Chinook

THE CANADIAN MAGAZINE OF WEATHER AND OCEANS

LA REVUE CANADIENNE DE LA MÉTÉO ET DES OCÉANS

VOL. 8 NO. 1 WINTER/HIVER 1986

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THE CANADIAN MAGAZINE OF WEATHER AND OCEANS

WHAT? *Chinook* is a popular magazine concerned with two major components of the Canadian environment – the atmosphere and the oceans. It is published quarterly by the Canadian Meteorological and Oceanographic Society (CMOS).

Features in *Chinook* include articles, weather summaries, interpretations of satellite and other photographs, and news and notes. These appear in the language submitted (English or French). In addition, summaries of all articles appear in the other language.

WHY? The aims of *Chinook* are

- to increase public awareness of meteorology and oceanography in Canada and of their modern scientific and technological aspects and achievements
- to stimulate public interest in and understanding of the impact of climate, weather and oceans on Canadian society and economics
- to inform Canadians about the education, information and interpretative services available to them on climate, weather and oceans

WHO? Features in *Chinook* are chosen to appeal particularly to

- secondary school and community college students
- farmers, fishermen and foresters
- marine-recreation, sports and tourism operators and enthusiasts
- aviators
- amateur observers of natural phenomena
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LA REVUE CANADIENNE DE LA MÉTÉO ET DES OCÉANS

QUOI? *Chinook* est une revue de vulgarisation qui traite de l'atmosphère et des océans – deux des importants éléments qui composent l'environnement canadien. *Chinook* est publié tous les trois mois par la Société canadienne de météorologie et d'océanographie (SCMO).

On retrouve dans *Chinook* des articles, des sommaires du temps, des interprétations de photos satellitaires et autres, des articles d'actualité et des notes. Ces articles paraissent dans la langue originale, le francais ou l'anglais; tous les résumés sont rédigés dans l'autre langue.

POURQUOI? *Chinook* vise à :

- éveiller la curiosité du public en ce qui a trait aux aspects de la météorologie et de l'océanographie au Canada et à l'informer des réalisations scientifiques et technologiques d'aujourd'hui;
- stimuler l'intérêt du public et l'aider à mieux comprendre les effets du climat, du temps et des océans sur la société et sur l'économie du Canada;
- renseigner les canadiens sur les services d'éducation, d'information et d'interprétation qui leurs sont disponibles et qui traitent du climat, du temps et des océans.

QUI? Les articles choisis pour *Chinook* vise à intéresser notamment :

- les étudiants d'écoles secondaires et de collèges communautaires
- les agriculteurs, pêcheurs et agents forestiers
- les exploitants d'établissements de nautisme, de sports et de tourisme, et les amateurs des ces activités
- les aviateurs
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- les spécialistes d'autres sciences
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This first issue of Volume 8 highlights one of the more spectacular and dramatic weather events: the tornadic outbreak of May 31, 1985 in the area of Ontario centred on Barrie. We are pleased to offer readers a perspective of the phenomenon and the events on that day recounted by a grade 12 student; also, the minute-by-minute activities of the Severe Weather Team of the Ontario Weather Centre. Finally, helpful hints and directions regarding severe weather events are presented.

A fascinating view of the oceans from space shows the complex but important interactions between ocean, atmosphere and land.

We are pleased that through the cooperation of the National Survival Institute and the Atmospheric Environment Service we are able to include this issue of *Chinook* with the Resource Kit on atmosphere, weather and climate, supplied to educators across Canada.

The next issue will introduce a new feature aimed at secondary school programs. A series of plotted weather charts will be provided containing conventional information, such as pressure, temperature, wind, precipitation, current weather and sky data. It is our hope that this series can be useful in geography and science classes dealing with atmospheric processes.

Hans VanLeeuwen

COVER

Intense thunderstorm development is shown crossing from Lake Huron into the Bruce Peninsula and the western counties of southern Ontario. The picture shows the NOAA-9 satellite near-infrared image for 2:45 p.m. on May 31, 1985. For more details see the article on page 13 describing the associated tornado outbreak.

COUVERTURE

Cette image satellitaire permet de suivre l'évolution d'orages violents, du lac Huron à la péninsule Bruce puis dans la partie ouest des comtés du sud de l'Ontario. L'image, prise dans la bande quasi-infrarouge, le 31 mai 1985 à 14h45, provient du satellite NOAA-9. Pour de plus ample détails, se référer à l'article de la page 13 qui décrit la tornade qui s'en est suivie.

Chinook

Winter/Hiver 1986 Vol. 8 No. 1

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ISSN 0705-4572

Published by
Canadian Meteorological and Oceanographic Society

Publié par
La Société canadienne de météorologie et d'océanographie

Second Class Mail Registration No. 4508
Winter 1986 Date of Issue – March 1986

Courrier de deuxième classe – enregistrement n° 4508
Hiver 1986 Date de parution – mars 1986

MAY 31 TORNADO

by Mark Ransom

Figure 1 Panoramic view of the catastrophic destruction in Barrie as a result of the late afternoon tornadoes on May 31, 1985. It shows the Adelaide Street townhouses with Kempenfelt Bay in the background. The selective and narrow path of the tornadic impact should be noted (Photograph: Frank Boddy).

On Friday May 31, 1985, a rare and unpredictable disaster hit central Ontario. Many locations were affected by a number of severe storms and tornadoes. The total number of tornado touchdowns is not known for sure, and probably never will be, simply because accurate surveying of the sites affected was not possible. Several cities, towns and small communities suffered differing amounts of damage, but a common effect of the storms was the type of damage and emotional tragedy that was sustained. This article will examine the characteristics of a tornado, and present eyewitness accounts of the destruction caused by the Barrie tornado. Centred on the City of Barrie, these accounts can be applied to almost any area or settlement that has been or will be hit by a tornado. I hope that, as an amateur meteorologist who lives in Barrie, these descriptions will verify further the awesome power and destructive capabilities of tornadoes.

Although tornadoes have no set geographical boundaries, they do occur in some areas more frequently than in others. Tornadoes usually occur at the boundary of two extremely different air masses (warm/cold), or in hot and humid air that is forced to rise. When this happens cumulonimbus clouds or thunder-clouds are formed. High-topped cumulonimbus clouds can spawn tornadoes, however, not every cumulonimbus cloud does so, since temperature and humidity conditions must be just right. In Canada, tornadoes usually occur during June, July and August when the air is warm, and the land is influenced by warm and moist tropical air masses. Few tornadoes develop in the late spring or early fall, and are very unlikely in winter. During the summer, most tornadoes develop and strike during the late afternoon or early evening, because the air at that time is very unstable due to heat build-up during the day, which causes the very warm air to rise. This lifting action combined with the interplay of two different air masses can produce some intense cumulonimbus clouds. These conditions form one set of criteria that make the possibility of a tornado even greater. The horizontal movement of a tornado is about 40–65 km/h and its internal wind speeds can be as high as 400–500 km/h. The average length of the path of destruction is very hard to measure because it varies so much in size and strength. For instance, on March 18th 1925, a tornado whose path was 350 km long affected three American states. However, small tornadoes have travelled as little as 800 metres. No matter how far the tornado travels its force can still remain the same. The danger with the smaller tornadoes, unfortunately, is the near impossibility of providing any advance warnings; therefore, they catch people by surprise.

In the hours before the tornado hit on Friday, May 31st, severe storm warnings had been issued over the radio. Despite these warnings most people in Barrie and other communities put little faith in them, and went about their normal 4:30 Friday afternoon routines. The memories and fears of the last tornado that hit Barrie over 70 years ago had long since been forgotten.

The 1985 tornado developed southwest of the city. Strong winds toppled major power transmission lines and tripped a load generation rejection system, cutting power to many regions in southern Ontario. The tornado had intermittently touched down southwest of the city. The first touchdown point in Barrie was a pine reforestation area where the wind snapped many of the trees at the 2-metre level, and permanently bent many others. From there the tornado moved northeasterly where it totally erased one square block of older frame homes, causing three deaths.

The next area hit was an industrial zone, where as many as 12 factories were destroyed, and several others on the outer edge of the tornado suffered heavy damage. Roofs were ripped open and blown away. When the roof was gone, the walls which had no support collapsed in almost every direction. Steel beams were bent and twisted under the enormous force. On some of the still standing walls that had faced the unbelievably strong winds, many small splinters of wood had been driven into the mortar – some with such force that they made fracture marks in the blocks. In the industrial area, miraculously only one person was killed. The tornado then travelled due east crossing Highway 400.

"I was driving home from work, the sky was aqua green in colour, it was really weird. I came to a stop behind several cars that were waiting for the light to turn green. I can't really remember what I was doing, I was just sitting there, when suddenly it got really dark. I looked around, and to my left I saw this wide wall of blackness coming towards me. I knew it was a tornado. I thought about pulling out around the cars in front of me, but before I could do anything debris started hitting my car. I lay down on the front seat and pulled my coat over my head. Soon after that the windows in the car were blown out, glass and debris were flying around hitting me, and the car was rocking and bouncing. I was thrown to the floor. The thing I can remember the most is the

left flattened that Friday. Examination of the tires showed they had obviously not been punctured by flying debris. It appears, however, that they exploded because the outside air pressure dropped suddenly. The tires expanded beyond their capacity and exploded much like the houses.

After moving up a hill and through another established subdivision, the tornado continued almost due east for another 3 kilometres. It destroyed several more houses by ripping off roofs, tearing down brick walls, and rolling cars down the street like tumbleweeds. Hundreds of trees were uprooted, and many homes were pushed off their foundations. The tornado then continued northeasterly hitting a marina on the shore of Kempenfelt Bay. Then the tornado seemed to lose much of its energy as it moved out over the cool water. Behind it was left an unbelievable path of destruction. It is impossible to describe or portray the true extent of the damage. How can you describe the eerie calmness after the tornado, when people crawled out of the rubble like ants to find themselves completely surrounded by destruction? Homes, that people worked so hard for, were destroyed in a few seconds. Financial aid was provided to those who lost their homes. However, you cannot buy back a life. Words or pictures cannot reveal the emotional aspect of the disaster. It is something that one would have to experience before knowing the true meaning of disaster. The tornado claimed four more lives when it raced across the southeast end of town leaving a long and lasting scar in the minds or many.

This rare occurrence of May 31, 1985 has happened before and will undoubtedly recur. It is important to learn more about tornadoes and what to do if you suspect one is likely to occur. The major problem of concern to authorities is how to pass on tornado warnings to the general public. For now, the only thing you can do is watch for threatening weather, listen to the radio for weather warnings, and if the weather conditions deteriorate keep a sharp eye out.

noise – it sounded like a train. Before I knew it the whole thing was over. I got up from the floor of the car to find another world...." The person who experienced this was situated almost directly across from the Barrie Raceway just off Highway 400. The cars that were hit by the strong winds were tossed about like toys. Many cars had small bullet-size holes and large dents that were caused by flying debris. Roofs and the glass-viewing-windows of the Raceway were torn apart and smashed. Homes situated downwind of the Raceway were coated with mud and manure from the horse stalls, causing health officials to be concerned. One eyewitness situated near the Raceway saw a horse lifted from one of the stalls, carried through the air and set down gently on a nearby road. This horse has been nicknamed "Twister Resistor" and has won several races at the Raceway since the tornado.

