northern Ellesmere Island, N.W.T. in 1958. M.Sc. 1959.

Shellabear, W.H.	Evaporation at Point Barrow, Summer 1956. M.Sc. 1959.
Larsson, P.	Meteorological observations on the Chamberlin Glacier, Brooks Range, Arctic Alaska, Summer 1958. M.Sc. 1960.
Rayner, J.R.	January temperatures in the Canadian arctic 1000 - 500 mb. M.Sc. 1961.
Jackson, C.I.	The meteorology of Lake Hazen, Ellesmere Island, N.W.T. Ph.D. 1961.
Davies, J.A.	Albedo measurements over sub-arctic surfaces. M.Sc. 1962.
Rouse, W.R.	The moisture balance of Barbados and its influence on sugar cane yield. M.Sc. 1962.
Tout, D.G.	The climate of Knob Lake. M.Sc. 1963.
Smith, S.I.	Climatic control of distribution and cultivation of sugar cane. Ph.D. 1963.
Chia, L.S.	Albedo measurements of various surfaces in Barbados. M.Sc. 1964.
Oguntoyinbo, J.S.	Rainfall variability on Barbados, and its influence upon sugar cane yield. M.Sc. 1964.
Rouse, W. R.	Aspects of a forest microclimate. Ph.D. 1965.
Hill, J.B.	Temperature variability and synoptic cold fronts in the winter climate of Mexico. M.Sc. 1966.
Findlay, B.F.	A hydrologic study in the Knob Lake area, Quebec-Labrador. M.Sc. 1966.
Frost, D.	The climate of the Rupununi savannas. M.Sc. 1966.

MONT STE. HILAIRE CLIMATOLOGICAL RECORDS

P. D. BAIRD*

Since January 1960 records of temperature and precipitation have been kept at Gault House, Mont Ste. Hilaire. The station is a "climatological station" (No. 501) in the Canada-wide network, reporting weekly to Quebec and thence, monthly, to Toronto.

The station, known as Mont Ste. Hilaire Gault, is at 570 feet above sea level and within 50 yards of the south shore of Lac Hertel, which is 80 acres in extent. The altitude and the lakeside situation naturally have effects on the local climate as opposed to that of the plain below. The average monthly temperature is always close to 3°F lower than recorded on McGill's Montreal campus. One degree of this can be attributed to difference in altitude, the other two degrees to "city heat". This is particularly noticeable in winter when a clear calm night drops the country temperature sharply compared to that of the city with its blanket of smoke and haze. In summer at Mont Ste. Hilaire the lake and the surrounding tree cover have a moderating effect on the highest temperatures. On only two days in seven years has the shade temperature exceeded 90°F, whereas at McGill there have been ten such days (five of them in July 1963). Precipitation is more variable. On the average, Mont Ste. Hilaire has had a little more rainfall and about 15 inches more snow fall per year than McGill. Much of the summer rain comes in heavy thunder-showers, the paths of which across the St. Lawrence Valley and lowlands are quite erratic. In August 1966, for example, rainfalls as follows were recorded locally:

Ste. Anne de Bellevue	3.33 inches
Dorval Airport	4.78 "
Montreal (St. Jean de Brebeuf)	3.25 "
McGill Campus	4.13 "
Mont Ste. Hilaire Gault	3.25 "
St. Hubert Airport	4.27 "

* P. D. Baird is Director of Field Studies in the Department of Geography, McGill University.

The difference in rainfall between McGill and Mont Ste. Hilaire is almost exactly accounted for in the thunderstorms of the afternoon of August 16th and the morning of the 17th.

In the seven years of observations at Gault House there have been 26 days with more than one inch of precipitation during one climatological day, a twenty-four hour period, which runs from 8 a.m. to 8 a.m., plus 6 days with more than ten inches of snow. 1963, the wettest year of the seven, provided more than the average including the storm on September 12th which was accompanied by a tree-felling wind and produced 1.88 inches of rain. But the most spectacular storm was that of 25/26 February, 1961, when an inch of rain (plus 1 and 1/2 inches of snow) fell at below freezing temperature. This caused widespread tree damage, probably caused the evacuation of all the deer on the mountain, to which they have not yet returned, and brought on a ninety-six hour electric power blackout. No climatological day has yielded more than 2 inches of precipitation, although there have been two twenty-four hour periods when this amount has just been exceeded.

