Chinook

THE CANADIAN MAGAZINE OF WEATHER AND OCEANS

LA REVUE CANADIENNE DE LA MÉTÉO ET DES OCÉANS

VOL.7 NO.1 WINTER/HIVER 1985

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FROM THE EDITOR'S DESK

With the mailing of this issue we hope to be on target again; subscribers will be receiving the other issues of Volumes 7 at normal quarterly intervals. Volume 7 will feature a mixture of meteorological and oceanographic articles and will aim at providing some in the French language. Summaries in the other official language will be provided. In a future issue an English article about a Canadian contribution to the Olympic Games will be featured. We will also try to keep our covers attractive and colourful. We look forward to your comments and contributions.

Hans VanLeeuwen
Editor

AILLEURS

Climats du monde

L'Organization météorologique mondiale a récemment publié la classification des climats du monde d'après la méthode développée par le professeur J. Litynski de l'Université du Québec à Trois-Rivières. Une magnifique carte de grand format (166 cm × 120 cm) est également disponible aux Editions Gamma, C.P. 366, Pierrefonds, Québec, H9H 1L1.

Livre sur la météorologie

Les Presses de l'Université du Québec viennent de publier *Connaître la météorologie* de Richard Leduc et Raymond Gervais. Ce livre explique ce qu'il faut savoir sur la température, l'humidité, la pression et la plupart des phénomènes météorologiques particuliers (tempête, tornade, ouragan, etc). Il initie à la prévision et aux instruments et montre également le vaste éventail des applications pratiques de la météorologie. *Connaître la météorologie* est abondamment illustré et comporte un lexique, une bibliographie et de nombreuses photos. Informations : PUQ, C.P. 250, Sillery, Québec, G1T 2R1.

Cartes climatologiques du fleuve St-Laurent

Le Service de l'environnement atmosphérique, Environnement Canada, a récemment publié une série de cartes climatologiques du St-Laurent qui seront particulièrement appréciés des navigateurs et plaisanciers. Ces cartes donnent les moyennes mensuelles des éléments suivants : vent, hauteur des vagues, marées, courants, visibilité, température et pression. Ces cartes couleur accompagnées d'un guide explicatif, sont disponibles au prix de $7.00. Information : SEA, Région du Québec, 100 boul. Alexis Nihon, 3e étage, Ville St-Laurent, H4M 2N6.

Chinook

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ARTICLES

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THE COVER

"Reflections", a painting by Philip Chadwick, shows typical scenery around Peggy's Cove, Nova Scotia. See the article on page 4.

ART APPRECIATION INTERPRETATION GUIDELINES

by Philip Chadwick

The painting REFLECTIONS *on the front cover of this issue is the subject of interpretation.*

It may not be obvious, but with the concepts developed in my previous article (*Chinook*, Volume 6 Number 4) we now have all of the tools needed to study realistic art. As a guide, the deciphering process is broken down into the following distinct analysis steps:

1. Is the radiation direct (from a source) or diffuse (scattered)?
2. Is the optical path long or short?
3. What is the size category of scatterers, if any, along the optical path?
4. What are the absorption characteristics of the medium?
5. If more than one medium is traversed:
   - Repeat steps 2, 3, and 4 for each medium
   - Does refraction modify the intensity, colour or position of object?
   - What is the balance between reflection and transmission for the given viewing angle?

With the above questions answered, one should be able to deduce and explain the relative intensities and colours in a painting. The following examples will illustrate the application of the technique.

I have chosen this particular painting, "Reflections", because it demonstrates most of the features that are encountered in landscapes. The setting is near noon local time, overlooking some boats on a rather quiet day. I will tackle the more interesting features one by one.

The sky at high elevations. The sky is blue at higher elevations and the intensity of the blue radiation decreases as you look higher in the sky.

With the sun at my back I observed diffuse radiation that had traversed a long optical path. The scatterers are air molecules (there is little air pollution in Nova Scotia) which scatter blue light in accordance with the Rayleigh Theory. Absorption of light by clean, dry air is insignificant in this application.

The low intensity at higher elevations is linked to the lower number of molecules along the shorter optical path with lower pressures and thus the amount of scattering is reduced.

The sky at low elevations. The sky is relatively bright white along the horizon.

With the sun still at my back, diffuse sky radiation is observed along a very long optical path. Once again the scatterers are air molecules (although imported pollution would enhance the effect), which scatter blue light. However, the concentration of air molecules under relatively high pressure is great and this path is optically thick. Photons of all colours are scattered even though blue radiation is preferentially scattered. Thus, many photons of all wavelengths reach the observer producing a relatively high intensity white horizon. Pollutants and water drops in the atmosphere, which preferentially scatter red light in accordance with the Mie Theory, would just make the low horizon optically "thicker".

The distant land mass. The distant land mass is a pale green compared to the deep green of the typical Nova Scotia forest.

Direct sunlight and diffuse skylight that illuminate the forest are initially returned as direct, low intensity, deep green radiation to the observer along a long optical path. The high density air molecules scatter mainly blue light out of the radiation beams producing a shift to yellow. The optical path is not as optically thick as in the case of the sky, but multiple scattering of non-preferred wavelengths does impart a white tint.

