Chinook

VOL. 1 NO. 2 JANUARY 1979

Launching Mini-T-Sonde, for Temperature and Wind Observations in Lower Atmosphere.

U2A Wind Speed and Direction Measuring System – Toronto International Airport.

Chinook January 1979 Volume 1 Number 2

Articles

Departments

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THE COVER

The flaring cirrus from the anvil of a winter cumulonimbus cloud catches the eye in this picture taken by *Arjen Verkaik*. His vantage point was a location near Newmarket, Ontario, and the photograph was taken at 10 a.m. on October 17, 1974 looking northwards towards Lake Simcoe. An early outbreak of Arctic air flowing across the Great Lakes region produced a street of cloud which typically stretches downwind from open water (in this case Lake Simcoe) in a narrow ribbon. The ground is already snow-covered and snow showers can be seen falling from the distant cumulonimbus as well as from a smaller cumulus cloud in the middle distance. The interaction between cold winter air and an underlying warmer water surface frequently produces snow squalls far more intense than shown here, but the essential configuration of a narrow line of cloud, bordered on both sides by clear sky, is graphically illustrated. For more on this phenomena see WINDOW ON WEATHER, page 17. This beautiful photograph is all the more remarkable by virtue of the fact that Mr. Verkaik, an amateur sky photographer with an extensive collection, is legally blind, with only 10% vision in one eye. His address is, Box 342, Islington, Ont., M9A 4X3.

FALSE STATEMENT WILL HARM INDUSTRY

First, congratulations on your Vol. 1, No. 1, issue of **Chinook**. The magazine is well organized and well presented. We particularly enjoyed the article **Wind Power Generation in Ontario**, although we disagree emphatically with the comment near the end of the article on p. 7 which stated that "the smallest unit (blade diameter 4.6 m) is unable to fully provide for the needs of a home with a 12,000 kWh per year demand anywhere in the province." This is indeed a false and erroneous statement and will do nothing but harm our industry. Power productivity from the wind is not only a function of design parameter, but is directly related to machine elevation, siting, living habits and particular demand for that home. For example, a horizontal axis aerogenerator four metres in diameter may produce 10,000 kWh per year in one location, and 20,000 kWh in another, depending upon wind conditions. Furthermore, the power requirements in one home may be 7,000 kWh per year, while in an identical home but with different living habits, the requirement may be 30,000 kWh per year. In our opinion, therefore, a retraction or clarification of that statement made in that particular article should be included in your next issue. There are also other areas within the article that we have strong reasons to disagree with you. We are taking the liberty of sending a copy of this letter to the originator of that particular document at the Atmospheric Environment Service.

Philip E. Coulter, P. Eng.
President,
Winflo (Canada) Limited.
Markham, Ontario.

(The document referred to by Mr. Coulter is, ***A Climatological Review of the Potential for Wind Power Generation in Ontario*** *by T. Eschle and M. Pennyfather. In an abridged version, this appeared under the title* ***Wind Power Generation in Ontario*** *in* **Chinook**, *Fall 1978. The Atmospheric Environment Service's reply (in part) to Mr. Coulter follows. Ed.)*

Continued p. 26

THE NATURE OF SNOWSQUALLS

By Roger Smith

Although beset by their own brand of blizzard, inhabitants of the prairies, and most Quebeckers are spared from snowsqualls — a winter phenomenon which is one of the most prolific of all snow producing storms in Canada. The more vigorous variety can even generate lightning and thunder as well as continuous heavy snowfall which typically accumulates at the rate of 4 or 5 cm per hour. From a viewpoint in space (see satellite photos next page), they can be easily distinguished by their banded formation. This unique structuring is the result of arctic winds blowing across a relatively warm underlying water surface. After a short trajectory across the water, the frigid air is quickly saturated and the resulting clouds are formed into a streamline or ribbon by the wind. In a flow transverse to the predominant axis of the water basin, multiple bands are formed (photos 2, 3, 4), while in the case of a flow parallel to the main axis, a few major cloud bands develop (photo 1, and photo below).

Overall, these ribbons of snow-producing cloud are several hundred kilometres long but only a few kilometres wide, and their orientation is highly dependent upon the direction of the wind. Most frequent and intense during the early winter when the contrast between the temperature of the warm water surface and the cold air is at its greatest, snowsqualls form over any fairly large body of water. Over the continental landmass, the air may be crisp and clear, but downwind from the large Manitoba lakes, Lake Nipigon, the Great Lakes and the Gulf of St. Lawrence, as well as more northern waters, long streets of snow are deposited by the wavering snowsquall cloud streams.

For as long as the wind continues to blow, the snowsqualls will continue to form. However, not every cold air mass in winter is capable of producing "lake induced" snowfalls. Some are too "stable", a term which means that warmer air is subsiding from high altitudes which in turn prevents the moisture from the water surface rising high enough to trigger the snow showers. Some air masses produce only very light winds which do not have enough energy to move the evaporated moisture inland. In other cases, winds above the surface change direction at various levels, and this shearing action literally tears apart any snowladen clouds that might form.

The banded structure of snowsqualls cloaks a dangerous threat to unwary highway travellers. Because the sky between the bands is bright, clear, and snowfree, stretches of highway in such areas are often bare and dry, and visibility is unlimited. Along highways which intercept a number of bands, (usually roads aligned north-south and thus more or less perpendicular to the prevailing winter wind), a traveller conditioned to the good road surface and unhindered driving in the cloud-free zone can suddenly encounter blinding snow, with near zero visibility and deep snow drifts. In March, 1973, just such a situation prevailed south of Barrie, Ontario, and resulted in a traffic pile-up and a 12-fatality accident.

In snowbelt areas, the annual snowfall can average as much as 350 cm, 60 to 65% of which is caused by snowsqualls and the remainder by the large, well organized storms which travel across North America. This abundance nurtures an important and thriving winter tourist and recreation industry, particularly in the area surrounding the Great Lakes. Living in the snowbelt as I have done, can be an exciting winter experience — when your furnace has a good supply of oil, or your stove has sufficient wood ready cut.

Roger Smith is a climatologist and the Manager, Weatherwatch Forecasting Program, Meteorological and Environmental Planning Company.

COURTESY AES

PHOTO (left). A REMARKABLY CLEAR PICTURE OF THE GREAT LAKES AREA taken March 22, 1976. The sky is clear everywhere except for the two major snowsquall streams across Lake Huron, and the clouds downwind from Lakes Erie and Ontario. Much of Georgian Bay is still choked with ice, but note the streak of fresh fallen snow from a recent snowsquall band (since dissipated) which evidently formed over the open water parallel to the Bruce Peninsula and then carried on across the shore of Nottawasaga Bay and southeastwards. The two lake Huron snowsquall streams have their origin at a point commonly observed as a generating location, north of the Michigan Peninsula.