Snow depth on the ground has been very variable over the seven years. The maximum depth recorded has been 44 inches on 7th March, 1963 (after a twenty-four hour snowfall of 12 inches) and the average maximum is 32 inches. Snow depth on the ground is particularly interesting in respect of the conditions it provides for skiing. From this point of view, winters have yielded the following results

Year	Snowfall	Ski conditions
1959/60	124 inches	very good
1960/61	97 inches	good
1961/62	119 inches	very good
1962/63	135 inches	very good
1963/64	82 inches	bad (max. snow depth 19")
1964/65	78 inches	bad (max. snow depth 20")
1965/66	120 inches	good, but snow late to arrive.

During the last three summers a tipping-bucket recording rain gauge has been in use to record rainfall intensities, but no very sensational results are yet apparent.

Since October 1960 weekly records of maximum and minimum temperatures have been kept in a screen on the top of "Sunrise Peak", 1330 ft. above sea level, on the Mont Ste. Hilaire estate. For the last three years, with some gaps due to instrumental difficulties, a thermograph has also been installed here. The results, which have not been intensively analysed, show a mean temperature at this altitude slightly higher than would be expected from adding the standard lapse rate to Gault House figures (760 feet below). The main interest has been to observe the inversions of temperature, which have amounted to as much as $13^{\circ}F$ between the stations. It is the frequency of such inversions, particularly in winter, which yields the unexpected difference mentioned above.

In September 1966 a second meteorological site was levelled in the orchard at a height of 680 feet. Early analysis of the observations at this station shows that it may be a little more "continental" than Gault House with slightly higher maximum temperatures and lower minima. The station was established at this location because around the Gault House area there is not enough open cleared space in which to site additional instruments.

The climatic records to date have been used for a variety of purposes (among others answering queries from local insurance adjusters!). They have, for example, formed the basis for certain research projects, such as an inquiry into the micrometeorology of the forest area and an investigation into the hydrology and limnology of Lac Hertel. The much more detailed and sophisticated observations which will be made at the new site will be helpful to many future projects in the biological fields as well as in the naturally associated fields of meteorology and climate.

Selected Climatic Data for Mont Ste. Hilaire Gault

Seven Year Averages (1960-66)

Table 1

Temperature (^{o}F)

	Mean	Warmest		Coldest	
Jan	12.9	20.0	(1964)	7.5	(1961)
Feb	14.8	20.5	(1960)	7.7	(1963)
Mar	26.4	29.4	(1962)	22.1	(1960)
Apr	39.9	40.7	(1960)	39.0	(1962)
May	54.7	59.6	(1960)	50.7	(1966)
June	63.4	64.6	(1963)	61.7	(1961)
July	66.4	68.6	(1963/4)	63.2	(1965)
Aug	64.1	66.0	(1961)	61.5	(1963/4)
Sept	56.9	63.9	(1961)	53.1	(1963)
Oct	46.9	52.6	(1963)	44.4	(1965)
Nov	35.3	38.6	(1966)	30.4	(1965)
Dec	18.8	23.3	(1965)	10.0	(1963)
Year	41.7				

Table 2

Rainfall (inches)

	Total	Wettest		Driest	
Jan	0.82	2.93	(1964)	0.05	(1961)
Feb	0.82	2.04	(1961)	nil	(1963/4)
Mar	0.92	1.57	(1966)	nil	(1965)
Apr	2.44	3.35	(1963)	0.62	(1966)
May	2.42	3.32	(1960)	1.76	(1966)
June	2.74	4.18	(1966)	1.10	(1965)
July	4.03	5.69	(1962)	2.36	(1966)
Aug	5.01	7.93	(1963)	2.30	(1960)
Sept	3.10	4.82	(1963)	0.88	(1961)
Oct	3.02	4.30	(1960)	0.52	(1963)
Nov	2.67	4.72	(1963)	1.13	(1961)
Dec	0.94	2.62	(1966)	0.13	(1960)
Year	28.90	30.98		25.35	1964