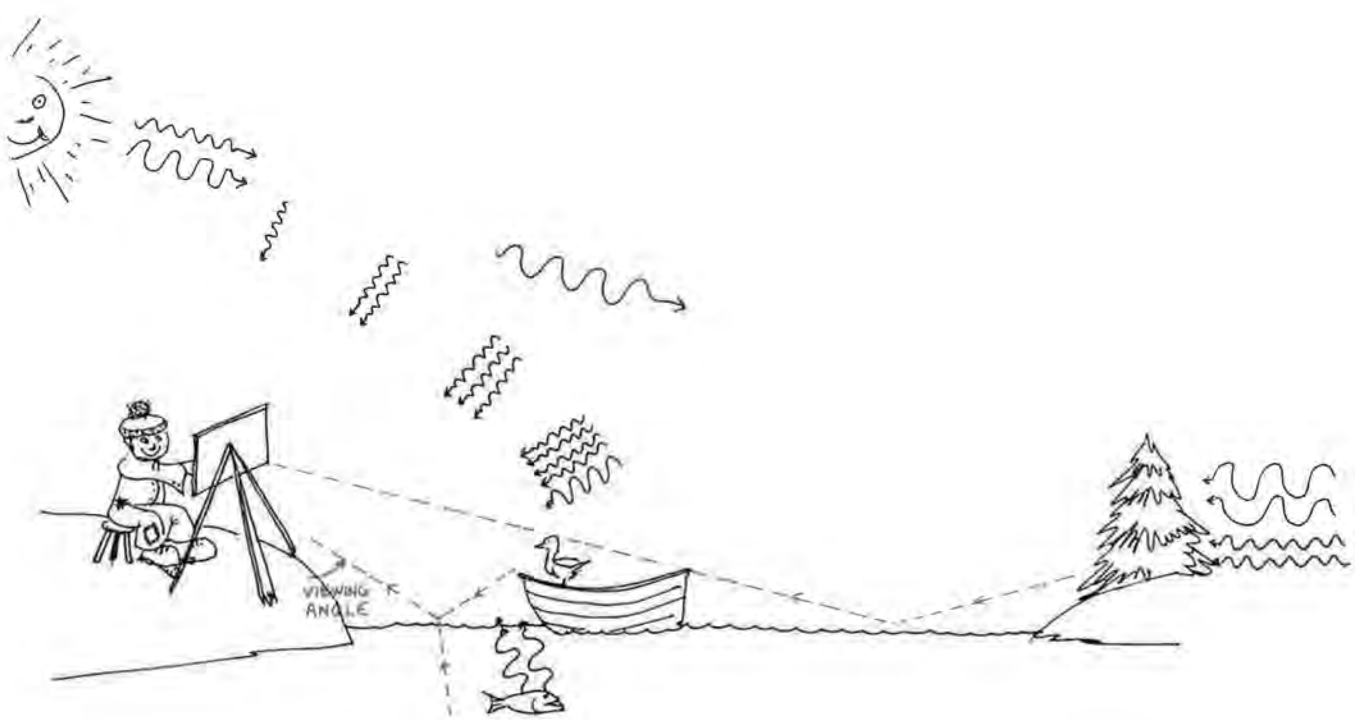
Finally, direct sunlight and diffuse skylight are Rayleigh scattered into the optical path adding back some of the blue radiation and increasing the white tint.

In approaching the forest, the optical path shortens, and becomes optically "thinner" so that less radiation can be scattered into it. In the extreme, when viewing pine needles close up, the trees will be a deep dark green in colour.

The ocean. Neglecting the slight wave action which disrupts the level ocean, the ocean is a luminous blue gradually changing to deep green at low observation angles.

The light reaching the observer has two distinct paths to follow and must be treated separately.

Direct sunlight and diffuse skylight shining on the water is refracted into the depths. Some process is required to return this radiation to the surface where it will be refracted back into the air and perhaps to the observer. Rayleigh scattering of blue light by the water molecules is one method but it is weak. Particulate Mie scattering is much stronger than molecular scattering. Debris, air bubbles and marine organisms (of all colours) efficiently scatter the light, some of which is directed to the surface. The red preferential scattering shifts the blue toward greener hues. As the concentration of scatterers increases, the shift towards green is greater and the light intensity increases.



The author-artist at work, showing in a schematic way the "physics" of the scene.

The shift towards green is partially counteracted by the slight blue of the water and the preferential absorption of red light by the water. However, an optical path of several metres is required before differential absorption is evident. The optical path to consider is the path down and back up.

The intensity of the incident radiation is decreased as a result of the two refractions. Horizontal variations in intensity result from local variations in density resulting from temperature or salinity gradients.

The other source of radiation to consider is the diffuse skylight reflected to the observer from the air/water interface. It should be noted that direct sunlight is reflected away from the observer in this scene, except at wavecrests which reflect the sunlight back. As in the case of the sky at high elevations, this diffuse skylight is blue and thus the reflected radiation is blue.

In order to complete the analysis, we must add the above radiation in an appropriate proportion for each viewing angle.

At viewing angles greater than 80 degrees, reflected skylight will dominate the upwelling transmitted ocean radiation. Thus the ocean will be predominantly blue.

The ocean for viewing angles less than 80 degrees will be coloured mainly by the upwelling transmitted ocean radiation. Intensity levels will be lower and the ocean will be distinctly greener depending on the concentration of particulate scatterers or air bubbles.

The "reflections" of the boats. The boats are white with hints of ultramarine blue but the reflections are decidedly deep bluish green.

The obstacles to overcome in solving this problem have largely been discussed in the ocean example. However, in this case, the only radiation available for reflection is the diffuse sky radiation reflected from the sides of the boats. The upwelling ocean radiation is identical to that discussed above. At a viewing angle near 70 degrees, the upwelling transmitted radiation overpowers the reflected light from the boat. This is the example of a situation when a reflection of a boat is not a boat!

The "reflection and refraction" of the pier support.
The solution to this problem is similar to that for the boats. However, I wanted to highlight the repositioning of the straight support under the water by refraction.

PARTING VIEWS

The world is a "strange and wondrous place where nothing is as it seems" is an appropriate quotation from Lewis Carroll's Alice in Wonderland.

The changes effected in the light emanating from a subject before and after the photons strike the surface can be astounding. The subject will rarely appear as it "should". The dedicated scientist in a search for truth can, by using the preceding principles as guidance, attempt to deduce reality from the altered information reaching the senses. "Reality" is more palatable to the calculating eyes of the scientist. To those that take up this challenge – Good Luck!

Fortunately, artists are allowed the luxury of selecting colours from their own palettes, oblivious to the complexities and duplicities of the world around them.

FURTHER READING

For those interested in more information on this topic, I would like to suggest any number of books on the fundamentals of optics or a series of excellent articles written by Craig F. Bohren in *Weatherwise*, June to December, 1983.

Philip Chadwick is a meteorologist with the Maritimes Weather Centre in Bedford, Nova Scotia. He is also a very successful artist.

LA SURVIE DES POMMIERS À L'HIVER

par Roger Léonard

Le printemps 1981 n'a pas été heureux pour les pomiculteurs de Québec. Le bilan, plus de 236 000 pommiers morts soit 15 % des arbres du Québec. Un an plus tard, ce bilan grimpait à 400 000 arbres ou 25 % des pommiers de la province suite aux séquelles de l'hiver 1980-81. Avec une production évaluée à 20 millions de dollars avant cette catastrophe, les pertes de production, sans compter le coût de remplacement des arbres, se chiffrent à quelque $5 millions par année pour plusieurs années à venir.

Bien que les causes de cette mortalité soient multiples, les conditions climatiques de l'hiver 1980-81 semblent avoir joué un rôle prépondérant. Par une analyse des paramètres climatiques enregistrés entre le printemps 1980 et à la fin de l'hiver 1981, il a été possible de cerner certains éléments du climat qui peuvent avoir contribué fortement à provoquer la mort des pommiers. On a aussi voulu analyser les données climatiques enregistrées depuis le début du siècle pour essayer de déterminer si les conditions météo « responsables » de la mortalité de 1980-81 se retrouvaient à d'autres périodes de mortalité.

Pommiers McIntosh sur *Malus robusta 5*, détruits par l'hiver 1980-81 à l'âge de 12 ans. Le porte-greffe *M. rob. 5* brise sa dormance trop tôt au printemps le rendant vulnérable au froid de certains hivers. (Photographie : Raymond Granger, Agriculture Canada.)