The next area to be affected was in an easterly direction – a large cluster of townhouses (Figure 1). The total destruction of the upper floors was a common sight throughout Barrie and many of the other communities hit by the centre of a tornado. The width of the path of significant destruction close to the centre of the tornado was about 350 m. Much of the damage was due to the extremely high winds, but another contributing factor was the sudden and extreme drop in air pressure associated with the storm. Normally, the pressure inside a house is the same as the air pressure outside. But during the passage of a tornado the air pressure drops very rapidly as the giant vacuum funnel sucks up air. Unless people have time or the foresight to open windows and doors, the house will simply explode from the inside.

This is evident from a close examination of the townhouses in Figure 1. The debris is spread around the outside of the homes, as though a bomb had exploded inside. The illustration shows the tornado travelled from the left to the right, as verified by the way the tree in the left-hand corner had been bent. In most cases the homes that were in the direct path of the tornado lost their roofs. Pieces of wood that had been hurled through the air by the strong force penetrated roofs and walls. At one particular home the sleeping compartment of a large transport truck was deposited on top of the chimney. Highway guardrails had been carried for several hundred metres and then were wrapped around trees and buildings like ribbons. The houses on the outer edge of the tornado suffered damage from high winds and flying debris. It was quite evident that the damage was less severe the farther you move from the centre of the tornado path. However, severe and moderate damage is separated by a distinct line along which air pressure differences disappeared.

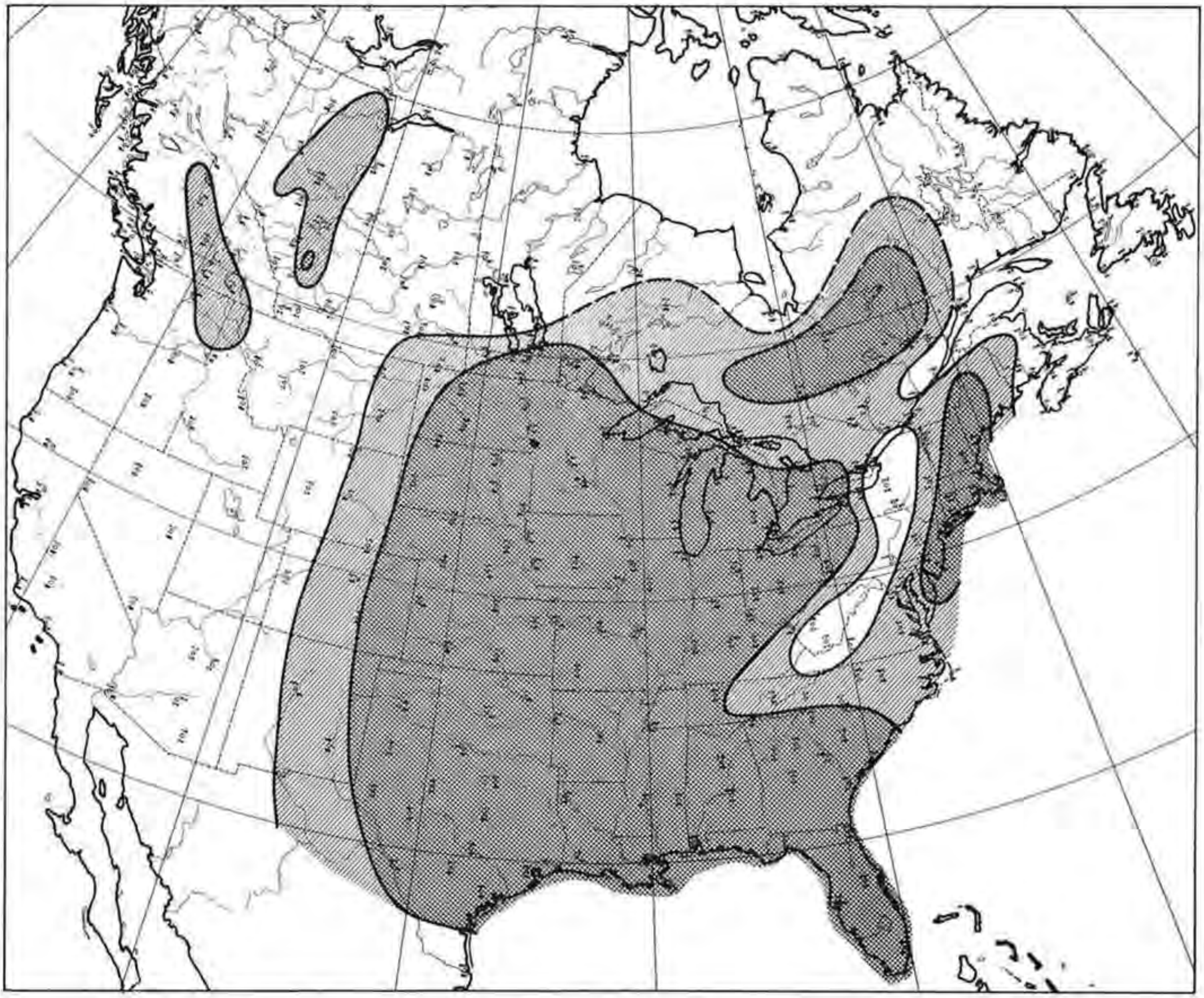
Other occurrences were related to the pressure drop. One family struggled to descend a flight of stairs to reach the safety of their basement – it was difficult to make headway down the stairs, not because of the wind or an updraught, but because of a force pushing them back. Also a number of car tires were

Mark Ransom is a Grade 12 student at Innisdale Secondary School in Barrie, Ontario. His article is one result of a project in the senior Geography course.

RÉSUMÉ *On décrit les conséquences de la tornade du 31 mai 1985, qui a touché la région du nord et du nord-ouest de Toronto, telles que perçues dans la région de Barrie. Un étudiant de la douzième année du secondaire, Mark Ransom, donne un aperçu des conditions de base nécessaires à la formation d'une tornade. On donne une description détaillée des dégâts considérables causés par la tornade principale qui a balayé les secteurs urbain et industriel de Barrie. Les récits de quelques témoins oculaires décrivent de façon poignante l'expérience angoissante de ce terrible désastre.*

TORNADO CLIMATOLOGY

by Michael Newark



Map of the tornado-prone regions of North America. In the lightly shaded zones one tornado can be expected on the average every two years in an area 100 km by 100 km. In the darker areas, at least one tornado per year on the average can be expected per 10,000 km^2. Although tornadoes have occurred in every populated part of Canada, the more devastating ones are found mostly in areas eastward from the Rocky Mountains to New Brunswick. "Tornado Alley" is a term commonly applied to the Oklahoma-Kansas area of the United States, but few realize that parts of Canada are also included in the tornado-prone region of North America.

Recent tornadic events such as the disastrous tornado outbreak of May 31, 1985 in southern Ontario and neighbouring Québec, and the St-Sylvère, Québec tornado of June 18, 1985, underscore the danger facing Canadians due to this type of storm.

Michael Newark is the founder-editor of Chinook (1978–1984). He was for many years a forecaster in the Ontario Weather Centre and the Centre's Summer Severe Weather Meteorologist. He is currently head of the Climate Monitoring and Prediction Section of the Canadian Climate Centre.

L'ÉTÉ DES INDIENS

par Monique Gauthier

Le concept d'été des Indiens a toujours intrigué une grande variété de personnes; plus d'un poète a chanté ses beautés, tandis que les plus scientifiques cherchaient l'origine exacte du terme et sa signification. Bien que le sujet devienne très populaire en période automnale, très peu de recherches ont été entreprises sur l'été des Indiens; les définitions rencontrées dans la littérature ne font en général que souligner le phénomène et ses principales caractéristiques.

DÉFINITION

Le terme « été des Indiens » se rencontre surtout dans l'est et le centre de l'Amérique du Nord; il fait référence à cette période de temps calme et sec, ensoleillé avec des périodes de brume sèche et des températures anormalement douces. Il peut se produire après les premiers gels de l'automne, à partir de la fin septembre jusqu'au début novembre. On insiste beaucoup sur les températures clémentes et agréables durant le jour avec de la brume ou des brouillards matinaux et des nuits froides, parfois avec du gel. Aussi l'été des Indiens, pour qu'on puisse l'appeler ainsi, doit nécessairement être précédé d'une période de temps froid et de gel, marquant en quelques sorte la limite entre le vrai été et le « second été » . On ne peut évidemment s'attendre à un retour du phénomène à chaque année; par contre, il peut se produire deux à trois fois au cours du même automne.

On estime que le terme « été des Indiens » aurait fait son apparition vers la fin du 18^{e} siècle en Pennsylvanie, puis se serait étendu dans les régions de New York et de la Nouvelle-Angleterre vers 1798, au Canada vers 1821 et en Angleterre vers 1830. Vingt ans après son apparition, il aurait été établi dans le langage courant dans tout le nord-est de l'Amérique et plus largement dans tous les pays anglophones. Les francophones du Canada auraient alors à cette époque traduit littéralement le terme anglais *Indian summer* par « été des Indiens » . Plusieurs hypothèses existent sur l'origine du terme lui-même. Celle qui revient le plus souvent est que cette expression provient du fait que les Amérindiens comptaient sur cette période de temps doux et sans pluie pour terminer leurs récoltes et se préparer pour l'hiver.

Il est intéressant de remarquer que dans plusieurs régions d'Europe, on retrouve des périodes analogues à l'été des Indiens, dont les différents noms font tous allusion à un élément culturel, religieux ou folklorique. Ceux que l'on retrouve le plus souvent dans la littérature sont : l'été de la Saint-Luc; l'été de la Saint-Martin; l'été de la Toussaint; l'été des bonnes femmes.

LES PÉRIODES D'ÉTÉ DES INDIENS EN ESTRIE

Un ensemble de critères reflétant le mieux possible les conditions météorologiques définissant l'été des Indiens a été établi pour la région de l'Estrie. Ces critères se résument ainsi : les périodes recherchées se situent entre le 1er octobre (ou fin septembre selon les cas) et le 15 novembre; la durée de ces périodes est de trois jours au minimum; la température maximum du jour est d'au moins 18°C; les périodes n'ont pas plus d'une journée de précipitation ne dépassant pas 1,3 mm; chaque journée totalise au moins 6 heures d'ensoleillement réel par jour.

La recherche des périodes s'est effectuée à partir des données météorologiques de la station de Sherbrooke (ville) entre 1904 et 1983.

Durant les 80 années à l'étude, on retrouve 42 années avec un été des Indiens, 6 années avec deux périodes et une année (1963) en contient trois, pour un total de 50 périodes. Trente-cinq périodes n'ont reçu aucune précipitation et quinze contiennent une journée avec moins de 1,3 mm de pluie (sauf la période du 14 au 18 octobre 1968 qui contient deux jours avec chacun 0,25 mm de pluie seulement). On compte seulement 5 périodes de trois jours comprenant une journée avec pluie. La proportion de périodes contenant une journée de pluie est plus forte dans les 40 dernières années : 10 périodes avec pluie sur 31 (32 %) après 1944, contre 5 sur 19 (26 %) avant 1944. La fréquence moyenne des étés des Indiens est de 6,25 fois par 10 ans et, compte tenu des années avec plus d'une période, on peut s'attendre à ce que 5,25 années sur 10 aient au moins un été des Indiens, soit une période de retour d'environ une fois sur deux. D'autre part, la probabilité d'apparition du phénomène deux fois dans le même automne est très faible, soit 8,7 %.