Table 3

Snowfall (inches)

	Total	Heaviest		Lightest	
Jan	21.8	38.4	(1966)	15.3	(1961)
Feb	22.8	43.4	(1960)	5.6	(1961)
Mar	17.4	23.4	(1961)	8.6	(1965)
Apr	7.4	23.2	(1961)	0.3	(1965)
May	2.5	12.0	(1963)	nil	
Oct	1.8	7.0	(1962)	nil	
Nov	9.2	22.4	(1965)	2.2	(1966)
Dec	23.8	34.6	(1962)	15.4	(1965)
Year	106.8	125.5	(1962)	80.8	(1964)

Table 4

Total Precipitation (inches of rain equivalent)

	Total	Most		Least	
Jan	3.00	4.47	(1964)	1.58	(1961)
Feb	3.09	5.19	(1960)	1.72	(1964)
Mar	2.66	3.46	(1960)	0.86	(1965)
Apr	3.18	5.33	(1961)	0.93	(1966)
May	2.67	3.80	(1963)	2.06	(1966)
June	2.74	4.18	(1966)	1.10	(1965)
July	4.03	5.69	(1962)	2.36	(1966)
Aug	5.01	7.93	(1963)	2.30	(1960)
Sept	3.10	4.82	(1963)	0.88	(1961)
Oct	3.20	4.94	(1962)	0.52	(1963)
Nov	3.59	6.31	(1963)	1.47	(1962)
Dec	3.32	5.42	(1966)	1.77	(1963)
Year	39.58	42.92	(1963)	33.43	(1964)

Table 5

Miscellaneous

	No. of days with measurable precipitation	No. of days with thunderstorms	No. of days Max. temp over 80°	No. of days Min. temp below 0°
Jan	16	-	-	11
Feb	15	-	-	9
Mar	12	-	-	1
Apr	14	1	-	-
May	14	3	2	-
June	11	6	5	-
July	13	8	5	-
Aug	15	6	3	-
Sept	11	2	2	-
Oct	13	1	-	-
Nov	15	-	-	-
Dec	21	-	-	5
Year	169	27	17	26

A PRELIMINARY REPORT ON TOPOCLIMATIC RESEARCH AT MONT STE. HILAIRE, P.Q.

Wayne R. Rouse*

A study into the microclimatic variations on north-facing and south-facing forested hillsides of an average 30° slope was instituted in the spring of 1966 on Lake Mountain at Mont Ste. Hilaire, Quebec. The project will continue through the summer of 1967. Research aims are to study the heat and water balances on north and south slopes through summer, fall, winter and spring periods.

During the summer of 1966 sustained measurements of solar and net radiation and periodic measurements of temperature and humidity profiles were taken with instruments mounted on 70 ft. towers which were erected on each of the hillslopes. In addition, complete seasonal changes in soil moisture were monitored by employing gravimetric techniques and soil moisture cells. Soil profile temperatures and air temperatures beneath the canopy have been measured for periods spanning the summer solstice and fall equinox and will be continued for the winter solstice and spring equinox. Precipitation both above and beneath the forest canopy is being measured continuously.

Plans for winter-time research during 1966-67 include snow depth and density measurements along lines running over the north-facing and south-facing slopes. Snow stakes will be placed in both systematic and random spacing to obtain snow depths, while density measurements will be made with a snow sampler. In addition, time-temperature-density measurements will be made at specific locations along the snow course. Special attention is to be given to the micro-climatic factors influencing snow accumulation, compaction and rates of snow melt, and to the freeze-thaw cycles on each of the hillslppes.

* Wayne R.Rouse is Assistant Professor of Climatology, Queen's University.