Vieux pommiers McIntosh gelés lors de l'hiver 1980-81 à Oka, Québec. (Photographie : Raymond Granger, Agriculture Canada.)

CLIMAT DE 1980-81

En examinant le climat qui a caractérisé la période d'avril 1980 à mars 1981, on remarque que les températures et les précipitations du printemps et de l'été 1980 se sont maintenues assez près de la normale. Par contre, les températures de septembre à janvier ont été sous la normale avec des froids intenses en décembre et janvier. Le 3 janvier, par exemple, le maximum n'a pas excédé −30°C, sous des conditions ensoleillées et par un vent d'environ 10 km/h. Les 13 et 14 janvier, les minimums enregistrés à Farnham ont été de −37,5 et −35°C. Par la suite une longue période de dégel est survenue entre le 16 et le 25 février sans que le mercure descende sous zéro une seule fois. Les 22 et 23 février, le maximum atteignait 17°C. Ce temps doux combiné aux 97 mm de pluies enregistrées durant le mois ont fait fondre rapidement le couvert nival mettant ainsi le sol à nu dans la majorité des régions pomicoles. Au début de mars, les températures saisonnières étaient de retour avec des minimums atteignant −15°C par endroits.

AUTRES SAISONS DE MORTALITÉ

Depuis le début du siècle, cinq autres saisons de mortalité ont été identifiées. À chacune de ces saisons, le climat de l'hiver est réputé avoir été la cause principale de la mortalité des arbres. Ces hivers sont les suivants : 1903-04, 1917-18, 1933-34, 1956-57, 1975-76.

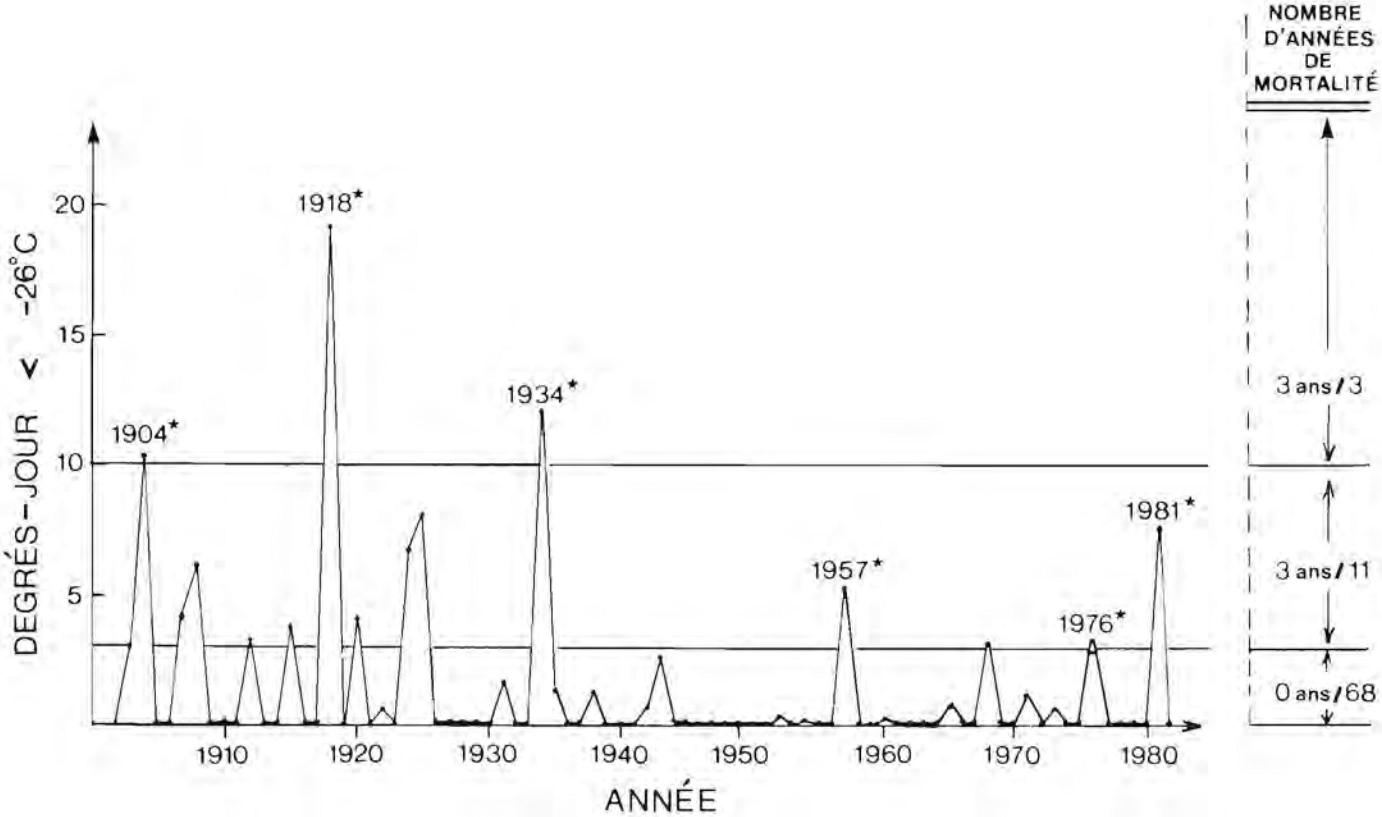


Figure 1 Le nombre de degrés-jours inférieurs à −26°C accumulés à chaque année en décembre et janvier depuis 1901, et la fréquence d'années de mortalité pour trois différentes classes de degrés-jours accumulés.

FACTEURS DE SURVIE ET DE MORTALITÉ

En plus des conditions hivernales, beaucoup d'autres facteurs peuvent influencer la survie des arbres à l'hiver. Ils peuvent contribuer soit à accroître leur résistance au froid, soit à la diminuer par le stress. Parmi les facteurs de stress, mentionnons entre autres : une trop forte production de fruits la saison précédente, un mauvais état hydrique et thermique durant la saison de croissance, l'aoûtement du bois qui ne se fait pas à temps à l'automne, un réveil prématuré durant un dégel hivernal prolongé, et plusieurs autres facteurs liés aux pratiques culturales comme la taille, la fertilisation, le contrôle des mauvaises herbes et des ravageurs, etc.

Parmi les paramètres climatiques analysés, un seul est apparu comme facteur commun aux saisons de dégâts identifiées depuis le début du siècle. Par contre, il était pratiquement absent durant les saisons sans dégâts. Ce facteur est le froid intense enregistré durant l'hiver, soit en décembre, en janvier ou en février.