WINDOW ON WEATHER

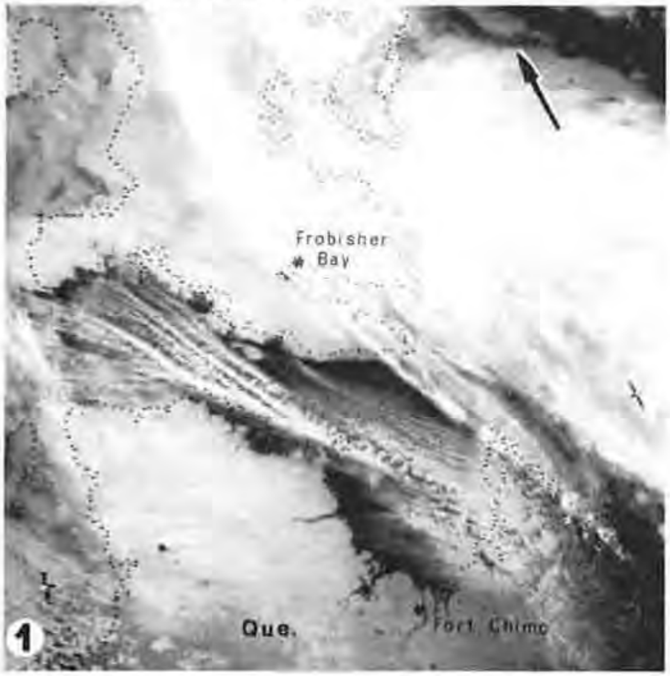
From an orbit 1400 km above the earth, the NOAA 5 weather satellite photographs snowsquall streams. The banded structure of the snow-laden clouds is usually masked from an earth-bound observer by the lack of perspective. It is only when we can step well back from the earth, so to speak, using the satellite as our eyes, that the true nature of this meteorological marvel is revealed.

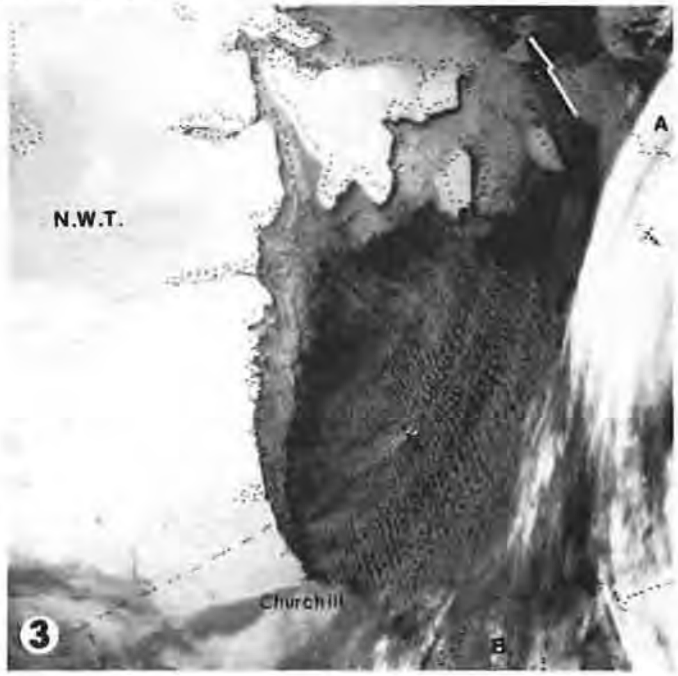
FIG. 1. A FEW MAJOR BANDS OF SNOW-SQUALLS stream the entire length of Hudson Strait and cross Ungava Bay. (the computer drawn geographical outline is displaced eastwards from the true coastlines in this photograph). Taken on October 31, 1978, the ocean and rivers are unfrozen and contrast sharply as dark areas in the picture.

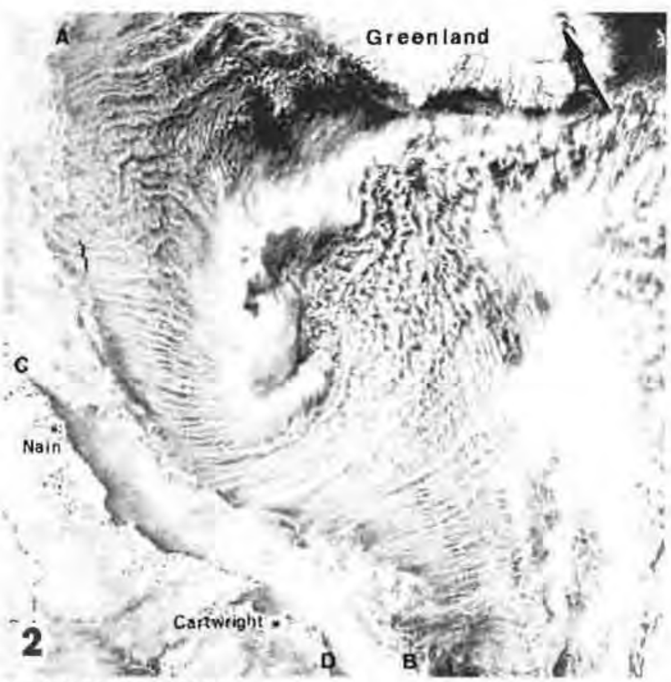
FIG. 2. ARCTIC WINDS ON MARCH 19, 1978 STREAM EASTWARDS OFF THE LABRADOR COAST and create hundreds of snowsquall ribbons, some of which merge into a graceful swirl. Near the easternmost edge of the photograph, as convection becomes deeper, and the wind velocity decreases, circular Bernard cells are formed. C,D marks the Labrador coastline which is edged with fast-ice. A,B is the eastern edge of a loose ice-pack which is reacting to ocean eddy currents offshore from Cartwright.

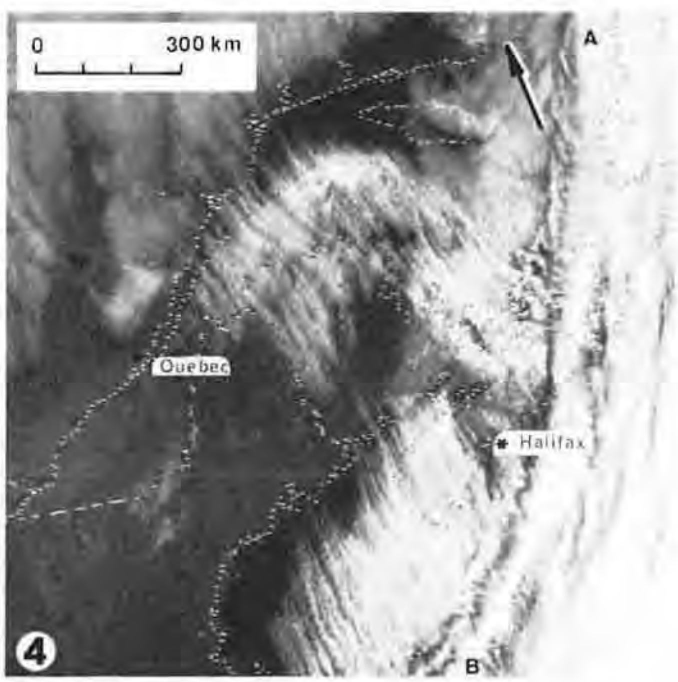
FIG 3. MULTIPLE SNOWSQUALL BANDS FORM ACROSS HUDSON BAY on October 30, 1978. The sky over the Northwest Territories and Southampton Island (largest island near the top of the photo) is clear, revealing the coastline and the fringe of ice which is beginning to form. A,B marks the curving cloud zone which accompanies the advancing edge of the arctic air.