On ne trouve pas vraiment de différence notable dans la durée des périodes depuis le début du siècle; la durée moyenne des périodes, par décade, varie de 3,57 à 5 jours, le maximum appartenant à la décade 1904–1913. Par rapport à la moyenne des 80 années, qui est de 4,24 jours, les 5 premières décades sont au-dessus de cette moyenne. Il semble que la durée des périodes tend à diminuer depuis le début du siècle, mais pas de façon très significative. De plus, les périodes minimales de trois jours se concentrent en majorité dans les 40 dernières années (15 périodes de trois jours après 1944 contre 7 périodes avant 1944) et c'est ce qui cause la légère baisse des durées moyennes par décade.

Les moyennes des maxima de température ($\bar{T}$) de tous les étés des Indiens varient entre 18 et 25°C. On compte 24 périodes dont la température moyenne est supérieure à 21°C, soit presque la moitié du grand total. De 1904 à 1943, on a 11 périodes avec une température moyenne supérieure à 21°C, sur une possibilité de 19 (58 %), et 13 périodes sur une possibilité de 31 de 1944 à 1983 (42 %).

Globalement, les étés des Indiens de 1904 à 1983 se caractérisent par ces constatations : ils ont été plus nombreux dans les 40 dernières années, mais en général plus courts avec un nombre plus élevé de jours de précipitation, par rapport à ceux d'avant 1944 qui sont moins abondants mais plus secs et de plus longue durée, en plus d'avoir été relativement plus chauds.

Une analyse des dates d'apparition montre que l'été des Indiens semble se produire préférentiellement à l'intérieur des fenêtres du 3 au 9 octobre et du 14 au 19 octobre. Plus spéficiquement, la période de trois jours du 3 au 5 octobre est plus fréquente; huit périodes commencent le 3 octobre pour se terminer le 5 ou le 6. Les fréquences du 3, 4 et 5 sont d'ailleurs les plus élevées. Toutefois, bien que l'on puisse considérer ces deux périodes comme plus probables, la diffé-

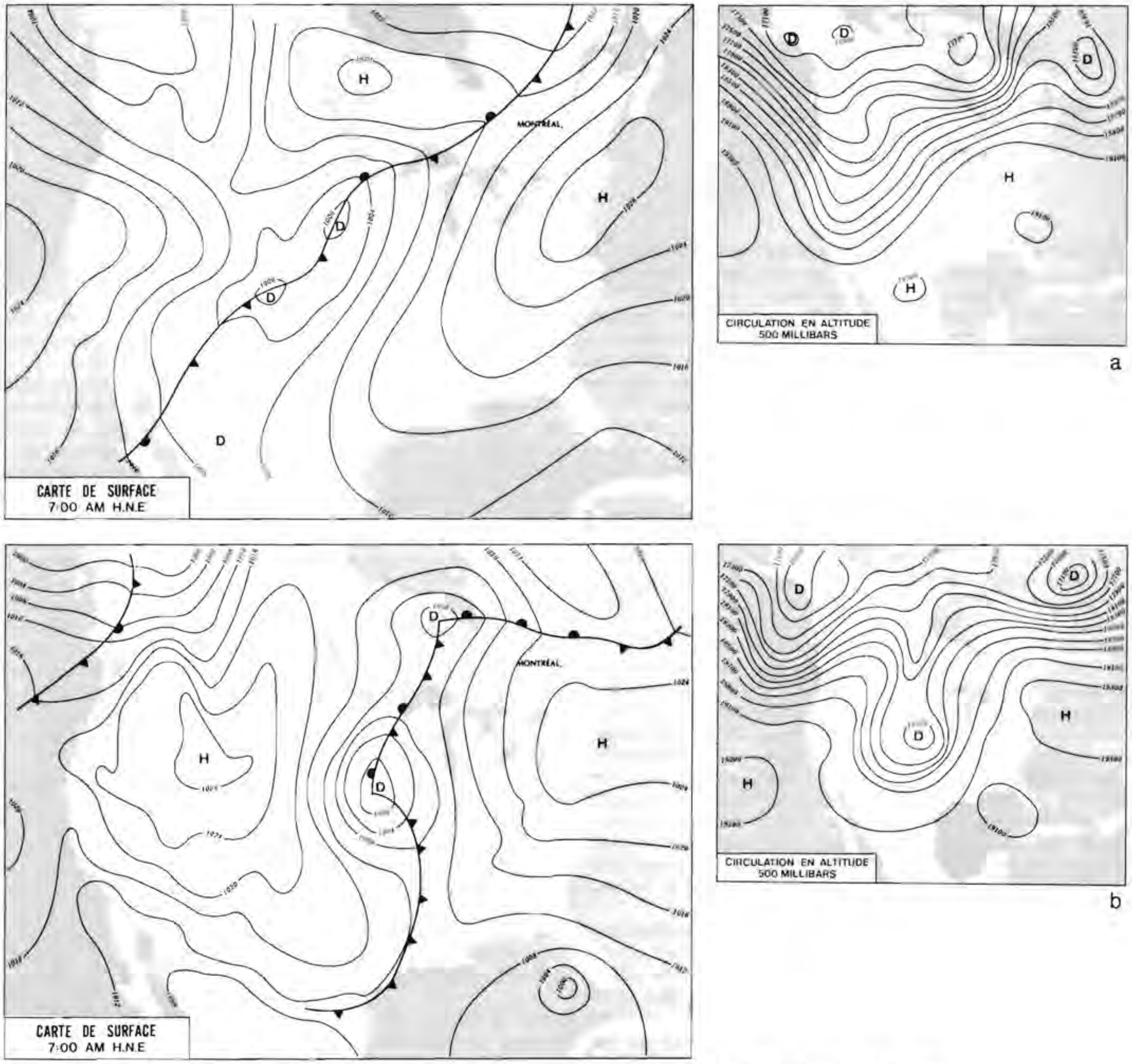


Figure 1 Cartes de surface et de 500 mb, à 0700 HNE pour le : a) 15, b) 17 et c) 18 octobre 1968.

rence avec les fréquences des dates intermédiaires n'est pas énorme. Aussi, peut-on dire que l'été des Indiens se produit le plus souvent entre le 3 et le 19 octobre.

QUELQUES ÉTÉS DES INDIENS EXCEPTIONNELS

Mentionnons d'abord quelques périodes exceptionnelles au niveau de la température :

- 5 au 11 octobre 1913 : sept jours avec $\bar{T}$ de 23,5°C;
- 4 au 8 octobre 1946 : cinq jours avec $\bar{T}$ de 25°C;
- 11 au 18 octobre 1947 : huit jours avec $\bar{T}$ de 23,5°C; et une T de 28°C le 17;
- 7 au 10 octobre 1970 : quatre jours avec $\bar{T}$ de 25°C;
- 20 au 23 octobre 1979 : quatre jours avec $\bar{T}$ de 24°C, particulièrement remarquable pour la fin du mois.

D'autres périodes méritent d'être soulignées pour certaines caractéristiques :

- 15 au 19 octobre 1908 : été des Indiens de 5 jours qui s'insère dans une période de sécheresse de 14 jours, du 13 au 26 octobre ($\bar{T}$ de 22,5°C);
- 7 au 14 octobre 1930 : période de huit jours consécutifs sans aucune précipitation, avec $\bar{T}$ de 21°C, et qui s'insère dans une période de sécheresse de treize jours du 2 au 14 octobre;
- 28 au 31 octobre 1935 : cette période n'a rien de vraiment exceptionnel, mais elle constitue un très bel été des Indiens tardif. C'est la période la plus tardive avec celle du mois de novembre 1944. On a quatre jours sans pluie, avec $\bar{T}$ de 21°C, ce qui est une très bonne moyenne pour la fin octobre;
- 11 au 16 octobre 1938 : période de six jours avec $\bar{T}$ de 23,5°C; température maximale exceptionnelle de 28°C le 12 et 13;
- 11 au 18 octobre 1947 : seule autre période de huit jours avec celle de 1930; elle contient toutefois une journée avec précipitation totalisant 0,5 mm le 13, et $\bar{T}$ de 23,5°C, ce qui est une excellente moyenne pour une longue

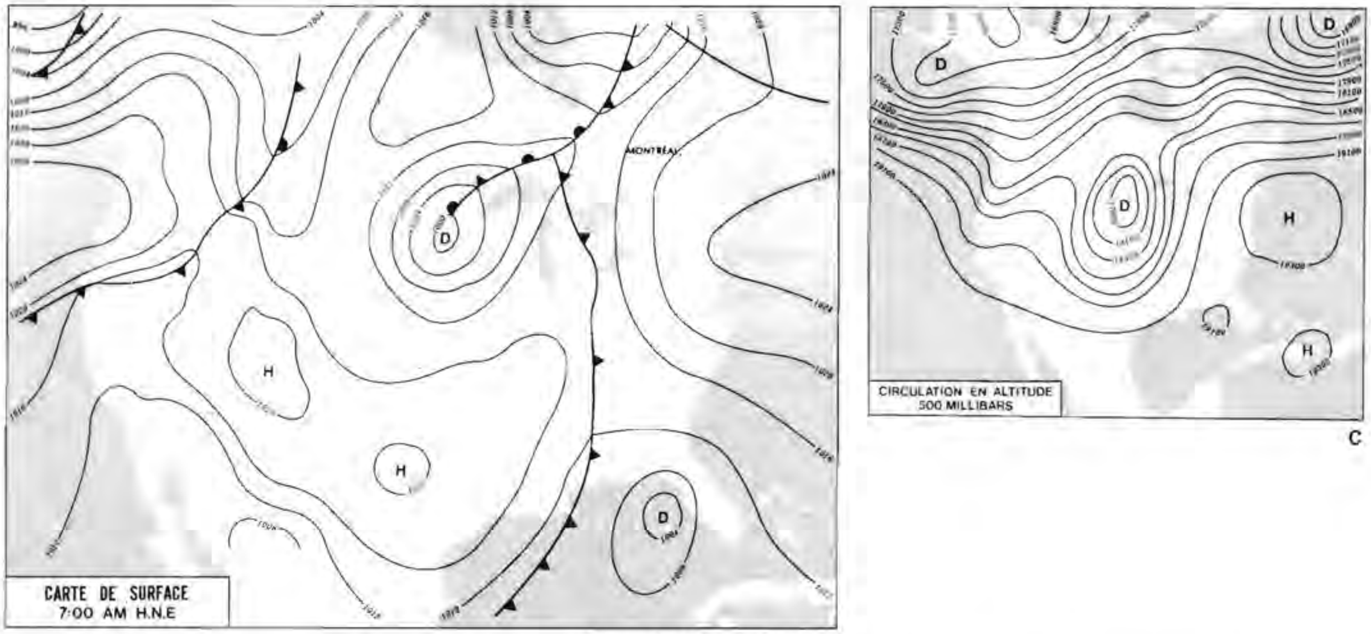


Figure 1 (Concluded).

période de huit jours;

- Octobre 1963 : le mois d'octobre 1963 fut vraiment unique, avec trois périodes d'été des Indines du 14 au 16, du 18 au 20 et du 23 au 27 octobre, et $\bar{T}$ de 20,5°C, 23,5°C et 21,5°C. De plus, ce sont des périodes sans aucune précipitation et toutes les journées sauf deux accumulent 6 heures ou plus d'ensoleillement. On retrouve également en octobre 1963 beaucoup de journées chaudes isolées.