During the spring and summer of 1967 concentrated studies on specific aspects of the heat and water régimes will be undertaken. In particular an attempt will be made to assess the non-vertical increment of rainfall on each slope during storm periods when the wind direction appears to affect differentially the amount of rain reaching the slopes. The downslope movement of water within the soil will be examined with respect to its influence on the soil moisture régime. An attempt will be made to determine optimum positions for radiation, temperature and humidity sensors above the forest crown.

The few results which have been examined to date are based only on some preliminary data analyses and are subject to revision. In the spring the soil moisture differences between slopes were large showing 12 cm. more moisture in north than in south slope soils. These differences decreased to 8 cm. at the summer solstice and 5 cm. at the beginning of August. At the time of writing (October 1966) the range appears to be increasing once again showing a 10 cm. difference between slopes by mid-September. There is apparently a substantial seasonal change in the moisture stress on each slope which may be linked closely with the sun's height and the magnitude of the solar radiational flux. At the summer solstice substantial defferences in soil temperatures and beneath-canopy air temperatures were observed between slopes. These differences increased downward, with the air temperature near the soil surface showing up to $2^{\circ}C$ higher values on the south slope than on the north and soil temperatures at the 45 cm. depth giving readings up to $4^{\circ}C$ greater. As yet the data for the above-canopy radiation fluxes and water vapour and temperature profiles have not been examined thoroughly.

The writer is indebted to the effort and ingenuity of Richard Wilson and Scott Monroe in contributing to this research work, to Jim Gardner who will direct the snow studies and to Colonel P.D. Baird and Professor Garnier for their ready aid and cooperation. The generous financial assistance of the National Research Council is acknowledged.

NOTES ON RADIATION AND SUNSHINE AT MONT STE. HILAIRE

(a) Comparative Solar Radiation Measurements for the Period August to November, 1966, at Mont Ste. Hilaire, by Richard G. Wilson*

Incoming solar radiation at Mont Ste. Hilaire is being measured by three different instruments. A Kipp-Zonen solarimeter is used as a standard[1/] to test a Belfort pyrheliograph and a Yellott Mark IV Integrating and Indicating Sol-A-Meter.

The purpose of the testing is to examine the accuracies of response of the pyrheliograph and the Sol-A-Meter since each has special characteristics. The Kipp-Zonen solarimeter provides an accurate measurement but it requires a separate stationary recorder and manual analysis of records is time-consuming. The pyrheliograph is a relatively inexpensive, portable, and self-recording instrument which is excellent for field use. The Sol-A-Meter has the advantage that it integrates internally the radiation received (using a Ferranti mercury bath integrator) so that radiation totals are easily calculated.

The Kipp-Zonen solarimeter sensor is a fourteen element constantin-maganin Moll thermopile, the Belfort pyrheliograph uses a bimetallic sensor and the Sol-A-Meter sensor is a gridded silicon cell. All three instruments measure radiation with wavelengths between 0.3 and 2.0 microns.

A comparison of the Kipp-Zonen and pyrheliograph daily totals is shown in Fig. 1. The pyrheliograph mean daily total showed a deviation of -4.5% compared to that of the Kipp-Zonen. There appears to be very good agreement except for two days when the Kipp-Zonen recorded about 550 ly and the pyrheliograph recorded some 14% less. A calibration of the pyrheliograph during the summer of 1966 showed no such peculiarities in this region. A

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* Richard G. Wilson is a candidate for the M.Sc. degree in Geography (Climatology) at McGill University. He completed his B.Sc. degree in Geography and Meteorology at McGill in June, 1966.

1/ Unfortunetely, the Kipp-Zonen sensors were destroyed during an intense lightning storm at the beginning of October.