FIG 4. WINDS BLOWING FROM THE NORTH cause multiple snowsquall bands across the lower reaches of the St. Lawrence River, the Gulf of St. Lawrence and the Bay of Fundy. Once again, in this photograph taken on October 24, 1978, the advancing edge of the arctic outbreak is marked by an organized line of cloud from A to B. The ground is not snowcovered and therefore appears dark in this picture, with the ocean waters somewhat darker still.









ALL PHOTOS COURTESY AES

TIPS ON LOCATING AN AEROGENERATOR

In the Fall 1978 issue of ***Chinook***, the article **Wind Power Generation in Ontario** examined the general usefulness of the wind resources in the Province. The following article deals with another but related topic, namely the meteorological and topographical factors which affect the selection of a site for an aerogenerator. It is a continuation from the same source* as the previous article but can be more widely applied to any locality.

Once the decision has been made to purchase an aerogenerator, usually the next question is "where to put it in order to take full advantage of the wind?" In answering this question it must be remembered that local topography plays a very important role in modifying the large scale wind patterns controlled by the prevailing winds. These topographical factors can be summarized as follows;

(a) the effects of slopes; (b) surface roughness; and (c) urban effects.

The behaviour of the general wind pattern is also changed by local meteorological factors which develop near the shorelines of lakes or oceans, and result in onshore-offshore breezes.

THE EFFECTS OF SLOPES

When the wind is blowing up the side of a large hill, wind speeds near the surface increase as you go up it. In Figure 1, the winds at site A are stronger than on level terrain, but are strongest at site B on the top. Unfortunately, at site B, substantial turbulence will have developed in the layer of air near the surface, thus eliminating some or all of the advantage over site A. However, if the site B tower is built high enough to get above this turbulence, the wind generator will be fully exposed to the stronger winds found at this elevation.

TIP NUMBER 1: LOCATE YOUR AEROGENERATOR ON HIGH GROUND, AND ON A TOWER TALL ENOUGH TO SURMOUNT THE EFFECTS OF TURBULENCE.

If the slope is in the form of a cliff, severe turbulence could be created when the winds flow towards it, as in Figure 2. A higher tower will be required near the cliff to get above this turbulence, while a shorter tower will be safe at a considerable distance from the cliff.

SURFACE ROUGHNESS

Areas that are relatively flat with no major obstructions will experience stronger winds because frictional effects will be less. For this reason, it is important to locate an aerogenerator in as open an area as possible so that there will be a good fetch of wind for all wind directions. For the best exposure, the World Meteorological Organization suggests that a wind measuring instrument should be positioned so that the distance between the instrument and any obstruction is at least 10 times the height of the obstruction. The same rule of thumb would apply to the exposure of an aerogenerator.

TIP NUMBER 2: IN FLAT AREAS, LOCATE THE AEROGENERATOR IN AS OPEN AN AREA AS POSSIBLE, AND AS FAR FROM SURROUNDING OBSTRUCTIONS AS POSSIBLE.

Unfortunately, not all sites can be found in such ideal locations. As a result, in siting a generator in more restricted situations, a tower tall enough to bring it well above the turbulence induced by rough surrounding terrain, low hills, trees and buildings will minimize the effects of this turbulence which tends to reduce the effective windspeed.

TIP NUMBER 3: IN RESTRICTED LOCATIONS, PLACE THE AEROGENERATOR ON A TOWER TALL ENOUGH TO REDUCE THE EFFECTS OF SURROUNDING OBSTRUCTIONS.

Sometimes, funnelling of the wind between large obstructions such as groves of trees or buildings, will increase the wind speed. Winds which do not have the same orientation as the wind funnel will result in generally lighter winds between the obstructions. Such a siting for a generator would only be an advantage when a high proportion of the winds tend to blow in the direction favouring funnelling.

TIP NUMBER 4: LOCATE YOUR GENERATOR DOWNWIND FROM OBSTRUCTIONS WHICH

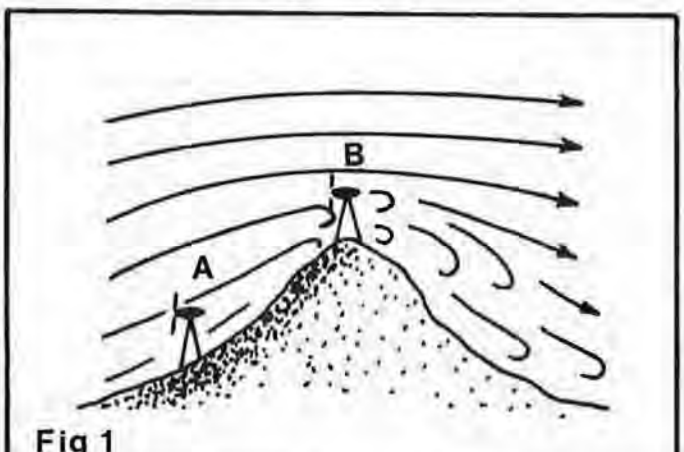


FIG. 1. INTERACTION OF AEROGENERATORS ON SHORT TOWERS with winds flowing over a hill. Exposure to turbulence may reduce power output and cause damage to unit B.

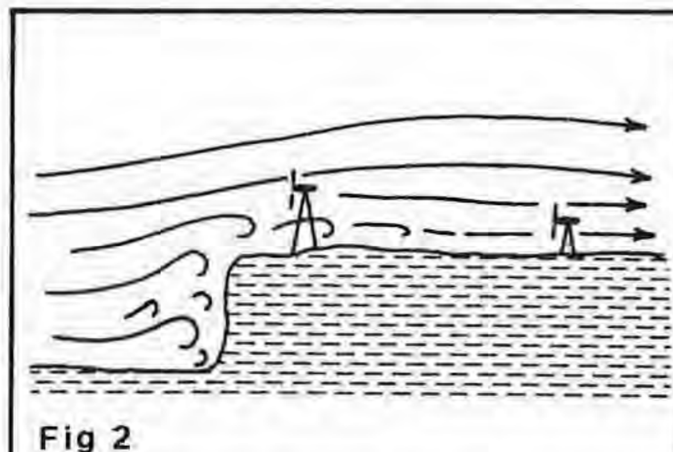


FIG. 2. CORRECT TOWER HEIGHT USED TO AVOID TURBULENCE in the proximity of a cliff. Potential hazard subsides with increasing distance from the cliff.

TEND TO FUNNEL THE PREVAILING WIND.

URBAN EFFECTS

Urban areas have distinct wind patterns. Generally, winds are lighter in an urban area because of the increased drag caused by the buildings. Strong gusts do occur in the vicinity of tall buildings caused by wind funnelling, and by the downward transport of the higher wind speeds aloft.

TIP NUMBER 5: AVOID LOCATING NEAR TALL BUILDINGS AND USE A TOWER TALL ENOUGH TO REACH THE STRONGER WINDS ABOVE THE FRICTION LAYER.