CAUSES MÉTÉOROLOGIQUES

Toutes les définitions de l'été des Indiens sont unanimes à dire que les conditions synoptiques à la source du phénomène sont essentiellement dues à des zones stagnantes de haute pression qui se déplacent très lentement. Ce sont souvent des anticyclones sub-tropicaux, du moins pour certaines régions plus au sud, qui s'accompagnent généralement d'inversions de température maintenues par de l'air subsident : ils donnent à l'atmosphère ses traits caractéristiques, c'est-à-dire un ciel dégagé et des ventes légers, des journées chaudes accompagnées de brume sèche, et des nuits froides.

Les conditions atmosphériques typiques d'un été des Indiens se visualisent sur les cartes du temps de certaines périodes obtenues. La figure 1 représente les cartes du temps de l'été des Indiens du 15 au 18 octobre 1968.

Un centre de haute pression en provenance de l'ouest, passe au-dessus des Grands Lacs le 12 et le 13 octobre et s'installe sur nos régions le 14.

La journée suivante, le 15, le centre s'installe un peu plus au sud, couvrant la région située entre les Grands Lacs et l'Atlantique, de la frontière canado-américaine jusqu'à l'état de la Caroline du Nord environ. C'est un centre de haute pression typique de l'été des Indiens pour nos régions, où l'air polaire continental se réchauffe ou se « tropicalise » au-dessus de la Pennsylvanie. Nous sommes juste à la limite de la région touchée par l'anticyclone : un peu plus au nord, la région de Québec ainsi que le Nouveau-Brunswick sont couverts et reçoivent des précipitations.

En altitude, la circulation générale est lente et les vents sont du sud-ouest. Le 16 et le 17, la situation est encore mieux démontrée; les isobares contournent une dépression centrée au milieu des États-Unis, et de l'air chaud nous vient directement du sud et du sud-ouest. D'ailleurs les températures ont augmenté et atteignent 25,5 et 24,5°C le 16 et le 17 octobre.

Le 18, l'anticyclone disparaît finalement vers l'Atlantique, tandis qu'un front froid se situant sur les Grands Lacs se dirige vers l'est.

Reconnu depuis longtemps comme une période que l'on attend avec enthousiasme, l'été des Indiens n'est pourtant pas toujours aussi bien apprécié de nos jours, spécialement dans les grandes concentrations urbaines. L'absence de ventilation et la couche d'inversion ont pour effet d'empêcher la dispersion atmosphérique des polluants. Dans les grands centres industriels du centre et de l'est des États-Unis, l'été des Indiens ramène régulièrement des menaces de nouveaux épisodes de pollution intense, qui peuvent être dangereux pour la santé humaine. On pense à l'exemple désastreux de Donora en Pennsylvanie, où il s'est créé un smog dense et persistant entre le 25 et 31 octobre 1948. De même, une étude sur la pollution particulaire à Québec a aussi mis en évidence un épisode de pollution du 26 octobre au 7 novembre 1977 dont le début correspond à une de nos périodes d'été des Indiens (25 au 27 octobre 1977). Ainsi, le temps brumeux attribué autrefois aux feux des Indiens est aujourd'hui remplacé par l'accumulation des poussières et des polluants dans la basse troposphère.

BIBLIOGRAPHIE

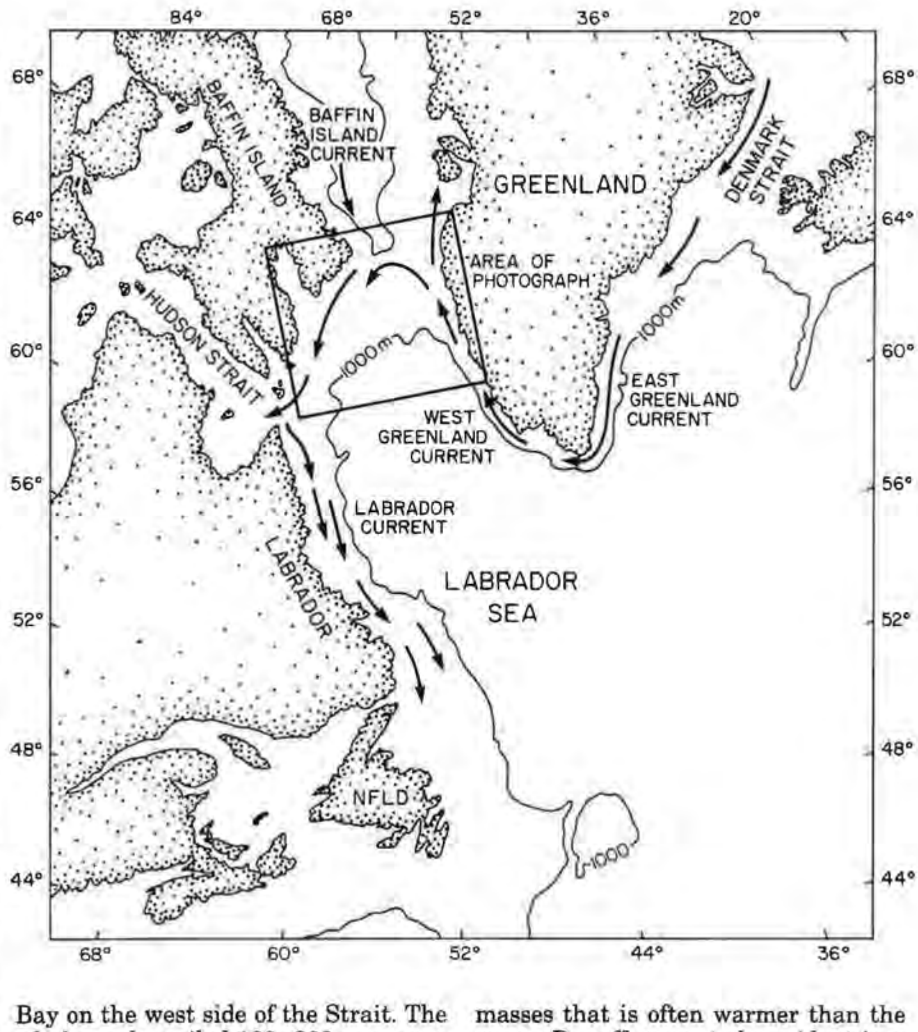
Gauthier, M. et J.J. Boisvert, 1984. L'été des Indiens en Estrie, Québec. Bulletin de recherche n° 79, Département de géographie, Université de Sherbrooke, 36 p.

Monique Gauthier a effectué un travail de recherche sur l'été des Indiens alors qu'elle était étudiante au département de géographie de l'Université de Sherbrooke. Elle complète présentement une maîtrise en sciences de l'environnement à la même université. Cet article a été rédigé lors d'un stage à la Direction de l'assainissement de l'air, Environnement-Québec.

SUMMARY *This article presents the results of a study aimed at defining and characterizing the climatological phenomenon known as Indian summer. A set of criteria were chosen to represent Indian summer in the Eastern Townships (Québec). A set of statistics on Indian summer are presented along with maps showing the general meteorological pattern during such a period.*

DAVIS STRAIT IN THE INFRARED

by John Lazier

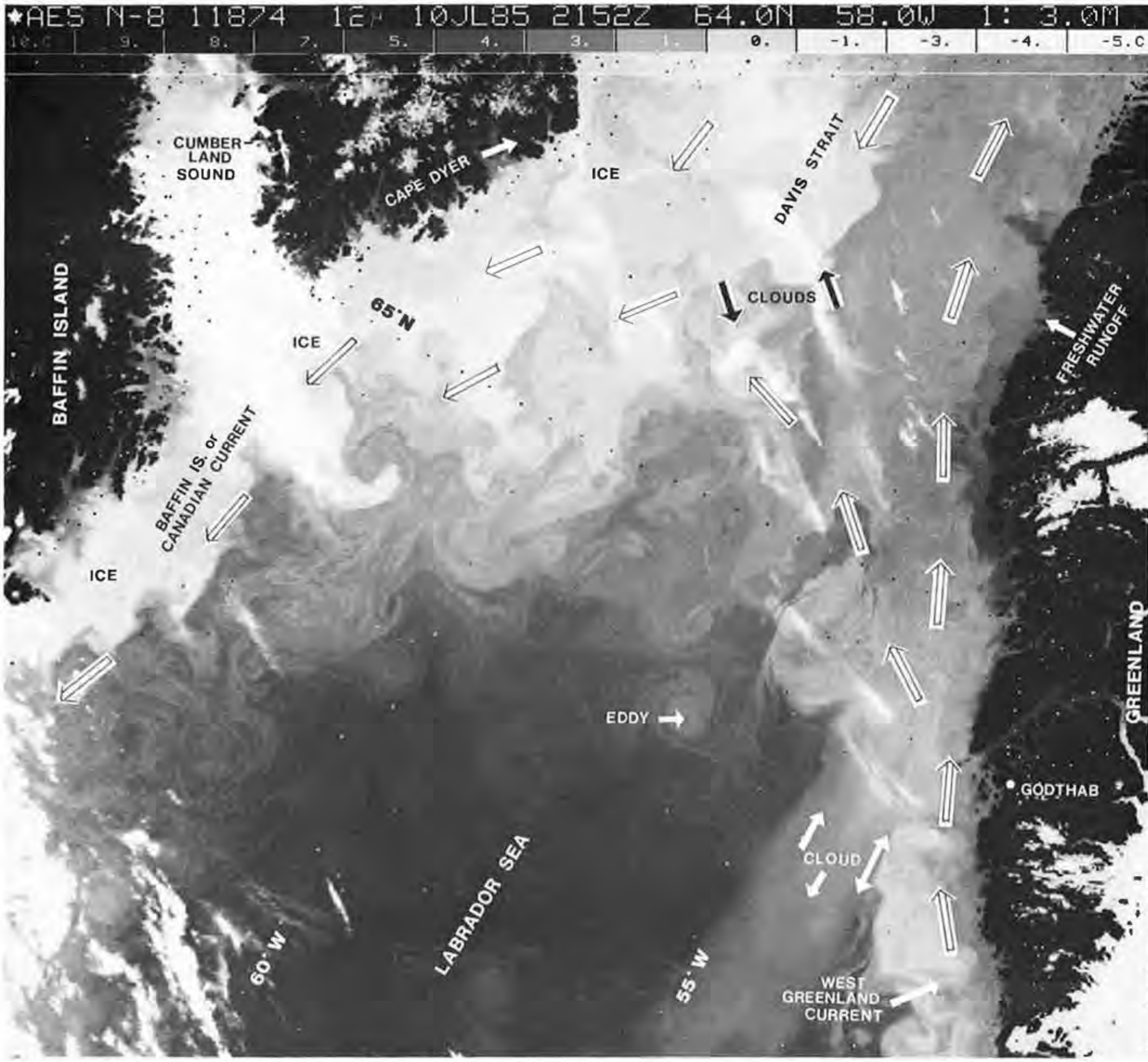


The photograph (Figure 1) was taken in the infrared on 10 July 1985 by the NOAA-8 satellite at a wavelength of 12 micrometres. Since the amount of energy emitted by the earth at this wavelength depends on its surface temperature, this figure depicts the temperature pattern of the earth's surface. The darkest areas, the land, radiate the most energy and are warmest at about 10°C; the white areas, clouds, ice and cold water, radiate the least energy and are the coldest. The grey areas are water between 0 and 7°C.