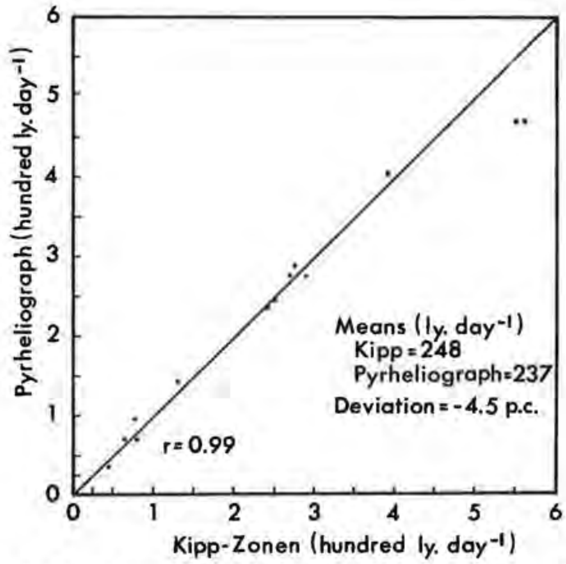
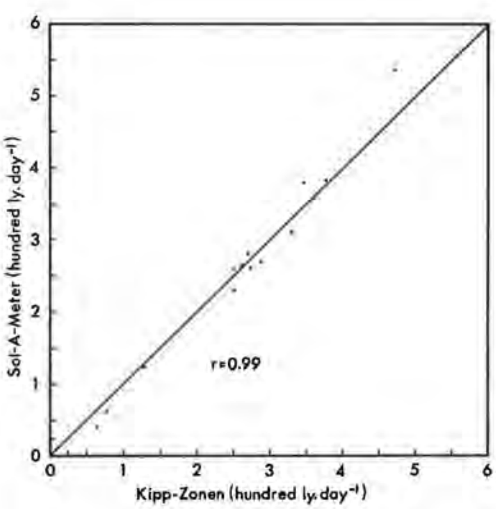


Fig.1 Comparison of Kipp-Zonen and Pyrheliograph For 13 Days Between Aug. 28 and Oct. 2, 1966



Sol-A-Meter Calibration 1 Amp. Hr = 306 ly.

Fig. 2 Comparison of Kipp-Zonen and Sol-A-Meter For 14 Days Between Sept. 20 and Oct. 3, 1966

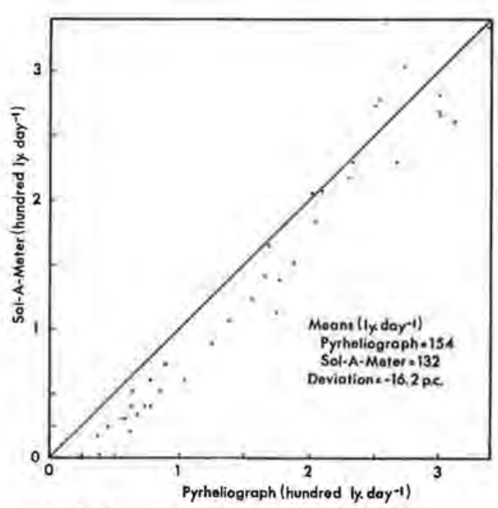


Fig.3 Comparison of Pyrheliograph and Sol-A-Meter For 39 Days Between Sept. 22 and Nov. 13, 1966

further error in the pyrheliograph totals is the manual analysis errors, estimated to be about ± 5%.

A similar comparison of the daily totals of the Kipp-Zonen and the Sol-A-Meter is shown in Fig. 2. The fourteen day total of the Kipp was used to calibrate the Sol-A-Meter; the calibration was 1 ampere hour = 306 langleys (the calibration provided by the manufacturer was 1 ampere hour = 240 langleys). It will be noted from Fig. 2 that agreement was fairly good over this period.

Finally, a comparison of the pyrheliograph (values corrected by +4.5%) and the Sol-A-Meter (calibration: 1 amp. hr. = 306 ly) is shown in Fig. 3. The performance of the Sol-A-Meter was entirely unsatisfactory with a deviation of mean daily totals of -16.2%. As well, the instrument showed extreme variation throughout the range of values. The instrument's integrator completely failed to respond to sunshine on November 27 following several overcast days, so it is possible that the integrator had been malfunctioning for an indeterminable period and thus destroyed any calibration which had been produced.