LAKE OR OCEAN EFFECTS

Wind speeds over a large water surface are naturally stronger than over land since surface frictional effects are much smaller. A wind generator set up close to a shoreline will be exposed to these stronger winds off the water. This is especially advantageous when a high proportion of the winds blow in an onshore direction. Since these offwater winds diminish rapidly as they move across rougher land surfaces, then

TIP NUMBER 6: THE WIND GENERATOR SHOULD BE AS CLOSE TO A SHORELINE AS POSSIBLE.

On days when light regional winds prevail, a shoreline location is favoured by the daytime on-shore breezes as well as by the night time off-shore breezes which develop due to the different rates of heating and cooling of the water and land surfaces.

Before locating the aerogenerator, it is a wise procedure to test the wind over a period of several weeks. A wind measuring instrument, (it could be a hand-held anemometer) should be employed to map out the wind speed and direction characteristics of the proposed site. A qualitative estimate of the wind characteristics aloft can be obtained by using an airfoil mounted on a pole, or by utilizing a kite and analyzing its behaviour.

FURTHER READING

Lamont, A. H., 1976: **A Simple Method for Estimating Available Wind Energy from Monthly Wind Speeds.** *Climatic Data Summaries*, CDS 6-76, Environment Canada, A.E.S., Toronto.

Shaw, R. W., Hirt, M. S., and Tilley, M. A., 1972: **Persistence of Light Surface Winds in Canada.** *Atmosphere*, Vol. 10, No. 2, pp. 33-43.

***A Climatological Review of the Potential for Wind Power Generation in Ontario,** by *T. Eschle* and *M. Pennyfather*. Internal Report SSU-78-6, Atmospheric Environment Service, Toronto.

ST. MARY'S CYCLO-STORMOGRAPH

Quietly, without a word to anyone, it has been sitting in the same spot for the past 60 or so years, forecasting the weather. All it needs to do its job is the care provided by Mrs. Marjorie Tuer who winds it up, feeds it ink, and changes its chart each week. Mrs. Tuer works at the *Journal-Argus* newspaper office, the weekly paper in St. Mary's, Ontario, and her charge for the past 36 years has been the Cyclo-Stormograph which is on display in the store-front window of the old building on Queen Street.

Passersby regularly stop, read the death notices posted in the newspaper office window, then look at the Cyclo-Stormograph for the forecast. Some of them at least. One old gentleman, who proudly announced that his 80th birthday was just a few days away, declared that he never looked at it. "If it rains, it rains" he said, "if it snows, it snows, anyway it always snows around here on November first."

John W. Eedy, the newspaper owner and publisher before his son Lorne recently took over the business, acquired the instrument from his grand-father just after the First World War. He also purchased a thermometer about 60 cm tall labelled "St. Mary's Journal Argus" which now hangs securely on the opposite side of the entrance from the Stormograph machine. Together these two collector's items constitute a truly reliable weather station according to local residents. "Half the people don't understand the Cyclo-Stormograph", confided Mrs. Tuer, a grand-motherly, no-nonsense lady, but gifted with a quick and ready sense of humour. She juggles my questions, efficiently takes payment for a bill and records details for an anniversary announcement, all at the same time. "I don't know if I'm hot or cold by this 22 or 23 degree business", she says referring to the relatively new Celsius or metric system of temperature measurement, but the big Fahrenheit thermometer just outside the front door gives her the required assurance.

Taking a peek at the 'Stormograph, I find that it looks something like a recording barograph, but without a visible aneroid unit. Finely machined but mysterious brass linkages and levers emerge from a sealed base plate and activate a pen which can move up or down. A clockwork driven drum, covered by a renewable weekly paper chart, rotates slowly against the pen, and the forces from the depths of the machine are translated into an indelible ink line. The line is falling and lies between two printed markings, G and H. The instructions read "for a falling line on the Cyclo-Stormograph between sections G and H, the approximate forecast is — clearing, slight squalls, fair, cooler tomorrow." Sure enough, on the way home, a few rain drops splatter onto the car windshield, but by evening the sprinkles turn into a steady 20 mm rainfall. As for tomorrow, it does indeed turn out to be a clearing situation, cooler and with generally fair skies. The weather gave us somewhat more than the 'Stormograph forecast, but perhaps we can blame that on the fact that the chart was on its second lap around. In the excitment of my visit, Mrs. Tuer had forgotten to change it.

MARJORIE TUER POSES WITH HER CHARGE

DR. WORKMAN'S WEATHER JOURNAL

by Scott Somerville

During the 1800's meteorology was a new and poorly understood science in Canada which made it a field ripe for misleading speculation, and fervent but dangerous weather prophets (see "Wigginism", ***Chinook*** Fall 1978). Based upon astrological misconceptions and other unfounded theories, the predictions produced by these prophets weren't worth the paper they were printed on. There were those who merely made fools of themselves, although some, aided by press publicity, caused disruption to commerce and the daily lives of the gullible. Fortunately, there were also capable, dedicated followers of the weather and its changes. One such man was Dr. Joseph Workman, whose life encompassed many interests including meteorology. As a hobby, he religiously studied daily weather by measuring barometric pressure and temperature. These readings, annotated by a large quantity of general comments concerning his weather observations, were recorded in a lengthy journal. The fruits of his labour are four leather-bound volumes which cover the years from 1860 to 1904.

Dr. Workman was a well known and respected physician who, at various periods in his life, also toiled as teacher and writer. Born in Ireland during 1805, he emigrated to Canada with his parents and family in 1829. He enrolled as a student of medicine at McGill University and, as a 30 year old graduate, engaged in practice at Montreal. Shortly afterwards, he withdrew to a private family hardware business in Toronto until 1846 when he returned to his first love, medicine. Besides re-establishing his practice, he was also much in demand as a lecturer and writer, being a regular contributor to newspapers and journals. In 1854 he was appointed Superintendent of the Toronto Lunatic Asylum in which capacity he served until his retirement in 1875.

The weather observations began March 23, 1860, but perhaps the most significant contribution to the collection of data for the last century are his comprehensive summaries of the daily weather. Occasionally, when noteworthy events occurred, he entered elaborate descriptions of the particulars in his journal. When the weather was significant enough to attract the attention of the newspapers, he invariably clipped out the stories and pasted them among his writings. He also collected items dealing with the weather earlier in the century. One such article concerns the rigours of the winter weather during the Papineau rebellion of 1837-38, and appears to have been written by his brother Thomas who was a loyalist volunteer. Thomas talks about sharp frosts in October and November of 1837 which impeded the advance of artillery since it could not be dragged through the freezing mud. Some of the soldiers commanded by Col. Gore arrived at the village of St. Denis (held by the rebels) without boots or shoes on their feet, and so tired out by their exertions that they were defeated. Later that winter, the bitter cold (16°F below zero) aided in the defeat of the rebels at St. Eustache by permitting a large well equipped attacking force to cross the Ottawa River on an ice bridge. Such details, saved by Dr. Workman have proved invaluable to climatologists interested in the possibility of climate change, and the relationship between the weather and historical events.