In the picture, as indicated on the map, the coast of Greenland is on the right and Baffin Island at the top left. The water between is Davis Strait, which becomes the Labrador Sea, farther south at the bottom. The most prominent oceanographic features are the bands (light grey and white) of cold water lying next to Greenland and Baffin Island. The band west of Greenland is part of the West Greenland Current; the band east of Baffin Island is the Baffin Island or Canadian Current. The latter current transports cold low-salinity water south out of Baffin Bay along the east coast of Baffin Island to Hudson Strait. This southward flowing water then becomes part of the Labrador Current. The West Greenland Current flows north from Cape Farewell at the southern tip of Greenland. The cold water in the Current flows from the Arctic through Denmark Strait, then south along the east coast of Greenland before turning north at Cape Farewell. The water in the West Greenland Current moves north towards shallower water in Davis Strait. However, all the water moving north cannot flow through, so that some is deflected west to the south of Davis Strait. This westward flow is confirmed in the photograph by the band of darker grey at about 65°N, halfway between the land masses. Some of the cooler water in the West Greenland Current does continue north through Davis Strait but it has become quite a bit warmer than it was originally and is certainly warmer than the water flowing south out of Baffin Bay on the west side of the Strait. The whalers who sailed 100–200 years ago to Baffin Bay knew and took advantage of this northward flowing water because it is warmer and more ice-free than the southward flowing water to the west.

These main features, the two cold currents with the warmer water between, are always seen on infrared pictures of this area. Ships will always find cold, low-salinity water in bands 50–100 km wide next to Greenland and Baffin Island. The details or small-scale features are, however, never the same; they are formed by irregular motions on many scales or by such factors as wind and freshwater runoff from nearby land masses that is often warmer than the ocean. Runoff seems to be evident in a dark strip of warmer water next to the Greenland Coast north of Godthab.

The swirls and eddies are made visible by the intermixing of waters of different temperatures. Many of these eddies form because the large currents near the coasts, the West Greenland and Baffin Island Currents, become unstable under certain circumstances and partly break up into waves and eddies. Other irregularities in the flow can be caused when the current is forced to flow over a bottom that is rapidly changing depth. The large tongue of cold water flowing out of Cumberland



Atmospheric Environment Service

Figure 1 Infrared image taken on 10 July 1985 at 2152 GMT by the NOAA-8 satellite.

Sound may have been pushed there by the wind. It should be noted that the direct observations needed to verify all these features are difficult to collect.

Clouds and ice can also be seen. To the right, wisps of cloud, some white and some grey, extend from the top to the bottom. Cloud also appears in the bottom left. It is sometimes hard to distinguish between areas of water and cloud, expecially if they have nearly the same shade. However, the fine structure of water is usually quite different from that of cloud; after some experience the two are easily identified.

Ice is more difficult to detect in these pictures because its temperature is almost always nearly the same as the water's . In another photograph (not shown here) taken in the visible part of the spectrum, it is much easier to distinguish ice from water because intensity in the image depends on surface reflectivity, which is much different for ice and water. The visible picture for 10 July 1985, indicates a fair amount of ice in Cumberland Sound and all along the Baffin Island coast from Cape Dyer south, even though this does not show up in the infrared picture. The ice and snow on the highlands of Baffin Island and Greenland are easy to pick out because they are much colder than their surroundings.

John Lazier is a physical oceanographer and research scientist with the Department of Fisheries and Oceans, in the Ocean Circulation Division of the Bedford Institute of Oceanography at Dartmouth, Nova Scotia. His research specialties are ocean currents and water mass properties in the northwestern North Atlantic. During the last 20 years he has led numerous oceanographic expeditions to the Labrador Sea.

TORNADO PREPAREDNESS

ALERTE EN CAS DE TORNADES

by/par Michael Newark

What is the difference between a "Watch" and a "Warning"?

Two types of message are used to communicate the hazard of severe local storms to the general public by the Atmospheric Environment Service of Environment Canada. Usually the first message that will be heard is the "severe thunderstorm watch". This is based upon an academic assessment of the weather situation and is intended to alert the public that there is potential for severe local storms in a certain area at some later time. This type of message implies "nothing is happening yet, but watch out and listen for warnings". When severe local storms are impending, or have actually been reported or observed by the surveillance system, then "Severe Thunderstorm Warnings" or "Tornado Warnings" are issued and updated. Warning messages mean business because things are happening, and all interests in the warning area should either take safety precautions or be prepared to do so.

It is important to realize that tornadoes are produced by severe thunderstorms; therefore the severe thunderstorm warning should be given the same amount of respect that is generated by an actual tornado warning. Sometimes, in fast-breaking situations, it is not always possible to precede the "Warning " message by a "Watch".

How are "Watch" and "Warning" messages communicated?

The most common method is by means of commercial radio and television broadcasts. They are also made available to the Canadian Coast Guard who retransmit them on marine radio channels. Police and other special agencies receive them on telex circuits.

There is, however, one method of communication, namely Weatheradio Canada, which can reach many Canadians individually if they buy a special but inexpensive portable radio receiver.

What is Weatheradio Canada, and how can it be used to receive warnings?

It is a service operated by Environment Canada from studios and transmitters at 13 major cities across the country, with 31 repeater stations in the Atlantic Provinces. This network broadcasts continuously on the VHF/FM band at three frequencies (162.40, 162.475 and 162.55 MHz).

Watches and warnings are broadcast by these stations as soon as they are issued, and special tones automatically activate receivers that are equipped with alarms. Clearly this is a much better way of receiving warnings than any other. Pocket-size receivers can be carried on fishing trips, picnics, while shopping, and on all types of outdoor excursions and activities where an individual may be out of sight and sound of regular radio and television broadcasts. Any weather-sensitive operation within range can receive an immediate, individual alarm.

Quelle diffférence existe-t-il entre une « veille » et un « avertissement »?

On se sert de deux sortes de messages pour signaler au public le risque que présentent les perturbations locales violentes par le Service de l'environnement atmosphérique d'Environnement Canada. D'ordinaire, le premier message diffusé est la « veille d'orage violent », découlant de l'évaluation de la situation météorologique et destinée à prévenir le public de la possibilité ultérieure de violentes perturbations locales dans une certaine zone. Ce type de message laisse entendre que « rien ne se passe pour le moment, mais qu'il faut être sur ses gardes et se mettre à l'écoute des avertissements éventuels ». Quand de violentes perturbations locales menacent de se déclarer ou que le système de surveillance en a signalé, on émet et met à jour des « avertissements en cas d'orage violent » ou des « avertissements en cas de tornade ». Il convient de prendre ces messages au sérieux, car il se passe bel et bien quelque chose. Toutes les personnes se trouvant dans les zones prévenues doivent soit prendre des mesures de sécurité, soit être prêtes à le faire.

Il est important de noter que les tornades prennent naissance dans des orages violents et qu'un avertissement pour de tels orages doit être traité aussi sérieusement qu'un avertissement pour des tornades. Lorsque la situation évolue rapidement il n'est pas toujours possible de faire précéder le message d' « avertissement » d'une de « veille ».

Comment sont distribués les messages de « veille » et d' « avertissements » ?

Géneralement par les postes de radio et télévision commercials, mais la Garde côtes canadienne les retransmet aussi sur les fréquences radio marines. La police et d'autres agences spécialisées les reçoivent par telex.

Il existe toutefois une méthode de communication directe par l'intermédiaire de la « Radiométéo » que l'on capte sur des récepteurs portatifs à bon marché et qui peut rejoindre ainsi individuellement de nombreux canadiens.

Qu'est-ce que Radiométéo Canada et comment s'en servir pour recevoir les avertissements?

Il s'agit d'un service exploité par Environnement Canada à partir de 13 villes de l'ensemble du pays et doté, dans les provinces de l'Atlantique, de 31 station-relais. Ce réseau diffuse en permanence sur la bande THF/MHz trois fréquences (162,40 MHz, 162,475 MHz, 162,55 MHz).

Ces stations diffusent les veilles et les avertissements dès qu'elles les ont reçues et une tonalité spéciale déclenche automatiquement les récepteurs pourvus de l'alarme. C'est sans conteste la meilleure façon de recevoir les avertissements. On peut transporter ces récepteurs, qui tiennent dans la poche, à des parties de pêche, à des pique-niques, lors d'emplettes et à toutes sortes d'excursions et activités de plein air, partout où l'on n'a pas accès aux émissions normales de radio et de télévision. Toute exploitation sensible au temps à portée d'une station peut recevoir une alarme immédiate et individuelle.

THE "BLACK FRIDAY" TORNADO OUTBREAK IN ONTARIO

A Forecaster's View of the Events of May 31, 1985

by Michael Leduc, Ole Jacobsen and Barry Greer

During the afternoon of May 31, 1985 a well-marked cold front moved through southern Ontario triggering a series of very damaging tornadoes. Twelve people were killed and scores of others injured as the storms crossed the Province. Property damage is estimated at well over $100 million (see article by Mark Ransom on pages 4–5).

METEOROLOGICAL CONDITIONS

On May 30th very warm, humid tropical air became established across the central United States. The air was also very unstable, meaning that with any sort of lifting mechanism very intense thunderstorms could develop. During the early afternoon a weak disturbance crossed Lake Erie and allowed some of this tropical air to enter extreme southwestern Ontario.

Another weak disturbance during the morning of May 31st pushed the warm humid air northeastward producing thunderstorms across all of southern Ontario. No damage was reported from these thunderstorms in Ontario but the arrival of the warm, very unstable air mass set the stage for the very dramatic events of later that day.

While the warm humid air was becoming established across the south half of Ontario an intense spring storm was developing just west of the Great Lakes. A low pressure centre with a strength more typical of a midwinter storm tracked across upper Michigan during the morning of May 31st to north of Sudbury by evening. A very sharp cold front trailed southward from this low pressure system.

The morning analysis at Environment Canada's Ontario Weather Centre (OWC) indicated that the thermodynamic and dynamic features necessary for the possible development of severe thunderstorms were present. The thermodynamic instability of the air mass was confirmed from the radiosonde reports east of the cold front crossing Michigan. The air layer above one kilometre was very dry and cool while the tropical air mass near the surface was very hot and moist. The dynamic features (triggering mechanisms) were strong, that is, a sharp cold front and a sharp upper trough crossing Michigan and a very strong westerly jet stream above 10 km with winds close to 400 km/h (200 knots). The cold front and upper trough were expected to cross southern Ontario during the afternoon and early evening.