In summary, the Belfort pyrheliograph appears to respond with good accuracy when compared to the Kipp-Zonen solarimeter. The response of the Yellott Sol-A-Meter was unsatisfactory in these tests but another series will be done when the instrument has been repaired.

(b) Correlation of Solar Radiation and Sunshine Duration for Station Mont Ste. Hilaire, October-December, 1966, by Atsumu Ohmura*.

The present study is summarized as follows:

(1) The regression lines for October and November are very similar in that they show equally high correlation coefficients. This implies that sky conditions are also similar in both months. December, on the other hand, reveals markedly different condition, as compared with the two previous months.

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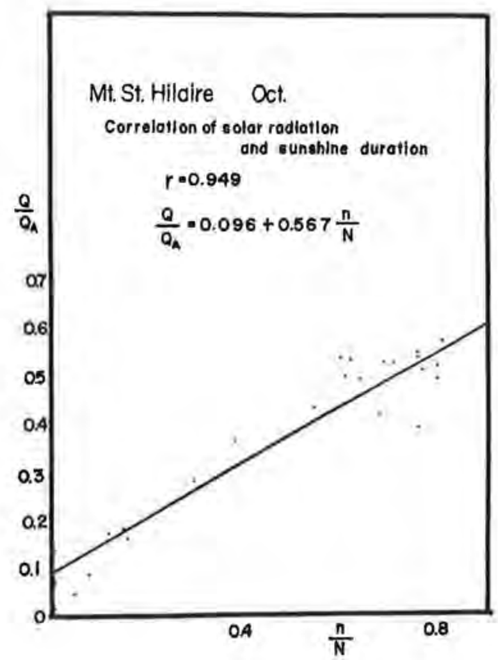
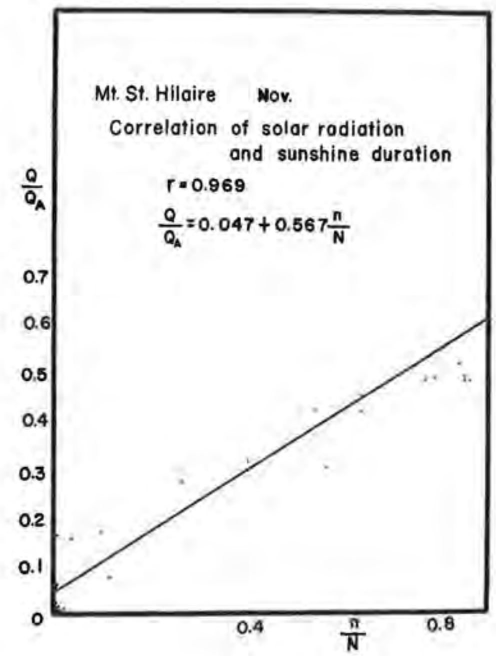
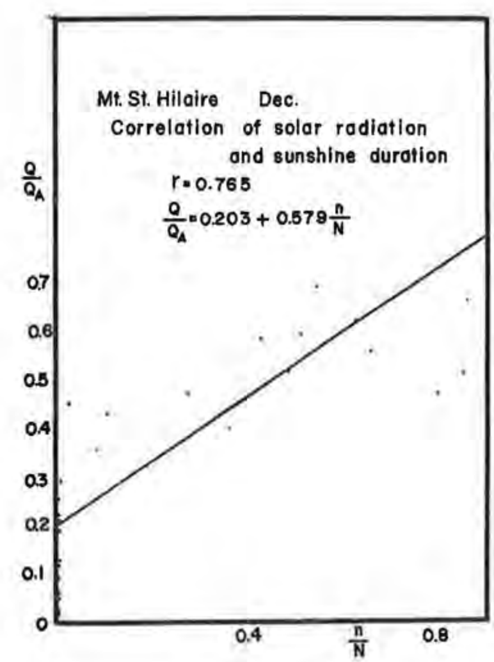
* Atsumu Ohmura is a candidate for the M.Sc. degree in Geography (Climatology) at McGill University. He joined the McGill programme in September 1966 and holds the B.Sc. degree from the University of Tokyo.