PORTRAIT OF AN UNIDENTIFIED PATIENT.
Picture found in Dr. Workman's Weather Journal.

Another interesting point frequently demonstrated by the Workman journal is his keen sense of weather observing. Many of his written comments paint a vivid picture of sky conditions, and, from his observations, Dr. Workman developed theories which are sound even by today's standards. For instance, he described the varying currents of the upper winds and clouds from which he correctly theorized concerning the weather conditions of adjacent regions. As an example, he entered the following passage into his journal for Friday, July 6, 1877;

"Wind continues northeast with small very sparse high scud. The northeast current is no doubt indicated by heavy precipitation in southwest regions. The papers today give reports of very severe rain, thunderstorms, in Ohio and West Pennsylvania."

On occasion, Dr. Workman wrote letters to the Editor of various papers presenting his theories with lucid reasoning. For instance, in one letter he commented that the sinking of the *Zealand* in a November 1880 Lake Ontario storm, could in all probability have been prevented by some instruction in meteorology. "Had the master of the *Zealand* consulted his barometer", he wrote, "and noted the prevailing under and upper cloud carriages, he would not have left port until the result of the atmospheric antagonism had been decided." The doctor argued that sailors should be familiarized with simple weather observing techniques in order to prevent such a re-occurrence. He also criticized nonchalant attitudes which prevailed toward the application of meteorology; "it is however a too well known fact that no very small proportion of those in command of our inland shipping are not only imperfectly acquainted with meteorological science, but, actually regard the whole subject with self satisfied contempt." It was in this article too, that Dr. Workman demonstrated his profound understanding of atmospheric behaviour derived from common sense observation, "at this hour (the departure time of the *Zealand*) a strong northerly wind, with rapidly flying scud, was blowing; but up above this scud-run there was a majestically flowing dense cloud field, moving from S.S.W. to N.N.E. Anyone who has attentively watched these opposite cloud-runs, and has noted their relation to barometric descents, must have felt convinced that a severe storm was coming up from the region whence the upper current was flowing." Dr. Workman was right on!

Another engaging item found occasionally pasted in the journal is the monthly meteorological summary from the Malden Lunatic Asylum in Amherstberg, Ontario. Weather observations were taken there which included daily readings at 7 a.m. and 9 p.m. of temperature, the barometer and wind. Remarks of noteworthy events such as thunderstorms etc., were also noted.

Despite Dr. Workman's perceptive knowledge of the weather, he never labelled himself as a prognosticator or weather prophet. In fact he maintained a rather scathing attitude toward weather prophets such as Mr. Vennor (author of *Vennor's Almanac*). For comparison, Dr. Workman would sometimes paste a clipping of Vennor's latest predictions beside his own daily summary which usually spoke of weather much different from the prediction. The doctor's wrath was not only reserved for the likes of Vennor. Entered in the journal for July 6, 1877 is the following statement; "In Manitoba the season has been so very wet as to prompt the clergy to pray for cessation. It is always prudent, in such troubles, to defer the praying until the rain belt is about to move off; just as in Lower Canada the priests used to wait till the caterpillars had devoured all the tree foliage, before making their procession for the purpose of driving off the pest."

By the 1880's age had commenced to take its toll on Dr. Workman. Although he never missed a daily observation, his handwriting wavered and his remarks dwindled to merely a few words if any. By the end of November 1892, his handwriting became so painfully illegible that someone, presumably his daughter, entered observations for him. In spite of this handicap, clippings of unusual weather events such as the blizzard of 1888, continued. Old age certainly failed to dull his enthusiasm. Observations ceased on February 14, 1894, exactly a month before his death. For an additional ten years afterwards, his daughter would occasionally narrate some unusual item, and even collected some newspaper clippings for the journal.

During July, 1922, Prof. C. F. Lavelle of Grinell University, New York, on behalf of his wife (a granddaughter of Dr. Workman) presented the four leather-bound volumes to Sir Frederic Stupart, Director of the Meteorological Office.

Weather diarists were very common during the last century, and many local museums treasure these pieces of weather history, but Dr. Workman stands out as an unusual man with a keen knowledge of meteorology.

PHOTO (above right). DR. JOSEPH WORKMAN M.D. 1805-1894.

PHOTO (right). THE FORBIDDING FACADE OF THE TORONTO LUNATIC ASYLUM. The windows of this building, the East Wing built in 1846, stare blankly at the outside world. It presents a virtually unchanged appearance in 1970 (when the picture was taken), from the days when Dr. Workman was Superintendent. Since then it has been torn down to make way for modern facilities.

PUBLIC ARCHIVES CANADA C52307

Courtesy Queen St. Mental Health Centre, Toronto

ALL ABOUT HURRICANES

COURTESY AES

HURRICANE *ELLA'S* BALEFUL EYE STARES BACK at the NOAA 5 weather satellite at 0045 GMT, September 2, 1978. At this time *ELLA* was in the Atlantic at 31.5°N and 72.9°W, or approximately 480 km southeast of Cape Hatteras, U.S.A., (location 1, diagram, p. 24) Maximum sustained winds near the centre were 160 kmh and the central atmospheric pressure was approximately 975 millibars. The picture is an enlargement and was taken using the infra-red portion of the spectrum.

Q. WHAT IS A HURRICANE?

A. It is a storm (called a tropical cyclone) which forms over warm tropical waters. When it intensifies to a stage where the surface winds near the centre increase to a sustained 118 kmh or stronger, it is called a hurricane (or typhoon in the Pacific).

Q. WHEN WAS THE EARLIEST KNOWN IN CANADA?

A. Hurricanes of the North Atlantic have been known since 1494 when they were encountered by Columbus during his voyages. The first listed for Canada, by Ivan Ray Tannehill in his book **Hurricanes,** was on November 19, 1813, although there is some doubt as to whether or not this storm was of tropical origin.

Q. HOW MANY HAVE WE HAD IN CANADA?

A. From 1886 to 1977 only 11 true hurricanes are known, although a total of 110 storms of tropical origin have been logged. The expansion of meteorological expertise and technology brought about by World War II led to better recognition of hurricanes, and all 11 have been recorded since that time. They constitute about 18% of the number of cyclones of tropical origin experienced in Canada since 1936. This is because Canada is insulated by over 1500 km from tropical oceans, and the majority of hurricanes are modified, either by interaction with cold northern waters or else by the continental land mass of North America, which robs them of their sustaining marine environment.

Q. WHERE DO THEY COME FROM?

A. There are six tropical cyclone basins around the globe. Figure 1 shows the extent of the North Atlantic basin which includes much of the North Atlantic Ocean and the adjacent coastal area of North America, the Caribbean Sea and the Gulf of Mexico. The birth-place of tropical cyclones is usually within 20 degrees of latitude from the equator. Almost all such storms which effect Canada begin in the North Atlantic basin, but every once in a while a maverick from the North Pacific will find its way into British Columbia. Typhoon *"Freda"*, beginning near Wake Island, about 1500 km from the coast of Japan, struck the southwest coast of British Columbia on October 12, 1962. A record gust of wind to 145 kmh was reported at Victoria. There were 7 fatalities and the final estimate of damage was $10 million.