SEVERE WEATHER WATCHES

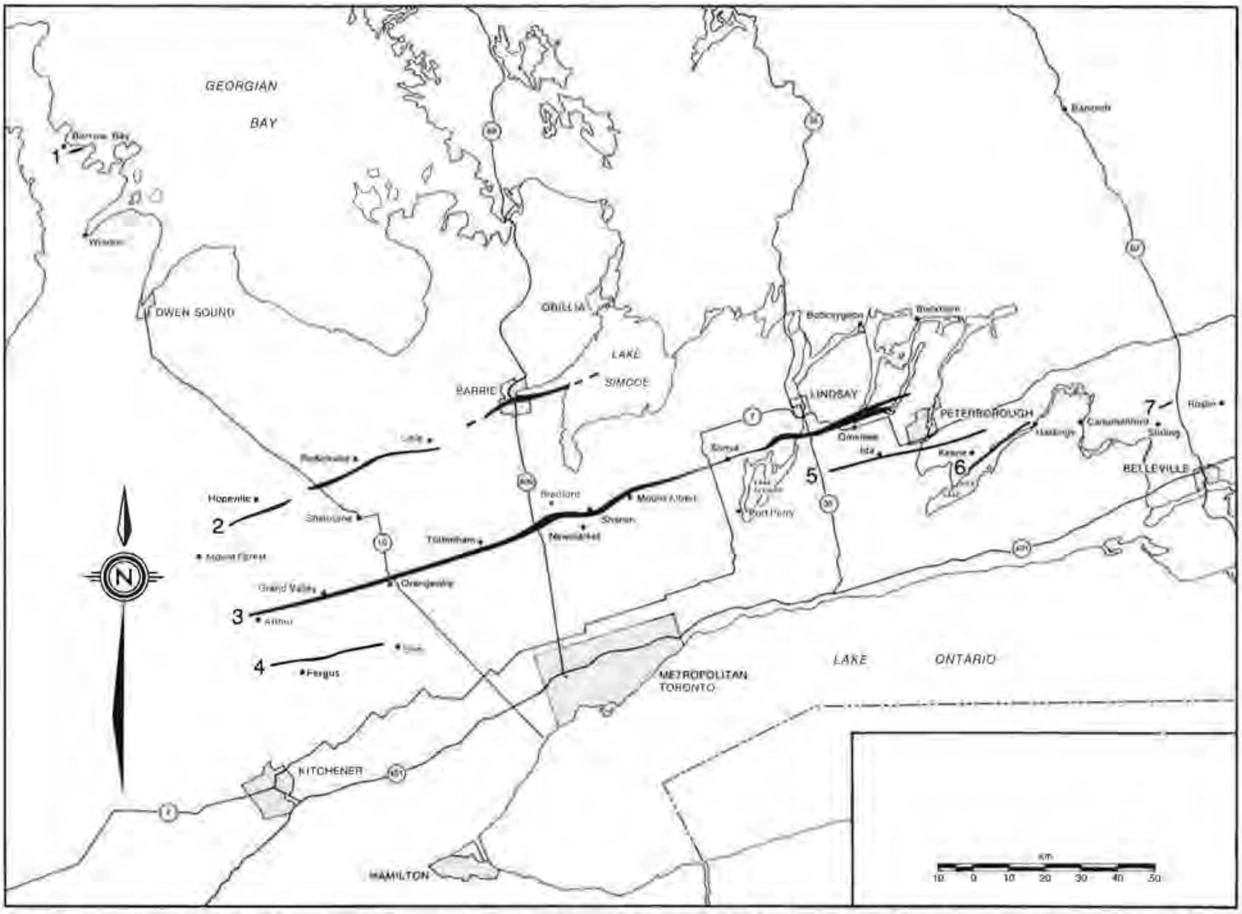
As a result, the Severe Weather Watch originally issued at 2:40 a.m. on May 31st, was updated and extended for all of southern Ontario at 7:00 a.m., 9:20 a.m. and 1:50 p.m. advising of the potential for the development of severe thunderstorms later in the afternoon and early evening. It was anticipated that these thunderstorms would be very strong since the cold front and trough were crossing the province near the time of maximum surface heating (late afternoon), which would produce the maximum thermodynamic instability in the air mass.

By noon on the 31st the thunderstorm activity associated with the weak disturbance that had affected southern Ontario overnight had virtually ceased. Radar reports presented no evidence of any thunderstorms along the cold front approaching the Bruce Peninsula from Lake Huron.

THE SEVERE WEATHER EVENT AND THE SEVERE WEATHER WARNINGS

At 1:40 p.m., radar showed the first thunderstorm cells developing west and north of the Bruce Peninsula. By 2:20 p.m. a line of potentially severe storms was indicated by radar (Figures 1, 2 and cover) to extend from the mouth of the French River to just off the Bruce Peninsula, with more cells beginning to form farther south. The first severe thunderstorm warnings were issued for Bruce County and Parry Sound District at 2:25 p.m. These severe thunderstorm warnings issued by the Ontario Weather Centre contained the statement: "Remember, some severe thunderstorms produce tornadoes." The line of severe storms continued to develop. Warnings were issued for Huron, Perth, Grey, northern Wellington and northern Waterloo Counties at 3:15 p.m. (Figures 3–6). The most severe storms on radar appeared to extend from Meaford to Perth County. Initial on-site observations of the severity of the storms were

Genesis and evolution of a tornado that occurred at Winnipeg International Airport on August 3, 1969 at 7:30 p.m. CDT (Photographs: John Alcock).



The damage tracks of the May 31, 1985 tornado outbreak as of June 16, 1985. Statistics of each track can be found in Table 1.

received by the Ontario Weather Centre at about 4:00 p.m. indicating that 2-cm hail and very high winds had occurred near Meaford and in the Dundalk area. However, no damage was reported up to that time.

Around 4:00 p.m., radar (Figures 7 and 8) revealed a line of severe thunderstorms from near Collingwood to eastern Perth County, which was moving east at 60 to 70 km/h. At 3:45 p.m. severe thunderstorm warnings were in effect to cover areas downstream as far east as Simcoe County and northern Peel County. Between 4:20 and 4:40 p.m. (Figures 9 and 10) there were indications that the southern end of the line was intensifying, so that warnings were issued at 4:53 p.m. to cover the counties along the west end of Lake Ontario from Hamilton-Wentworth to Durham and Victoria Counties. Following a confirmed report of a tornado at Shelburne, a tornado warning was issued at 5:00 p.m. for southern Simcoe, northern Peel and York Counties (Figure 12).

Reports of the tornadoes at Grand Valley and Barrie were received by the Ontario Weather Centre at 5:00 and 5:20 p.m., respectively. Tornado warnings were issued at 5:40 p.m. for the downstream areas of northern Durham, Victoria and Haliburton Counties. Radar reports between 5:20 and 5:40 p.m. (Figure 11) also indicated the very rapid development of storms moving across eastern Lake Erie to the Niagara Peninsula. As a result, at 5:50 p.m. severe-storm warnings were issued for the Haldimand-Norfolk and Niagara Regional Municipalities.

Further details on tornadoes in Orangeville and in the Tottenham area came into the Ontario Weather Centre between 5:30 and 6:00 p.m. Based on the continuing strength of the radar echoes, tornado warnings were extended to southern Durham and Peterborough Counties at 6:05 p.m., and to Haliburton, Northumberland, Prince Edward and Hastings Counties at 6:25 p.m. At 7:00 p.m. all watches and warning messages were cancelled for all regions except for Haliburton County and Lake Ontario east of Oshawa. Between 6:40 and 7:20 p.m., reports were received about tornadoes just southwest of Peterborough and in Rawden Township of southern Hastings County (Figures 13 and 14).

At 7:10 p.m. the tornado warning was extended east again to include Lennox and Addington, Renfrew and Frontenac Counties, which mark the easternmost areas served by the Ontario Weather Centre. At about the same time, the Québec Weather Centre in Montréal, which handles forecasts for Ottawa-Cornwall and vicinity, was notified of the continuing presence of tornadoes in the storms headed their way. Finally at 9:20 p.m. the remaining watches were cancelled for eastern Ontario.

TORNADO PATHS AND TIMES

The tornado path and time estimates contained in this report were determined from aerial surveys and on-site investigations of the tornado paths carried out by staff from the Ontario Weather Centre and various Regional and Headquarters units, provincial police reports, photographs, newspaper clippings, weather watcher reports, and eyewitness accounts.

Numerous reports of large hail and damaging winds were received on May 31st as the severe thunderstorms developed and moved across southern Ontario. In particular, over the southern Niagara Peninsula hail as large as softballs was reported. Fortunately, these storms missed the fruit belt north of the escarpment. However, in the Welland and Port Colbourne areas there were numerous reports of damage

Table 1 Preliminary summary of damage statistics. The values are not definitive, but only indicate the order of magnitude of the damage dimensions, tornado times and strengths.

Track Number	Damage Dimensions: Overall Length (km)	Average Width (m)	Area (km^2)	Maximum Strength (F-Number)	Estimated Time (p.m.): Touchdown	Lift-off	Number Killed
1*	2	unknown	unknown	strong (F2)	3:00	unknown	0
2	85	300	25	violent (F4)	4:10	5:00	8
3	190	300	60	violent (F4)	4:15	6:15	4
4	33	50	2	violent (F3)	4:20	unknown	0
5	45	70	3	violent (F3)	6:15	unknown	0
6*	11	unknown	unknown	strong (F2)	6:25	unknown	0
7*	1	15	<0.1	strong (F2)	6:35	unknown	0

Notes:

a) An asterisk (*) indicates damage tracks that had not been completely field surveyed as of June 16, 1985.

b) Damage to trees was reported at Lyndhurst (downtrack from number 7).

c) Damage to trees and trailers was reported in the vicinity of Stony Lake and north of Bobcaygeon (exact locations unavailable). This could be an extension of track number 2.

d) Damage to farm property and light airplanes was reported in and near Ottawa.

e) Softball-size hail was reported near Welland and Port Colborne.

f) A possible tornado touchdown was reported at St-Canute, Québec (near Mirabel) at about 10:30 p.m.

to cars and property due to the extremely large hailstones. An estimated 40 people suffered minor cuts due to flying glass. Preliminary estimates of hailstorm damage were in excess of $1 million.

The general area affected by severe thunderstorm activity is depicted in the map of southern Ontario, which also shows the approximate locations of all confirmed tornadoes.

The accompanying table provides a detailed comparison of the times of tornado occurrence in each county with the times of issue of severe thunderstorm warnings and tornado warnings. For counties west of Lake Simcoe severe thunderstorm warnings were issued 45 minutes to one hour in advance of the occurrence of the tornadoes. From Lake Simcoe eastward, once tornadoes had been reported, tornado warnings were issued 15 to 45 minutes in advance of the tornado occurrences.