LE FROID HIVERNAL

Une bonne façon de quantifier le froid accumulé au cours d'une période consiste à accumuler les degrés-jours quotidiens sous une température de référence qui correspond au froid que l'on désire mesurer. Par exemple, pour une température de référence de −26°C et une température moyenne quotidienne de −28°C le nombre de degrés-jours inférieurs à −26°C est de 2. Cependant, lorsque la température moyenne quotidienne est égale ou supérieure à la température de référence le nombre de degrés-jours est zéro.

Parmi les températures de référence utilisées, le seuil −26°C s'est avéré le meilleur, permettant le mieux d'isoler les années de mortalité des autres années où les arbres ont bien survécu.

La figure 1 montre le nombre de degrés-jours inférieurs à −26°C accumulés à chaque année en décembre et janvier depuis 1901. La fréquence d'années de mortalité pour trois différentes classes de degrés-jours accumulés est aussi représentée, soit pour les classes de 0 à 3 degrés-jours, 3 à 10 et plus de 10 degrés-jours.

Toutes les années sans dégâts se retrouvent sous la classe 0 à 3 degrés-jours tandis que la classe 10 degrés-jours et plus ne comprend que des années de dégâts (3 années). Dans la classe intermédiaire (3 à 10 degrés-jours) cependant on identifie 3 années de mortalité et 8 années sans mortalité.

Ainsi la comparaison entre les degrés-jours inférieurs à −26°C accumulés en décembre et janvier et les années de forte mortalité indique que le froid intense de l'hiver pourrait être la cause principale de la mortalité des pommiers sur le sud-ouest du Québec. Cependant, comme le montre les résultats de la classe intermédiaire (3 à 10 degrés-jours), d'autres facteurs importants, qui n'ont pu être évalués de façon satisfaisante par cette méthode, ont aussi contribué. Une étude avec des données plus nombreuses et plus précises sur les dégâts observés avant 1980 permettrait sans doute de mieux cerner les autres facteurs climatiques qui peuvent entraîner un risque de mortalité dans les vergers.

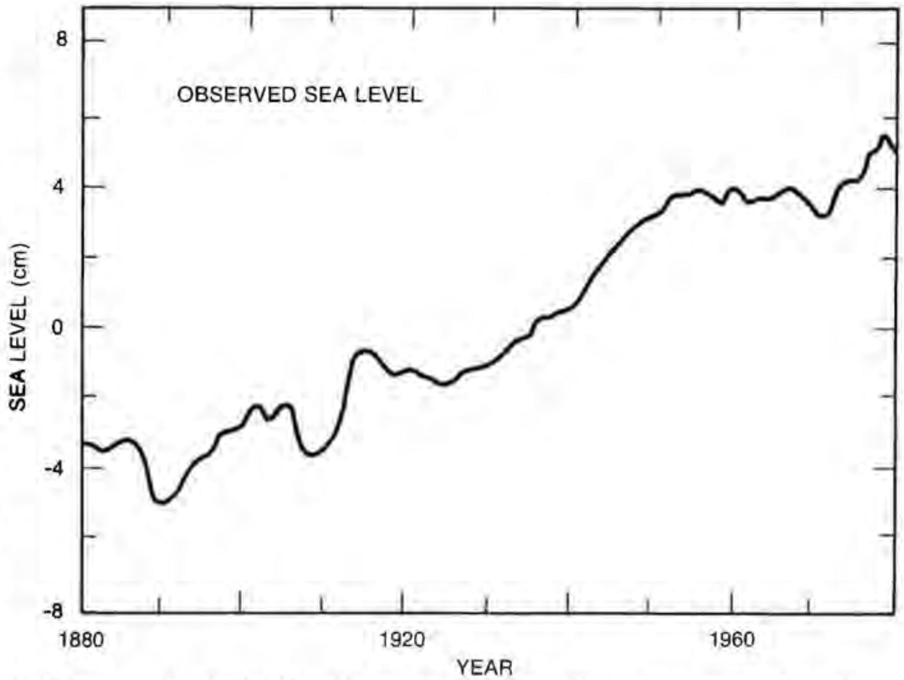
M. Roger Léonard est un météorologue à la section d'agrométéorologie du Centre météorologique du Québec. Il est un expert en météorologie agricole.

SUMMARY *A 1981 spring survey of the Québec orchards established the mortality of apple trees at 15% (236,000 trees); this percentage reached 25% at the end of 1982.*

A study of the climatic conditions related to the mortality of apple trees indicates that the extreme cold of the winter months could have been the major factor involved in the six winter-kill episodes observed in southwestern Québec since the turn of the century; a good correlation was obtained between these episodes and the accumulated degree-days below −26°C during the winter months.

CLIMATE CHANGE AND RISING SEA LEVELS

by Henry G. Hengeveld



Global mean sea-level trend from tide-gauge data corrected for tectonic trends (adapted from Gornitz et al., 1982).

The threat of rising ocean levels around the world is becoming a major international concern. Recent analyses of sea-level records reveal a gradual rise has already been occurring during the past century. New projections of the impacts of potential global warming indicate the possibility of a 0.5-m rise within the next 100 years. There is a further risk of a 5.7-m rise in the centuries thereafter. The implications for coastal dwellers are serious.

Until recently, changes in sea-level measured along coastal areas were assumed to be regional only and caused by tectonic uplifting or subsidence of the land mass affected. These changes have been particularly evident, and problematic, in such diverse areas as Venice (Italy), Galveston (Texas) and Long Beach (California). Now, however, scientists have uncovered significant evidence that today's ocean level rises are global and, furthermore, are climate-related. Careful analysis of data from a world-wide network of sea-level measuring stations, corrected for long-term tectonic trends, reveals a consistent rise in ocean levels over the past 100 years at the rate of 1-1.5 cm per decade. This rise is believed to be due to the thermal expansion of ocean waters, caused by a net global surface warming of 0.3°C, and the related increase in melting of temperate-zone glaciers and polar ice-sheet margins. The present sea-level trend is neither large nor rapid. It has nevertheless already generated considerable concern because of the increased erosion of sandy coastal regions and the more frequent occurrence of coastal flooding and land contamination during storm surges. Future trends in sea-level rises may, however, be of much greater concern. Predictions by the atmospheric scientific community that the global atmospheric temperature may increase by 3 ± 1.5°C over the next 100 years owing to increasing concentrations of atmosphere carbon dioxide suggest that ocean levels may be dramatically affected. First, the continued warming of the oceans and the increased melting of ice-sheets at temperate latitudes and elevations that would result appear likely to increase sea levels by 45-90 cm. More significantly, a large atmospheric warming could affect the health of existing polar ice-sheets, particularly that of the unstable west Antarctic ice-cap, eventually increasing ocean levels by many metres.