Q. WHERE IN CANADA ARE TROPICAL CYCLONES MOST FREQUENT?

A. Figure 1, shows that New Brunswick, Nova Scotia, P.E.I. and Newfoundland are most commonly affected (not necessarily in that order). A small number also occur in Labrador, Quebec and Ontario east of Sault Ste. Marie.

Q. AT WHAT TIME OF THE YEAR CAN THEY BE EXPECTED?

A. The season in Canada begins in June and ends in November (Fig. 2). Fully 40% of the total number in the east have occurred during the month of September. A regional breakdown of the total indicates the same trend for Ontario and the Maritimes, although for Quebec, the season peaks in August.

Q. WHICH WAS THE MOST DAMAGING CANADIAN STORM OF TROPICAL ORIGIN?

A. Without doubt, hurricane *"Hazel"* must be considered one of the most destructive of such storms (if not number one) in Canada. Striking southern Ontario on October 15, 1954, *"Hazel"* left behind 80 fatalities, $24 million damage (in 1954 dollars), up to 182 mm of rain (although there is reason to believe that as much as 255 mm actually fell), and produced wind gusts up to 125 kmh.

Other tropical storms have produced more rain. Hurricane *"Beth"*, on August 16, 1971, deluged Nova Scotia with as much as 296 mm of rain which washed out about 20 highway bridges, and caused several million dollars' worth of damage.

Stronger winds than those of *"Hazel"* were recorded in southern Ontario during a tropical storm on September 25, 1941 when London measured gusts to 130 kmh (as well as the record gust to 145 kmh during typhoon *"Freda"*).

Possibly greater loss of life was caused by a very destructive hurricane which swept across the Maritimes on August 25, 1873. Trees, bridges, breakwaters, wharves, dykes and buildings were destroyed, but worst of all was the loss of more than 1200 vessels.

Acknowledgement

Much of the information in this article has been derived from the publication **Tropical Cyclones of the North Atlantic Ocean, 1871-1977** (see further reading).

Further Reading

Mason, A. H., Thomas, M. K., and Boyd, D. W., 1955: **The October 15-16, 1954 Storm, "Hurricane Hazel" in Ontario.** Department of Transport, Meteorological Branch, CIR 2606, TEC 210. (Available from A.E.S. 4905 Dufferin St., Downsview, Ont. M3H 5T4).

Tannehill, I. R., 1950: **Hurricanes.** Seventh Edition. Princeton University Press, Princeton.

U.S.A., 1971: **Hurricane, the Greatest Storm on Earth . . .** U.S. Dept of Commerce, NOAA/PA 70021.

U.S.A., 1978: **Tropical Cyclones of the North Atlantic Ocean,** 1871-1977. U.S. Dept. of Commerce, NOAA.

COURTESY OF NOAA U.S DEPT. OF COMMERCE

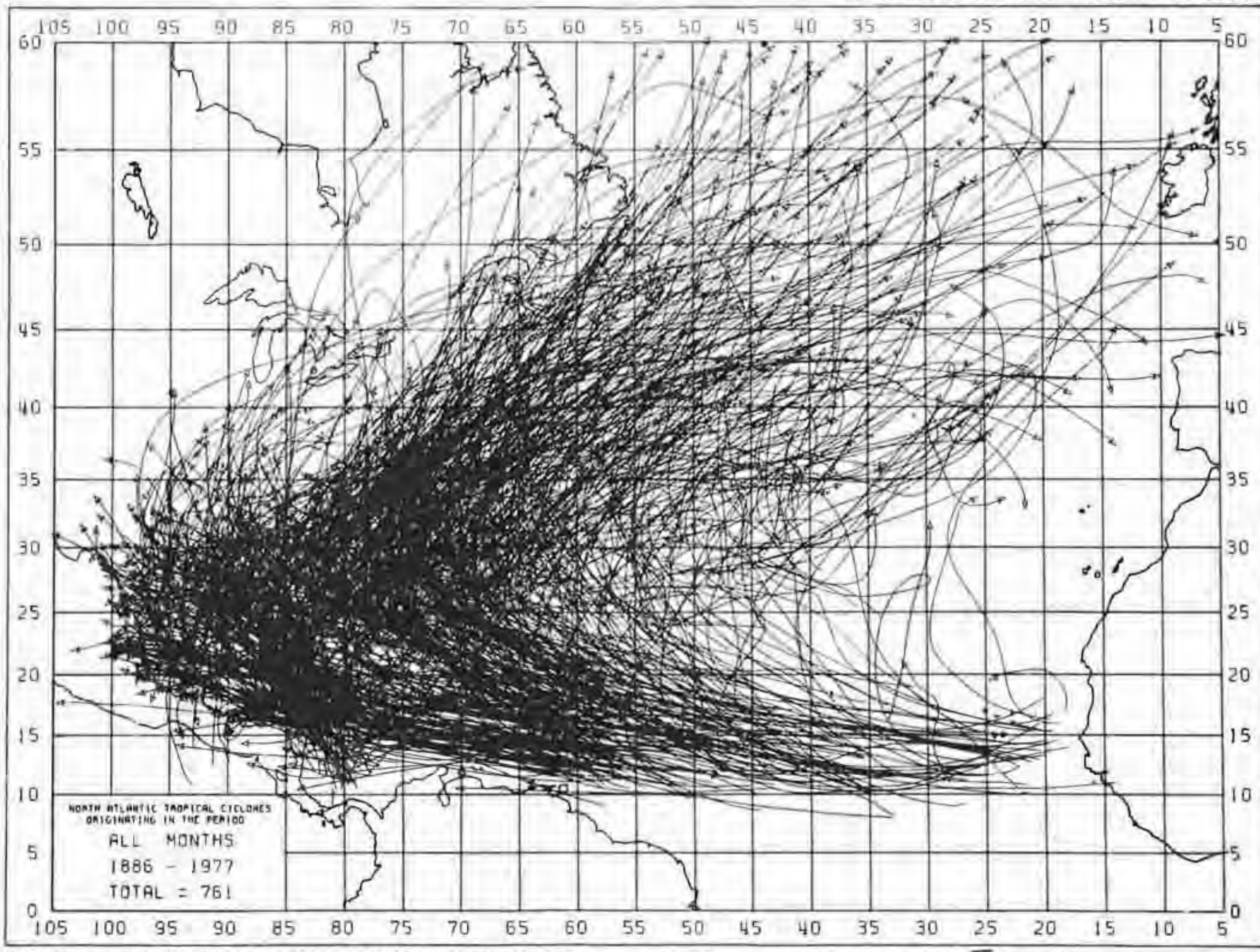


FIG 1 (above) TRACKS OF 761 ATLANTIC TROPICAL CYCLONES show the extent of the Atlantic tropical cyclone basin. This computer plot of all the known tropical storms during the period 1886 to 1977 clearly shows their tendency to recurve towards the northeast once they encounter the prevailing winds which blow from the west at higher latitudes. This behaviour, plus the fact that they need a sustaining marine environment, results in few reaching Ontario and none reaching central sections of Canada west of Lake Huron.