County	Issue Times (p.m.): Severe Thunderstorm Warning	Tornado Warning	Time of Tornado Occurrence
Northern Bruce	2:25	—	3:00, Rush Cove tornado
Northern Wellington	3:15	—	4:15, Tornado touchdown near Arthur
Dufferin	3:54	—	4:28, Grand Valley 4:45, Orangeville
Southern Grey	3:15	—	4:17, Tornado touchdown near Corbetton
Southern Simcoe	3:54	5:00	5:18, Holland Landing
Northern Simcoe	3:54	—	5:00, Barrie
Northern York	4:53	5:00	5:25, Holt
Northern Durham	4:53	5:20	5:40, Wagner Lake
Southern Victoria	N/A	5:20	6:05, Reaboro
Southern Peterborough	N/A	6:05	6:20, Cavan 6:25, Birdsall
Southern Hastings	N/A	6:25	6:35, Minto

AWARD-WINNING PERFORMANCE

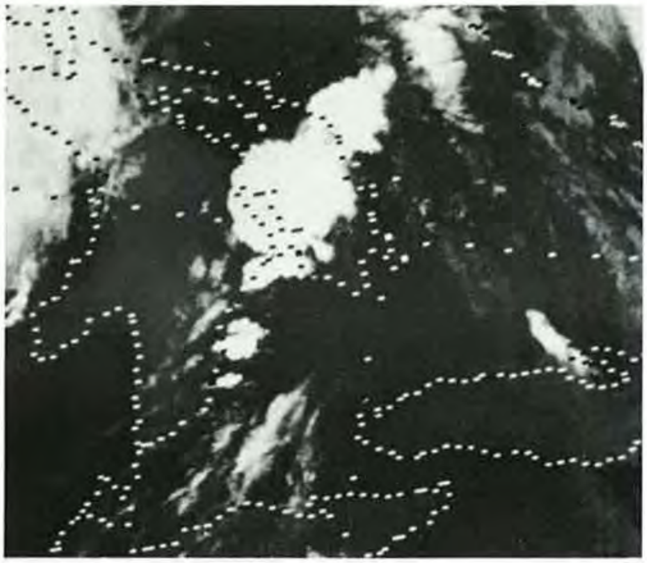
On July 18, 1985, Jim Bruce, the Assistant Deputy Minister responsible for the Atmospheric Environment Service, presented AES Achievement Awards to staff of the Ontario Weather Centre. The Award, the first of its kind in the Service, recognized the outstanding manner in which the OWC forecast team handled the severe weather event of May 31st. Mr. Michael Leduc, the senior Summer Severe Weather Meteorologist at OWC, was singled out for an individual award for his outstanding skill and leadership.

Figures overleaf in colour **Radar charts corresponding to the adjacent satellite photographs. The radar instrumentation is located at King City (north of Toronto) operating at a wavelength of 5 cm.**

The MAXR (Maximum Rainfall Rate) charts (Figures 6, 9 and 11) indicate the strongest radar returns in a vertical column. The chart colour scheme is in the upper left-hand corner. Each colour represents a range of precipitation rates or echo top heights. For example, blue indicates rainfall rates between 8.0 and 15.9 mm/h or highest radar returns between 10.0 and 11.9 km. The numbers in the lower left show the areas corresponding to the colours, along with the total area.

The ECHO TOPS charts (Figures 2, 4 and 7) indicate the heights of the highest radar returns, and represent the vertical distribution of rainfall.

The green numbers and letters lying outside the red circle (220 km from the centre) indicate the lightning flash occurrences in the adjoining 10-degree sectors during the five minutes prior to chart time. Each number must be doubled to obtain the actual number of flashes, e.g., 8 indicates 16 flashes; A, 20; and C, 24.



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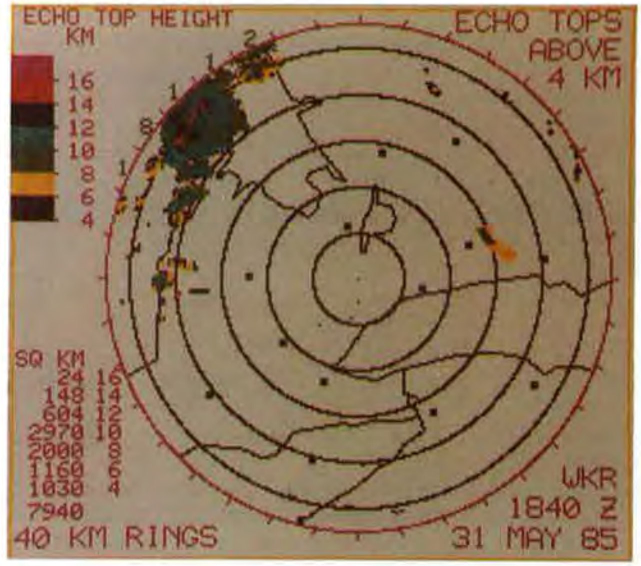

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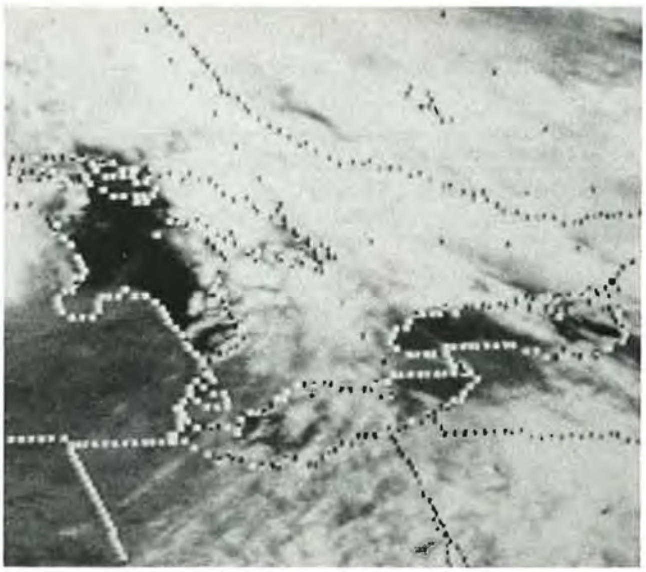

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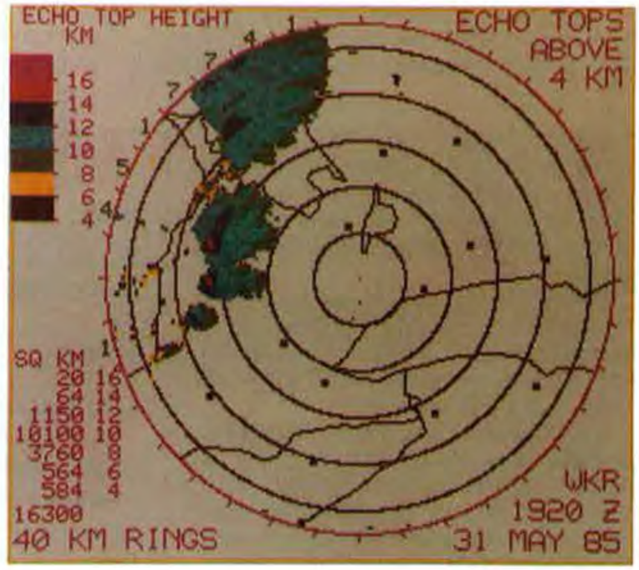

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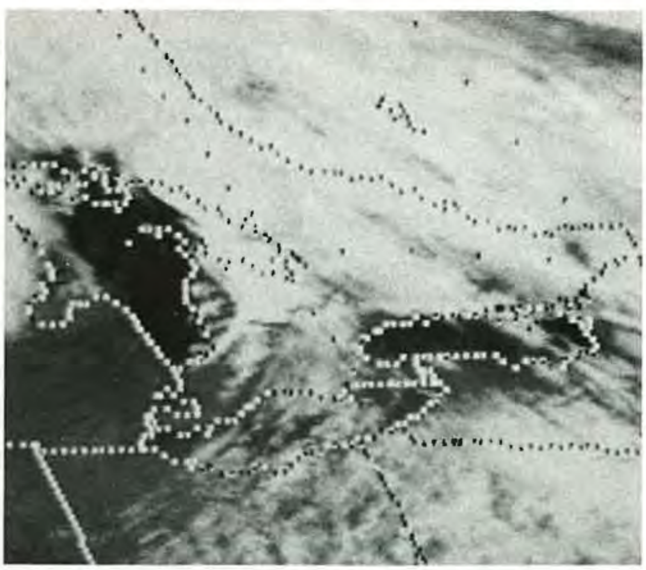

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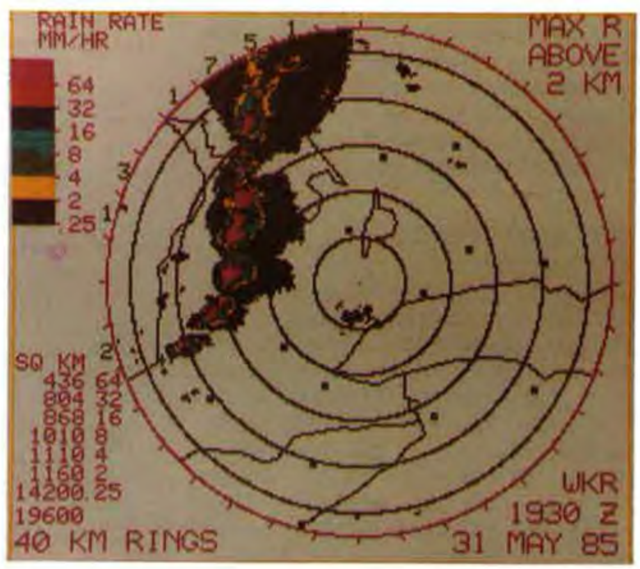