The relationship between climate, extent of the polar ice-sheets, and sea-levels over time-scales of millenia has long been recognized. For example, during the last ice-age maximum of some 18,000 years ago, while much of North America and Europe lay under a sheet of ice, sea-levels were about 100-150 metres below those of today. In fact, ocean levels of today are believed to be the highest of the past 100,000 years. Should the remaining ice-sheets on Greenland, east Antarctica and west Antarctica completely disappear, rises in sea-level of 5-7 m, 50-60 m and 5-7 m, respectively, would occur.

The Greenland and east Antarctic ice-caps are land-based and change their volume primarily through the process of the net annual accumulation or melting of ice at their surfaces. While warmer climates would induce increased melting and glacial surging at the margins of these ice masses, increased moisture availability from the surrounding seas might increase winter snowfall rates and hence net annual accumulation rates at higher elevations. Glaciologists are not yet sure of the net effect on the total volume of these ice-sheets but agree that the trend, whether positive or negative, would be slow and would have a minor role in ocean level rises over the next 100 years. The west Antarctic ice-cap, however, is largely grounded below sea-level and is considered unstable. A global warming of 3°C appears likely to be adequate to remove the ice shelves buttressing this ice-sheet, resulting in a relatively rapid surge of the entire ice mass into the oceans. Estimates on how soon this could occur vary from one to five centuries from now.

The socio-economic impacts of a major global sea-level rise could be devastating. More than 30% of the world's population lives within 50 km of the adjoining oceans and seas. River deltas and lowlands, generally the most fertile and densely populated regions of the world, would be threatened by salt water insurgence. Major coastal cities would experience massive flooding, while individual countries such as those of the European lowlands, Bangladesh, Japan and other island nations would be par-

Significant rises in sea-level could result in flooding of large sections of the Low Countries of Western Europe, such as the rich agricultural and horticultural areas in western Holland.

Climate stations in Canada below 10 m ASL

Province/ Territories	Number of Stations	Percentage
PEI	5	24
Nfld.	25	23
NS	14	15
BC	72	14
NB	8	11
NWT	4	5
Qué.	20	4

ticularly vulnerable. Results of a recent study on the impacts of a 7-m sea-level rise on Americans suggest that four of the coastal states as well as the District of Columbia would lose 17–35% of their land area, affecting 11 million people. Florida would be most significantly affected.

Although the potential impacts of sea-level rises appear not to be as devastating for Canada as for many other coastal nations, the many coastal villages along the Atlantic and Pacific coasts and in the Gulf of St. Lawrence would be significantly affected. Lowlands such as Prince Edward Island would also lose much of their valuable farmland. However, the effect of a 5-m ocean rise on major Canadian population centres appears to be comparatively small. The most substantial reclamation of the land by the sea would occur in the sparsely populated regions along the Hudson Bay coastline and in the Mackenzie delta.

Considerable controversy and uncertainty still remains among scientists on almost all aspects of the probability, magnitude, timing and impact of future sea-level rises. Much more research must be undertaken to improve our understanding and our future projections before our concern can be translated into action. Nor are the potential impacts of sea-level rises inescapable. Techniques already developed in low-lying coastal regions of the world to hold back the sea can be adopted for many of the threatened areas. Time will likely be available to develop and implement new strategies. However, an ocean rise of at least 0.5 m over the next 100 years now appears highly probable, while an additional 5–7 m rise could occur within the next few centuries. The ability of coastal populations to cope with such rises will depend on their resilience and preparation. Improving these must be the objectives of the coming decades.

Impact of a 7-m sea-level rise on some American coastal states (from Kellogg and Schware, 1981)

State/District	Area Flooded (%)	Population Affected (millions)
Florida	35.5	3.8 (55%)
Louisiana	31.4	1.8 (50%)
Delaware	25.0	0.1 (25%)
Dist. of Columbia	20.0	0.2 (20%)
Maryland	17.3	0.4 (10%)

FURTHER READING

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Mr. Hengeveld is an Advisor to the Canadian Climate Centre in Toronto on carbon dioxide related matters including climate change.

His article is reprinted from *Climatic Perspectives* Vol. 5 November 1983, published by the Atmospheric Environment Service.

JEUX OLYMPIQUES DE LOS ANGELES
Une expérience unique pour deux météorologues canadiens

par Monique Loiselle

Suite à des négociations et ententes avec le National Weather Service (NWS; Service national de la météorologie) des États-Unis, le Service de l'environnement atmosphérique d'Environnement Canada décida d'envoyer deux météorologues canadiens à Los Angeles durant l'été 1984 pour faire partie de l'équipe responsable des services météorologiques pour les Jeux de la XXIII[e] Olympiade. Ces deux météorologues devaient, en plus de prendre une part active aux prises de décision et à la production des prévisions, fournir des services en français à la communauté olympique. En octobre 1983, André Lachapelle, météorologue surveillant au Centre météorologique de l'Alberta, et moi apprenions que nous étions les heureux élus pour cette affectation unique. De plus, on a demandé à André de mettre cette expérience à profit et de participer à la planification des services météorologiques pour les Jeux olympiques d'hiver qui auront lieu à Calgary en 1988.

De gauche à droite, Roger Papas, Chef de service du bureau météorologique de Long Beach, Ed Gross, Coordinateur du projet et Bob Storey, Technicien responsable du programme d'observation à la station marine *Aquarius*.

À Los Angeles en 1984, les services météorologiques pour les jeux olympiques provenaient de deux sites différents. Tous les services météorologiques pour les courses de voiliers étaient dispensés à partir d'une installation temporaire, une remorque transformée en véritable centre de météorologie maritime au site olympique de Long Beach; les bulletins météorologiques pour toutes les autres disciplines olympiques étaient préparés à West Los Angeles dans une salle adjacente au bureau météorologique de Los Angeles dans un édifice du gouvernement fédéral. Deux météorologues français, experts en météorologie marine fournissaient des services en français au bureau de long Beach pendant qu'André et moi faisions de même au bureau de Los Angeles.

À partir du moment de notre sélection en octobre 1983 et jusqu'à notre arrivée à Los Angeles en juillet 1984, le NWS a été très souvent en rapport avec nous; on nous a fourni de très bons manuels pour nous familiariser avec le climat, la géographie et les problèmes météorologiques du sud de la Californie. On nous a aussi envoyé du matériel pour nous familiariser avec le Système informatique américain d'accès à l'information météorologique, AFOS. On nous a aussi remis, en avril 1984 un livret intitulé « Serving the Weather Needs for the 1984 Olympics »; ce livret qui décrivait un plan complet et détaillé de toutes les facettes des services météorologiques pour les Olympiques nous a donné une bonne vue d'ensemble de toute l'opération avant notre arrivée.