UPI PHOTO

FIG. 2

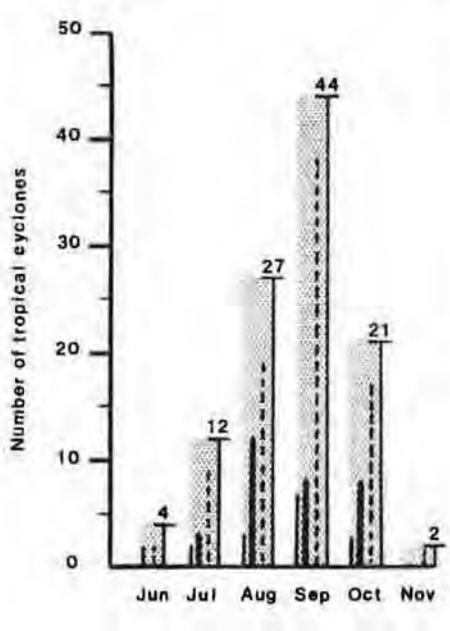


FIG 2 (left). THE SEASONAL VARIATION OF TROPICAL CYCLONES in Canada during the period 1886-1977. The T-bars indicate the total number each month. To the left of the T-bar, the dashed bar indicates the total number for the Maritime Provinces (including Newfoundland); the heavy bar indicates the number for Quebec, and the bar on the extreme left indicates the number for Ontario. Twenty-five of the storms crossed provincial borders and are counted more than once in the regional breakdown hence the total of all the regional storms shown is greater than the national total.

PHOTO (left) THE AWESOME POWER OF TYPHOON WINDS sweep a man off his feet in Japan. September 14, 1978.

SEVERE STORM LOG

NEWFOUNDLAND'S BRUSH WITH HURRICANE ELLA

Gaining strength on August 31, 1978, tropical storm *Ella* began her six day lifetime as a hurricane. When first located by weather satellite pictures and ship reports, *Ella* was positioned about 545 km south of Bermuda with maximum sustained winds of 130 kmh.

At first, her track was towards Cape Hatteras in North Carolina and U.S. residents from Cape Lookout northwards to the Virginia border were advised to go about their normal business, but to consider the hurricane a threat to the Labour day weekend. Early on September 2nd, the hurricane stalled about 480 km southeast of Cape Hatteras. At this point the central pressure in the eye was at its lowest level — 970 millibars (about 5% below the value considered to be sea-level normal for the atmosphere), and maximum winds were estimated to be 160 kmh.

By midnight of September 3rd, *Ella* began to move again, this time northeastwards towards Newfoundland. Along the outer banks of North Carolina, nothing more than rough surf and heavy seas were noted, but an ominous strengthening of the wind within an 80 km radius of the hurricane centre was observed. While speeding through the main Atlantic shipping lanes early on September 4th, about 490 km south of Halifax, Nova Scotia, the wind velocity reached a maximum sustained strength of 225 kmh.

Expecting *Ella* to pass very close to Cape Race late on the 4th, the Newfoundland weather office issued a hurricane warning for the Grand Banks and storm warnings for the southeastern tip of the province. The safety of residents of the Avalon and Burin Peninsulas now depended upon how close the hurricane approached. A slight shift in direction either way could mean all the difference between raging damaging winds, driving rain, swamping seas and just another nor'easter so common to the area. *Ella* had already passed a scant 120 km south of Sable Island, Nova Scotia, but peak winds of only 90 kmh were reported by the weather station there. Like all hurricanes, she was a tight storm of relatively small diameter.

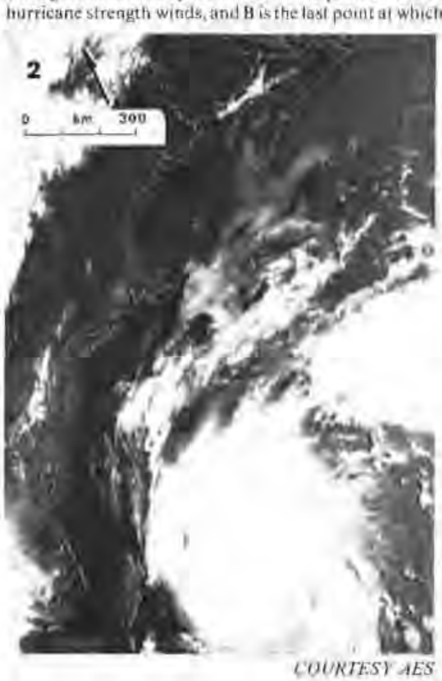
In North Sydney, Nova Scotia, the ferry *Ambrose Shea* loaded with 300 passengers, delayed departure for Argentia, Newfoundland, to allow the storm to pass. Inshore fishing vessels, pleasure craft and about 50 foreign trawlers which had been fishing the Grand Banks all sought haven in ports. Located far enough from the hurricane centre to feel more secure, the Canadian trawler fleet remained at sea and weathered the storm.

During the early hours of September 5th, the eye of the hurricane, weakening but still packing winds of 160 kmh, passed about 80 km south of Cape Race where the lighthouse keeper reported top winds of 115 kmh. Moving rapidly eastwards, *Ella* quickly lost her tropical characteristics over the cold North Atlantic waters, and by evening could no longer be identified.

The strongest winds reported in the St. John's area were 75 kmh, while rainfall amounted to about 45 mm. Neither the Canadian Coast Guard, nor the RCMP received reports of damage due to the hurricane, but two days later the Newfoundland schooner *Swile* was reported overdue at Bar Harbor, Maine. The Canadian Armed Forces' search and rescue unit in Halifax began a hunt for the boat and its crew of two. She had sailed from Argentia before the hurricane arrived and over a month later was still missing.

Although the maritime provinces of eastern Canada are insulated by many hundreds of kilometres from the tropical birth-place of hurricanes, they are nonethelesss a well known meteorological hazard to the area. See the article "All About Hurricanes" (p. 22) for more information.

THE NOAA5 WEATHER SATELLITE PHOTOGRAPHS HURRICANE *ELLA* as she curves northeastwards along the Gulf Stream towards Newfoundland. The diagram (right) shows the track of *Ella* and her position at 1000 GMT each day from Aug. 31 to Sept. 5, 1978. Acceleration is clearly evident in *Ella's* forward speed during the last two days. A indicates the point at which tropical storm *Ella* achieved hurricane strength winds, and B is the last point at which *Ella* could still be identified. Point number 1 is the location at which the photograph on page 22 was taken, while photos taken at points 2 and 3 can be seen left and centre. Photo number 2 was taken at 1409 GMT, September 3, 1978. In photo number 3, (1323 GMT Sept. 4, 1978), the white cloud mass over Newfoundland and Nova Scotia is acutally unrelated to the hurricane.



COURTESY AES

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THE HALLOWEEN DELUGE, B.C.