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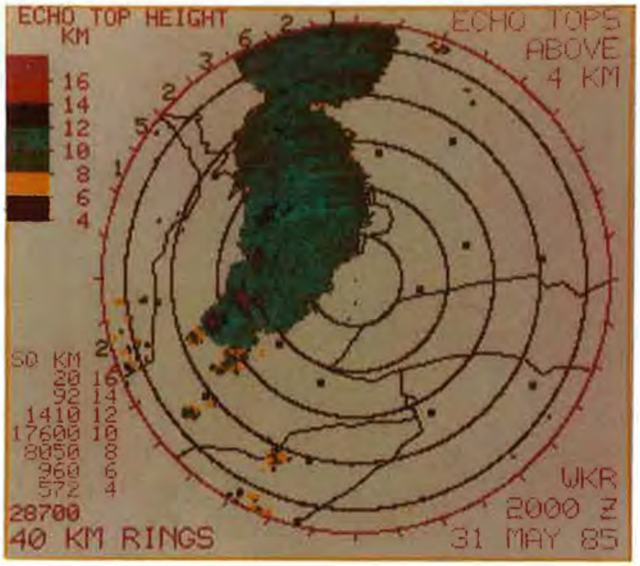
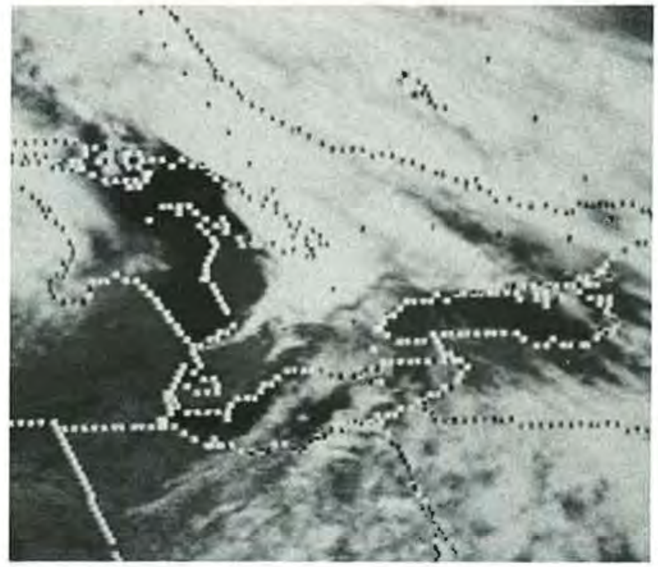
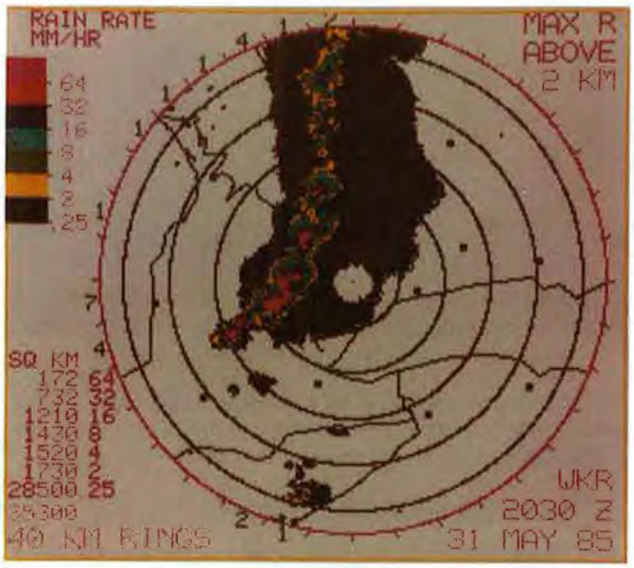
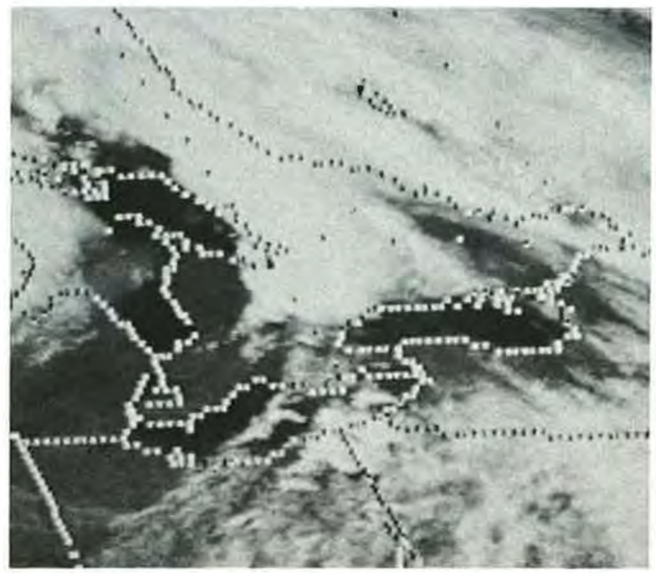
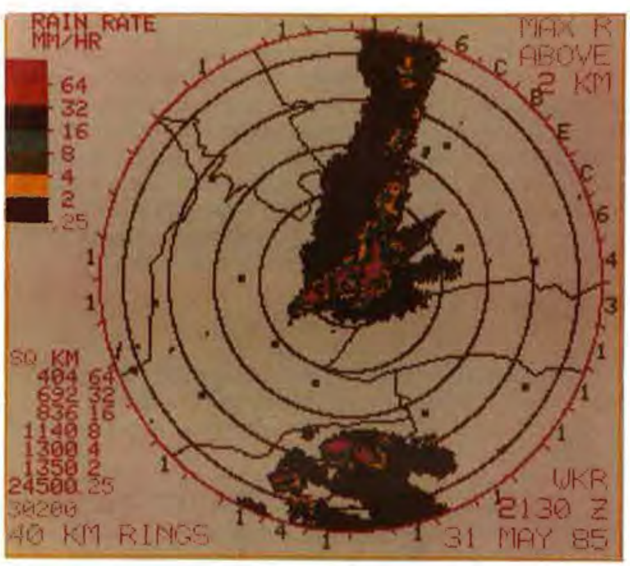
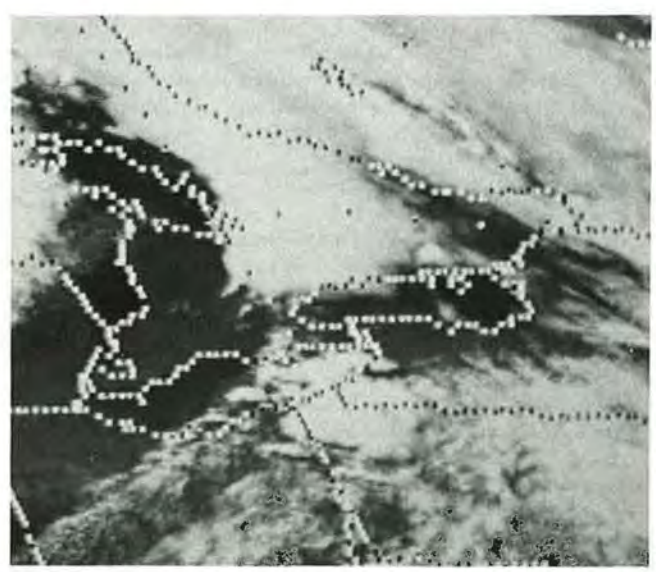
Satellite photographs and colour radar charts illustrating the movement and the development of the line of severe thunderstorms on May 31, 1985. *Figure 1* The NOAA-9 near-infrared (11-micrometre) image at 2:54 p.m. showing the line of developing thunderstorms extending from Sudbury across the Bruce Peninsula. *Figure 3* The GOES (Geostationary Satellite) image at 3:01 p.m. showing the clearing wedge behind the developing line of thunderstorms. *Figure 5* The line of severe thunderstorms at 3:31 p.m., 7 

 8

9 

 10

11 

 12

east of the Bruce Peninsula. *Figure 8* At 4:01 p.m. the sharp back edge of the line of severe storms is clearly shown. *Figure 10* The tornadic storms at 4:31 p.m. moving eastward north of Toronto. Also notice two developing lines of thunderstorms across Lake Erie and moving through northern Ohio and Pennsylvania. *Figure 12* The 5:01 p.m. GOES image shows the storms when reports of tornadoes at Grand Valley and Barrie were received. The line of thunderstorms over eastern Lake Erie and northwestern Pennsylvania have reached the severe stage.

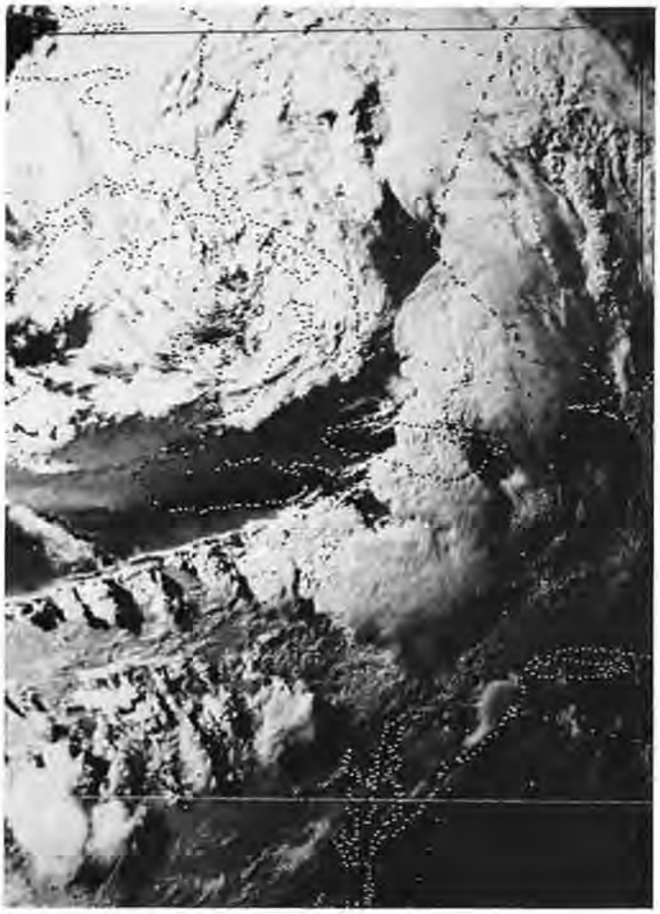


Figure 13 Visual.

Figure 14 Near-infrared (11 micrometres).

NOAA-6 images for 7:05 p.m. Figure 13 very clearly shows the line of severe thunderstorms and the eastward shadows of the anvils over northern Ohio, Pennsylvania and New York States. Figure 14 illustrates the cold, high-level thunderstorm tops as bright areas. A line of developing thunderstorms can be identified in both figures over La Verendrye Provincial Park in southwestern Québec (at upper right).

FURTHER READING

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Staff from the following units of the Atmospheric Environment Service contributed to the content and details of this article: Ontario Weather Centre, Ontario Region Scientific Services Division, and the Peterborough and Kingston Weather Offices. The article is in part adapted from the preliminary OWC report by Lawrynuik et al. (1985).

RÉSUMÉ *La tornade dévastatrice qui a frappé le nord de Toronto le 31 mai 1985 s'est formée suite à une combinaison favorable des facteurs dynamiques et thermodynamiques, dans l'atmosphère. De l'air chaud et humide à la surface devant un front froid, en combinaison avec un creux en altitude et un fort courant-jet d'ouest ont entraîné le développement d'orages violents tôt dans l'après-midi. Le personnel du Centre météorologique de l'Ontario a observé sur radar, à intervalles de 20 minutes, la formation de ces orages dans la péninsule Bruce et leur évolution vers l'est dans l'après-midi.*

Une veille de temps violent a été diffusée à 2h40, puis mise à jour à 7h00, 9h20 et 13h50. À 14h25, le premier avertissement d'orages violents qui était diffusé pour les comtés de l'ouest incluait le message suivant : « certains orages violents produisent des tornades ».

Vers la fin de l'après-midi, des tornades étaient signalées et l'on émettait des avertissements de tornades.

L'article décrit dans un certain détail la progression des prévisions, des veilles et des avertissements pour cette journée; on emploie aussi les cartes radar et les images satellitaires appropriées. Les trajectoires de plusieurs tornades sont aussi décrites. Ailleurs dans ce numéro, on trouvera des articles en francais sur le temps violent en été ainsi que des conseils sur la sécurité.

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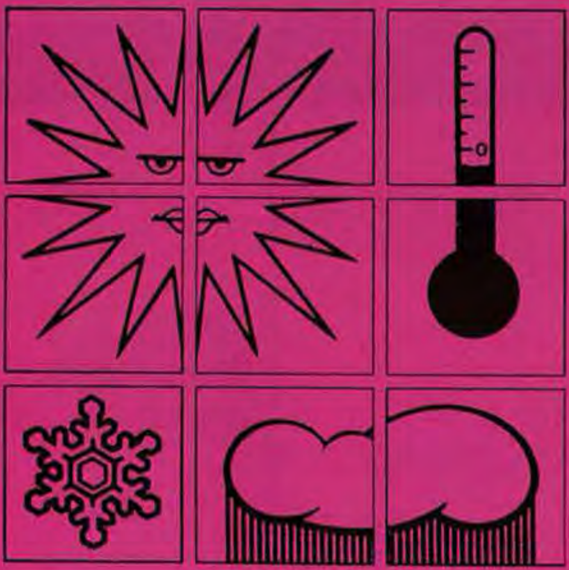

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