Finalement après des mois d'attente et d'anticipation, je suis arrivée à Los Angeles le 19 juillet. J'ai utilisé les premières journées pour me familiariser avec les lieux, et surtout pour apprendre à utiliser le système américain d'accès à l'information météorologique (AFOS); ce système diffère du système informatique utilisé dans les centres météorologiques canadiens et est assez spectaculaire parce qu'il fournit à l'usager, sur demande, n'importe quelle carte météorologique courante, sur l'écran cathodique (on peut aussi, sur demande, superposer des cartes).

Enfin une semaine avant les cérémonies d'ouverture tous les membres de l'équipe météorologique des deux sites étaient réunis pour la première fois pour une journée intensive d'information. Ensuite, nous avons tous mis à profit la semaine précédant les cérémonies d'ouverture pour opérer un bureau météorologique simulé, mettre au point les formats des différents produits, et ajuster les horaires de travail.

Comme tous les amateurs de sports ont pu le remarquer, le temps est resté au beau durant toute la période des Olympiques. En fait, une dépression quasi-stationnaire au-dessus du désert de l'intérieur de la Californie et un anticyclone stationnaire au-dessus du Pacifique ont contribué à maintenir des cieux ensoleillés près de la côte autour du bassin de Los Angeles. Les problèmes de prévisions les plus difficiles que nous ayons eu à résoudre étaient habituellement d'estimer l'heure de passage du front de brise de mer aux différents sites olympiques; ceci est évidemment très

Deux fois par jour, on tient une séance d'information au site de Long Beach.

```
LOUS00 KLAX 11133077LAX
NATIONAL WEATHER SERVICE LOS ANGELES CA.
FOLLOWING IS THE FRENCH VERSION OF THE OLYMPIC FORECASTS.
*****
LA84-PREVISIONS METEOROLOGIQUES POUR LA XXIII OLYMPIADE
EMISES A 06H30 HAP SAMEDI LE 11 AOUT 1984 PAR LE NATIONAL
WEATHER SERVICE A LOS ANGELES.

.PREVISIONS POUR AUJOURDHUI ET CE SOIR AVEC UN APERCU POUR DIMANCHE.
LES PROCHAINES PREVISIONS SERONT EMISES A 11H00 HAP.

LES TEMPERATURES SONT EN DEGRES CELSIUS.. L HUMIDITE RELATIVE EN
POURCENT.. LES VENTS EN KILOMETRES/HEURES.

.AUJOURDHUI.. PERIODES NUAGEUSES.. CHAUD.. HUMIDE. MAXIMUM
 VARIANT DE 24 PRES DE LA COTE A 32 A L INTERIEUR. VENTS DU
 SUD-OUEST 10 A 16 KMH.

.CE SOIR.. NEBULOSITE CROISSANTE. MINIMUMS 18 A 21. VENTS LEGERS
 ET VARIABLES.

.APERCU GENERALE POUR DIMANCHE.. NEBULOSITE VARIABLE. UNE PROBABILITE
 DE 10 POURCENT D AVERSES. CHAUD ET HUMIDE.

    ------------------------------------------------------------

                        ....COLISEUM.... .

.APERCU POUR LES CEREMONIES DE FERMETURE DIMANCHE... GENERALEMENT
 NUAGEUX. CHAUD ET HUMIDE.
                                    16H00       19H00       22H00
        TEMPERATURE                  27          24          22
     HUMIDITE RELATIVE               55          65          75
           VENT                     SO/6        SO/5        CALME

    ------------------------------------------------------------

$$

.PREVISIONS GENERALES POUR AUJOURDHUI...

FOOTBALL AU ROSEBOWL... PERIODES NUAGEUSES. MAXIMUM 30-31.
 VENTS DU SUD-OUEST 10 A 16 KMH.

TENNIS A L UCLA... PERIODES NUAGEUSES. MAXIMUM PRES DE 26.
 VENTS DU SUD-OUEST 6 A 10 KMH.

.PREVISIONS POUR LES SITES OLYMPIQUES POUR AUJOURDHUI..

L ATHLETISME... PERIODES NUAGEUSES.
                                                                 EXTREMES
            07H00   10H00   13H00   16H00   19H00   22H00   D APRES-MIDI
     TEMP    20      24      27      27      24      22          28
     HUM     75      55      45      50      60      75          45
     VENT   CALME   CALME   SO/5    SO/6    SO/5    SO/5        SO/13

TIR A L ARC... PERIODES NUAGEUSES.

     TEMP    18      24      24      24      22                  25
     HUM     90      75      70      70      75                  65
     VENT   CALME   S/5     SO/8    SO/10   SO/5                SO/24

SPORTS EQUESTRES... PERIODES NUAGEUSES.
                                                                 EXTREMES
            07H00   10H00   13H00   16H00   19H00           D APRES-MIDI
     TEMP    19      23      29      28      27                  31
     HUM     85      70      50      45      50                  40
     VENT   CALME   CALME   SE/5    SO/10   SO/8                SO/19

HOCKEY SUR GAZON... PERIODES NUAGEUSES.

     TEMP    19      24      28      28      26                  28
     RH      80      70      50      45      60                  42

NATATION ET PLONGEON... PERIODES NUAGEUSES.
                                                                 EXTREMES
            07H00   10H00   13H00   16H00   19H00           D APRES-MIDI
     TEMP    20      24      28      27      23                  28
     VENT   CALME   CALME   SO/5    SO/8    SO/8                SO/16

CANOE ET KAYAC... PERIODES NUAGEUSES.

     TEMP    17      20      26      26      22                  29
     HUM     90      70      65      70      80                  60
     VENT   CALME   CALME   SE/5    SE/8    SE/6                SE/19

FIN
```

Bulletin de prévisions typique.

important parce que les températures et le vent dépendent beaucoup de cette brise de mer.

Pour nous aider à prendre les bonnes décisions et à suivre la situation météorologique de très près, on disposait d'un réseau horaire d'observation (qui est déjà beaucoup plus dense que ce que l'on retrouve au nord de la frontière) et de plus, le NWS avait déployé des stations automatiques à tous les sites où des compétitions se tiendraient à l'extérieur. En tout, 9 stations PAM II (Portable Automatic Station) et 2 autres de type Mysco se trouvaient dans le bassin de Los Angeles; des cartes météorologiques étaient produites automatiquement à intervalles de 20 minutes, mais entretemps on pouvait aussi interroger indirectement ces stations au besoin.