The Events

From October 31st, through the week ending November 7th, 1978, unprecedented rains lashed the Skeena River Valley communities around Terrace, B.C. Named *The Halloween Deluge* by Brian Hammond, a Vancouver meteorologist, this storm poured an all time 24 hour record rain on Terrace where 114.8 mm was measured on October 31, 1978, and also pummelled the area with winds gusting as high as 125 kmh. Between October 31 and November 7, a total rainfall of 318 mm was recorded in the Terrace — Kitimat area. From the surrounding mountains, melting snow runoff glutted the streams rushing down to join the rain-swollen Skeena. The result was chaos. Numerous washouts closed highway 25. On highway 16, as well as the parallel CNR mainline, there were at least 25 mudslides and washouts, with 4 major bridges carried away. The only natural gas pipeline serving the area was severed. South of Terrace, Lakelse Lake rose 3 m, flooding homes in Remo and Lakelse where residents had to be evacuated by boat.

The Toll in B.C. and Alberta

Two CNR crew members, an engineer and a conductor, were lost into the Skeena on November 2, 1978 when the saturated roadbed gave way beneath their 4-car work train. Two motorists were injured when their truck plunged into a washout. On November 4, 1978, 150 men and 100 pieces of equipment began work on the largest highway reconstruction project in B.C. history, repairing an estimated $10 million damage.

In Alberta, winds from the same storm, wrung dry of moisture by the Rockies, caused millions of dollars worth of property damage in parts of Calgary and Grande Cache on October 31 and November 1, 1978. The wind pushed a CP railway car loaded with 50 head of cattle 70 km from Pincher Creek to Monarch.

The Storm

The culprit storm formed as a secondary development in the circulation around an old decaying storm in the Gulf of Alaska. Developing over the Pacific early on October 31 at about 45°N, it moved rapidly northeastwards, intensifying until it reached the Alaska Panhandle late on November 1, 1978. Throughout this time, moisture-laden south to southwest winds lashed the northwest coast of B.C., producing continuous moderate to heavy rainfall.

Acknowledgement

Meteorological information provided by Weather Information Officer, N.E. Penny, Pacific Weather Centre.

TORNADOES

THE GEOGRAPHICAL DISTRIBUTION OF TORNADOES during the 1978 tornado season. The number in parenthesis is a tornado death. The total amounts to 77, not all of which are confirmed due to lack of information. The first occurred on May 6th, and the last on October 5th. In order to draw a comparison between Canada and the U.S., the number of Canadian tornadoes must be prorated by 7.5 (the ratio of the settled area of the two countries). This gives an adjusted annual number of 577 for Canada compared to an annual average 750 in the U.S.

BOOK REVIEW

White Death — Blizzard of '77 by *Erno Rossi*, 77 Publishing, Box 77, Port Colborne, Ontario, L3K 5X8. 1978. 356 pages. Paperback $8.95, hardcover $12.95.

It was Mark Twain who said that "weather is a literary specialty and no untrained hand can turn out a good article on it." *Erno Rossi*, in his new book **White Death — Blizzard of 77**, has obviously read Mark Twain and taken the hint. He has let everyone else do the writing for him. And that, as it turns out, is not a bad idea, for the book does have a kind of sustained dramatic interest that only a disaster of the proportion of a hurricane, a tornado or other natural catastrophy can generate. In letting the people who endured the crippling blizzard of Jan.-Feb., 1977 tell the story in their own way, an added measure of credibility is achieved.

Rossi divides the book into two parts —the Canadian experience and the American experience. More than one hundred stories, anecdotes and many excellent pictures are devoted to each part. There are stories by an amazing cross section of society — from drug addicts to disc jockeys, from the military and the mayors, from the police and the psychiatrists — all of them telling their story in their own way, all of them for the moment forgetting the social stratifications in the performance of tasks of mercy and courage. In the face of weather's implacable influence and devastation, people everywhere develop a new sense of community.

The reports of the military, the police, the various government agencies are found particularly interesting and informative. The least satisfactory part of the book is that there is little or no attempt to draw all the various stories and reports into a coherent whole. Nevertheless, in the absence of anything else more substantive on the great storm, the book should have local appeal in the Niagara Peninsula and Buffalo areas. It should certainly have a place in the libraries and emergency measures organizations of those regions.

Bev Cudbird
CFRB Staff Meteorologist

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TO THE EDITOR *from page 15*

Dear Mr. Coulter:

To more capably answer your criticism of that study, we are forwarding you a copy. This study was prepared by Mr. Thomas Eschle and Miss Margaret Pennyfather while both were employed as part of the Federal Labour Intensive Projects (FLIP) Job Creation Program. In all stages, their work was monitored by meteorologists at the Ontario Region and Headquarters of the Atmospheric Environment Service. As a consequence, we have confidence in the statements made in the report.

We feel that perusal of the full report, especially chapter 4.4, will justify the authors' comments to which you take exception.

R. G. Lawford
Superintendent
Scientific Services
AES, Ontario Region

A FEW QUESTIONS

Sir, I would like to ask a few questions about the weather. Here they are:

What is the closest a tornado came to Barrie (Simcoe County, Ontario)? *There have been at least two in Barrie (1940 and 1862), and a number in Simcoe County. On June 24, 1951 there was a near miss as a tornado damaged property and trees in Midhurst and passed within 30 metres of Springwater Park.*

Is Barrie in a snowbelt? *Yes. (See WINDOW ON WEATHER this issue).*

Is ***Chinook*** always going to be a thin magazine? *Not if we can get some fat advertisers.*

Paul Vink
Barrie, Ontario

*(**Chinook** cannot guarantee to answer every letter written for the purpose of asking weather questions, but we will print the more interesting requests from time to time. Ed.)*

CONGRATULATIONS

I was thrilled to see your first issue of ***Chinook*** and want to be a charter subscriber. Congratulations on your initiative as well as both the content and attractiveness of Vol. 1, No. 1.

M. K. Thomas
Director-General
Central Services Directorate
Atmospheric Environment Service
Downsview, Ontario.

FOR SALE

Quarterly Journal of the Royal Meteorological Society, unbound, complete 1950-1976. $30 plus shipping. Also *Weather,* first issue (May 1946) to Feb., 1978, almost complete. $15 plus shipping.

Bob Stark, PO Box 397, Downsview, Ont. M3M 3A8.

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IN THE NEXT ISSUE — feature articles about;

- The effect of weather on bees and honey production,
- A lightning tragedy which took 23 lives near Brockville, Ontario,
- Automatic weather stations.

by
R. G. Stark
(answers next issue)

1. DOUBLETS

Lewis Carroll invented word doublets. The object is to convert one word into another word of the same length by changing one letter at a time. Each step must also form a word (proper names not allowed). For example, RAIN can be changed to HAIL using the intermediate step of RAIL.

Try these;

From WIND produce GUST
Cool DEW to get ICE
Make CLOUD bring forth STORM

2. ONE-LINED CROSSWORD

This Rudolph was not a red-nosed reindeer. His engine worked according to

1	2	3	4	5	6	7	8	9	10	11	12	13

principles.

CLUES

- 9, 10, 11, 3. Until recently, only the female sex was used to ______ hurricanes.
- 1, 12, 7, 8. After a severe storm things are seldom this.
- 13, 6, 7 The earliest North American staple.
- 12, 13, 3. You can salt it away.
- 7, 8, 9, 3. This is not a physicist's invitation to eat.