Mt. St. Hilaire Oct.
Correlation of solar radiation and sunshine duration
r = 0.949
$\frac{Q}{Q_A} = 0.096 + 0.567 \frac{n}{N}$
$\frac{Q}{Q_A}$
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.4
$\frac{n}{N}$
0.8


Mt. St. Hilaire Nov.
Correlation of solar radiation and sunshine duration
r = 0.969
$\frac{Q}{Q_A} = 0.047 + 0.567 \frac{n}{N}$
$\frac{Q}{Q_A}$
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.4
$\frac{n}{N}$
0.8


Mt. St. Hilaire Dec.
Correlation of solar radiation and sunshine duration
r = 0.765
$\frac{Q}{Q_A} = 0.203 + 0.579 \frac{n}{N}$
$\frac{Q}{Q_A}$
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.4
$\frac{n}{N}$
0.8

For correct interpretation of the graphs, it should be noted that the Campbell-Stokes sunshine recorder and the actinograph read too low values, because of weather influences (snowfall, glaze, etc.). The reason for this is that, if it snows, the recording charts and the glass globe of the sunshine recorder are often covered with snow so that a measurable burn is prevented. The actinograph, however, would still give some amount of radiation under similar conditions. It is the more pronounced weather influences in December which are responsible for the rather low correlation coefficient in that month.

(2) The frequency distribution of the ratio n/N shows two marked peaks both for October and November. This implies a sky liable to either clear or completely cloudy weather indicative of cyclones and anticyclones alternatively migrating over the area. But in December, the frequency distribution shows only one peak at very small n/N values. This negative skewness of the frequency curve is caused by the above mentioned weather influences.

(3) Although straight regression lines were constructed through the distribution of dots, the actual plotted values rather suggest convex upwards graphs. This convex tendency implies that the obstruction of solar insolation occurs mainly in the early morning and late afternoon hours, when the sun's altitude is rather low. The obstruction is caused by two major factors firstly, the topography around the station and secondly the thickness of the air mass, both of which can weaken the insolation. This convex trend is strongest in December owing to the low sun paths.

(4) Thus, for October and November, we can safely estimate the insolation values from sunshine duration records. But as suggested by the low correlation coefficient for December, the same way of estimation in this month gives rather inaccurate results.

MONT STE. HILAIRE STATION

SELECTED CLIMATIC DATA

October, 1966

Day	Air Temp. °F Max.	Air Temp. °F Min.	Precipitation Ins. Rain	Precipitation Ins. Snow	Sunshine hours	Radiation langleys/day
3	56.0	37.0	T	nil	4.1	204
4	56.0	42.0	.23	nil	0.0	40
5	53.0	48.0	.03	nil	6.6	99
6	52.0	36.0	nil	nil	7.2	267
7	63.0	41.0	nil	nil	7.0	286
8	68.0	49.0	.09	nil	8.3	291
9	70.0	52.0	nil	nil	7.5	277
10	62.0	41.3	.08	nil	0.4	24
11	50.6	40.6	.23	nil	1.3	89
12	46.2	38.5	.01	nil	1.7	70
13	51.9	39.5	nil	nil	8.9	261
14	57.6	46.7	nil	nil	0.1	84
15	63.6	51.1	.14	nil	5.7	209
16	56.8	35.0	nil	nil	2.9	M
17	56.8	36.0	nil	nil	2.9	137
18	40.0	34.5	nil	nil	0.7	41
19	41.9	34.1	T	nil	nil	49
20	43.7	35.7	0.68	T	M	2
21	42.2	31.2	0.24	T	M	31
22	56.3	34.9	nil	nil	6.7	226
23	59.7	44.9	nil	nil	7.8	237
24	61.3	38.6	nil	nil	6.4	238
25	58.3	37.3	nil	nil	8.2	236
26	50.1	32.2	nil	nil	8.5	214
27	51.0	31.9	nil	nil	8.2	219
28	57.0	35.0	nil	nil	8.6	240
29	58.9	44.5	nil	nil	7.0	175
30	44.9	21.0	T	T	M	7
31	29.8	19.0	T	T	7.6	159