Le bureau de prévisions pour les Olympiques de Los Angeles était en exploitation tous les jours de 5 h 00 à 21 h 00 avec une équipe de deux météorologues qui travaillaient de 5 h 00 à 13 h 00 et une autre équipe pour l'après-midi. J'avais, avant mon arrivée, indiqué ma préférence pour l'équipe du matin (j'avais évidemment rêvé de passer mes après-midi au soleil à la plage); ce choix s'est avéré judicieux, puisque le travail de l'équipe du matin était des plus excitants. Nous devions faire un effort considérable pour bien analyser la situation météorologique et préparer le premier bulletin de prévision pour 6 h 30; ce bulletin se voulait détaillé et nous demandait de prévoir pour diverses heures de la journée (parfois jusqu'à six) des valeurs de température, humidité relative, vitesse et direction du vent pour tous les sites extérieurs. Les prévisions subséquentes n'étaient habituellement que des ajustements de la prévision du matin. En plus des prévisions (4 par jour) nous émettions aussi des bulletins sur les conditions météorologiques actuelles (« nowcast ») aux différents sites 5 fois par jour et, en soirée un bulletin sur les conditions météorologiques ailleurs sur la planète (« La météo internationale »).

En plus d'être émis sur les circuits de communications ordinaires, ces bulletins étaient retransmis au système informatique utilisé par la communauté olympique et, diffusés par Radio Météo Olympique (il y avait une bande de fréquence réservée exclusivement à la météorologie olympique). Le tout était disponible en anglais et en français, langues officielles des Jeux olympiques.

En général les média semblaient très bien accueillir le format détaillé des prévisions pour les Olympiques et n'hésitaient pas à les publier ou à les lire intégralement. J'ai encore l'impression qu'après les jeux, la population de Los Angeles a dû réclamer à grand cris la continuation de tels services météorologiques.

Durant mon séjour, j'ai eu l'occasion à deux reprises de visiter le site de Long Beach d'où l'on dispensait les services météorologiques pour les courses de voiliers (le yachting). Il s'agissait d'une installation unique et extrêmement bien équipée. En plus du système AFOS utilisé par le personnel de l'équipe météorologique, il y avait un autre ordinateur que les compétiteurs pouvaient consulter; mieux encore, on pouvait pousser quelques boutons et activer une traceuse qui produisait la carte météorologique demandée par l'usager. Les compétiteurs pouvaient aussi regarder les séquences animées de photos satellitaires sur un écran. On tenait aussi à ce site deux séances d'information par jour (matin et après-midi) où deux membres de l'équipe météorologique donnaient un exposé météorologique en préparation de la prochaine course de voiliers.

Le yacht *Aquarius*, gracieusement mis à la disposition du NWS, servait de station d'observation.

Pour complémenter toutes les données et aider à préparer des bulletins, la « station marine *Aquarius* » envoyait à la remorque des observations du vent, de la température (air et eau) et des courants près des lignes d'arrivées; c'est ainsi qu'on appelait le yacht *Aquarius* qu'un résident de Los Angeles avait gracieusement mis à la disposition du NWS pour l'occasion.

L'atmosphère qui régnait à la remorque du NWS de Long Beach était saine et amicale et on pouvait détecter l'enthousiasme des prévisionnistes et des usagers; cela était certainement dû au fait que les prévisionnistes souvent en contact avec les usagers se sentaient utiles et recevaient beaucoup de feedback.

Vers la fin de la période des Olympiques, presque toute l'équipe était réunie de nouveau; il s'agissait cette fois d'une occasion bien spéciale : le NWS avait décidé de remettre à chaque membre de l'équipe une plaque en gage de sa participation à cet événement unique.

Tout semble s'être passé trop vite; à peine commencé, le travail des météorologues était déjà terminé... tout comme les Jeux.

Au lendemain de mon retour à Toronto, une tornade touchait le sol et des pluies torrentielles s'abattaient sur Toronto. En ma qualité de météorologue aux services scientifiques j'ai dû passer ma première journée de retour au travail à examiner sur place les quantités de pluies recueillies à divers endroits... quel choc culturel après un mois dans le sud de la Californie!

Monique Loiselle est météorologue à la Division des services scientifiques du Service de l'environnement atmosphérique dans la Région de l'Ontario.

TODAY'S WEATHER FORECASTS

GENERAL FORECAST: Low clouds, clearing by late morning inland, remaining partly cloudy along coast; afternoon temperatures a few degrees cooler at inland venues; winds southwest to west 8-15 m.p.h./13-24 km.h. in afternoon.

BASEBALL (Dodger Stadium): Low clouds clearing by midmorning; fair afternoon and evening; high 81F/27C, winds southwest at 7-10 m.p.h./11-16 km.h.

CYCLING (Dominguez Hills): Morning low clouds; mostly sunny afternoon; high 80F/27C; winds southwest to west 8-12 m.p.h./13-19 km.h.

FIELD HOCKEY (East L.A. College): Morning low clouds; mostly sunny afternoon; high 80F/27C.

ROWING (Lake Casitas): Chance of morning low clouds, clearing after sunrise; winds through 10 a.m. east at 2-4 m.p.h./3-6 km.h., becoming southeast to south at 4-6 m.p.h./6-10 km.h. in late morning; 10 a.m. temperatures 78-82F/26-28C.

SHOOTING (Prado Recreaction Area): Fair; high 87F/31C; afternoon winds southwest to west 12-18 m.p.h./19-29 km.h. with gusts to 23 m.p.h./37 km.h.

SOCCER (Rose Bowl): At game time, fair; temperature 72-77F/22-25C; light southwest winds.

SWIMMING (USC): Morning low clouds; mostly sunny afternoon; high 80F/27C; southwest winds 7-10 m.p.h./11-16 km.h.

WATER POLO (Pepperdine University): Morning and night low clouds; partial afternoon clearing; high 73F/23C; winds southwest 8-12 m.p.h./13-19 km.h.

YACHTING (Long Beach Marina): Mostly cloudy through 11 a.m; haze visibility 4-5 miles/6.5-8 kilometers; sunny afternoon; visibility improving to about 7 miles/11 kilometers; winds southerly 4-7 knots through noon, increasing and becoming southwesterly 12-16 knots between 3 p.m. and 6 p.m.; afternoon wind waves 1-2 feet/0.3-0.6 meters; southwest swell 2-3 feet/0.7-1 meter; Catalina eddy could occur, keeping afternoon winds more southerly and speeds lighter.

Olympic forecasts by the National Weather Service—also available in continual VHF broadcasts in English and French on 162 475.

TODAY'S SMOG FORECASTS

	Maximum PSI	Hour
Baseball (Dodger Stadium)	67 at	4 p.m.
Cycling (Dominguez Hills)	67 at	1 p.m.
Field Hockey (East L.A. College)	113 at	2 p.m.
Rowing (Lake Casitas)	58 at	10 a.m.
Shooting (Prado Recreation Area)	175 at	3 p.m.
Soccer (Rose Bowl)	50 at	7 p.m.
Swimming (USC)	67 at	11 a.m.
Water Polo (Pepperdine University)	42 at	1 p.m.
Yachting (Long Beach Marina)	42 at	1 p.m.

Pollutant standard index (psi). 0-100 good; 100-200 unhealthful for sensitive people; 200-300 unhealthful for all; 300-500 hazardous
Olympic ozone forecasts by South Coast Air Quality Management District.