MONT STE. HILAIRE STATION

SELECTED CLIMATIC DATA

November, 1966

Day	Air Temp. °F Max.	Min.	Precipitation Ins. Rain	Snow	Sunshine hours	Radiation langleys/day
1	55.7	42.4	0.08	nil	nil	22
2	67.0	55.1	0.16	nil	4.0	120
3	63.1	32.5	0.45	nil	1.1	27
4	38.3	25.3	nil	TR	5.6	111
5	39.1	30.3	nil	nil	6.0	154
6	37.0	30.2	nil	0.9	0.3	58
7	43.3	34.9	0.06	nil	2.5	99
8	49.7	41.1	0.25	nil	nil	nil
9	55.1	45.1	0.88	nil	nil	nil
10	60.9	39.8	1.08	nil	nil	17
11	47.7	38.4	TR	nil	5.0	144
12	43.2	24.2	TR	nil	nil	19
13	30.2	21.2	nil	nil	8.0	161
14	36.6	25.3	nil	0.2	0.8	55
15	30.3	18.3	nil	0.2	5.8	147
16	35.6	19.9	nil	0.7	nil	nil
17	37.2	27.1	0.26	nil	nil	2
18	45.9	21.2	M	nil	nil	nil
19	25.0	18.3	nil	nil	7.8	149
20	31.8	16.7	nil	nil	7.8	149
21	33.9	22.5	nil	nil	7.6	159
22	42.8	29.7	nil	nil	7.0	145
23	47.5	34.7	0.08	nil	7.1	145
24	46.1	38.1	0.07	nil	nil	nil
25	52.5	40.5	0.36	nil	nil	nil
26	43.9	37.6	nil	nil	nil	2
27	52.1	41.9	nil	nil	6.0	158
28	61.5	48.1	0.02	nil	6.8	144
29	55.8	33.1	nil	nil	3.8	M
30	39.4	27.1	nil	nil	nil	45

MONT STE. HILAIRE STATION

SELECTED CLIMATIC DATA

December, 1966

Day	Air Temp. °F Max.	Min.	Precipitation Ins. Rain	Snow	Sunshine hours	Radiation langleys/day
1	29.8	11.4	nil	3.7	nil	27
2	12.9	5.2	nil	0.3	3.2	108
3	11.1	1.4	nil	0.2	0.7	96
4	20.5	3.5	nil	nil	7.3	179
5	28.4	20.9	nil	0.4	2.3	127
6	33.6	22.8	0.50	nil	6.8	126
7	42.9	33.2	0.56	nil	nil	5
8	51.5	42.9	0.28	nil	nil	14
9	54.5	40.1	0.35	nil	nil	58
10	51.4	30.0	0.36	nil	nil	17
11	30.9	14.4	nil	nil	1.6	83
12	20.8	12.5	nil	nil	7.2	132
13	23.7	14.8	M	M	4.1	133
14	28.3	11.4	nil	nil	0.1	76
15	22.3	11.0	nil	nil	5.5	143
16	34.5	22.4	0.01	0.1	nil	48
17	37.0	32.1	0.14	TR	nil	31
18	35.0	-0.2	nil	0.1	nil	6
19	9.4	-0.7	nil	nil	7.0	M
20	22.3	3.7	nil	nil	5.2	162
21	23.8	15.6	nil	nil	nil	66
22	23.1	3.0	nil	0.5	nil	52
23	9.6	0.9	nil	TR	3.6	146
24	21.3	9.5	nil	6.0	4.3	149
25	22.3	12.1	nil	12.0	nil	32
26	20.5	6.1	nil	0.2	0.2	114
27	18.0	0.2	nil	nil	0.9	110
28	25.5	2.8	nil	6.0	4.6	176
29	25.9	14.5	nil	5.0	nil	M
30	17.2	6.6	nil	nil	5.5	M
31	23.8	11.4	nil	0.4	3.4	M