Prévisions telles que publiées par les media.

SUMMARY *The author is one of the two Canadian meteorologists from the Atmospheric Environment Service who went to Los Angeles during the summer of 1984 to participate with the Olympic Weather Support Team. This team consisted of U.S. National Weather Service (NWS) forecasters with additional help from French and Canadian forecasters who provided services in French besides their normal duties.*

A variety of services were provided daily during these Games. They included site and venue-specific forecasts and nowcasts as well as briefings and consultations with the media and the athletes. The Support Team was divided into two groups: one in support of sailing events at Long Beach and the other in support of all the other outdoor events at the various sites. The forecasters had at their disposal data from the NWS AFOS system as well as a network of automated weather observation platforms in and around the various venue sites. These data facilitated the provision of detailed and well-tailored weather information to all interested parties.

A YEAR IN THE CLIMATE HISTORY OF CANADA
December 1983-November 1984

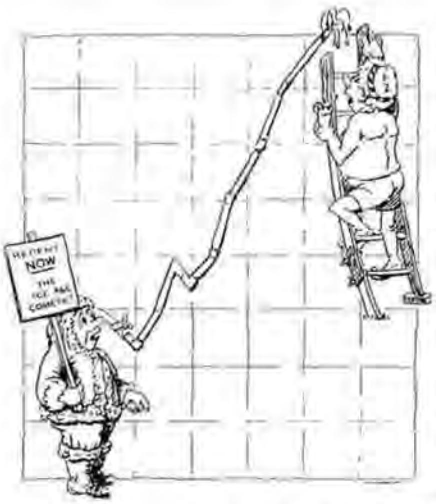
by Morley Thomas

The weather of 1984 across Canada could hardly be considered "normal" regardless of the definition of the word. The unusual spells of weather resulted from abnormalities in the general circulation of the atmosphere that gave northwest Canada five consecutive months of almost continuous warmer than normal temperatures, a remarkably poor spring and early summer on the Pacific Coast, a major drought on the Prairies during the spring and summer, abundant snow along with record-breaking warm February temperatures in southern Ontario and southern Québec, several severe storms in the Atlantic Provinces during the first half of the year and an abnormally early winter in western Canada.

WESTERN WARMTH - JANUARY TO MAY

Almost continuous mild conditions were reported from January to the end of April in western Canada. In January and February, positive anomalies as high as 10°C were reported dropping to 6 to 8°C in April and March. The maximum warmer than normal areas were centred in British Columbia in January, Saskatchewan in February, the Yukon Territory in March and the Northwest Territories in April. In January and March the warmer than normal conditions were limited to western Canada, while in February and April they covered just about all of southern Canada. The warmer than normal weather continued in the Northwest Territories with positive departures as high as 4°C in May and June and 2°C in July.

In January the abnormal circulation brought 18 cm of snowfall to Whitehorse in one day, a 24-hour record, and more than 50 cm of snow at Churchill, three times the normal monthly amount. Also in January, there were floods and avalanches in British Columbia, but by March the weather was suitable for gardening and other outdoor activities. April was the fourth consecutive month with warmer than normal temperatures in Alberta and in the Yukon, where major highways opened earlier than usual. Ice went out of the Yukon River at Dawson two weeks earlier than normal and ice bridges on the Mackenzie River were closed by May 6. Because of the warmth and dryness there were more than the normal number of forest fires in May in the Yukon.



Both record warm and cold spells reported from Canadian regions in 1984.

POOR SPRING ON THE PACIFIC COAST

After a warm February and early March in the Vancouver-Victoria portion of British Columbia, the weather turned cloudy with frequent precipitation in mid-March. April was unsettled and cool and May was cloudy and wet. The month proved too cold and wet for agriculture and was especially unfavourable for the fruit and berry crops. The disappointing weather continued in June with lower than normal temperatures and widespread rain during the latter part of the month. By July however, pleasant summer weather came to southern British Columbia.

THE PRAIRIE DROUGHT

After a mild winter with less than normal snowfall, concern was expressed early in the spring about a major drought in the Prairie Provinces (see *Chinook*, Volume 6, Number 2). Below normal precipitation continued across most of the region in March and although major storms in mid-April brought significant precipitation to southern Manitoba, the dry conditions continued in Alberta and southern Saskatchewan. In May, abundant precipitation fell across the central and northern portion of the province, but the month continued very dry in southern Saskatchewan where Estevan reported a meagre 9 mm of rain, only 17% of the normal amount. Duststorms were reported in southern Saskatchewan at the end of the month. Although severe weather with abundant rainfall occurred sporadically across southern Manitoba and southern Saskatchewan in June, abnormally dry conditions were prevailing again in July. In many areas of southern Saskatchewan, precipitation amounts for the period from April 1 until July 30 were less than 50% of normal. The dry conditions continued into August, which helped to promote a serious grasshopper infestation in southern Saskatchewan and southern Alberta and grass fires in southwestern Saskatchewan during the latter part of the month. Primarily because of the abnormal weather, wheat production fell by about 25% in Alberta and Saskatchewan although the grain was of high quality. In Manitoba, however, as a result of June rains, the wheat production was about 8% above normal.

SPRING IN FEBRUARY - ONTARIO AND QUÉBEC

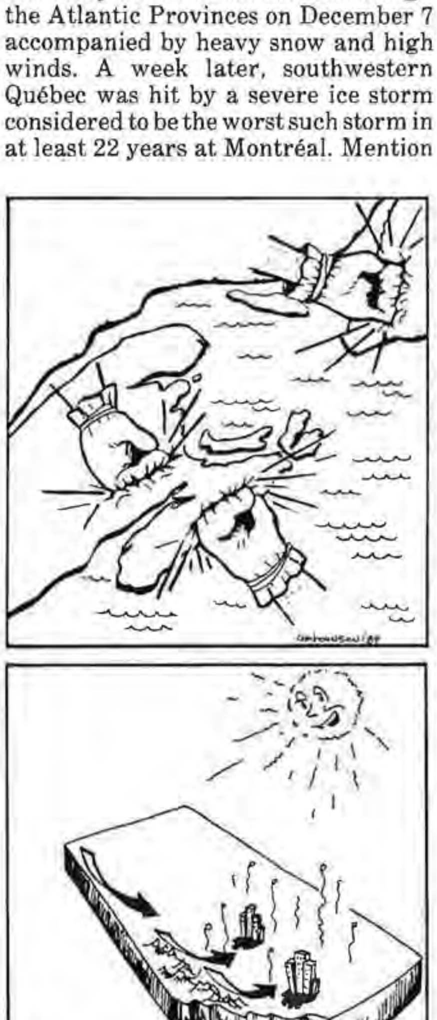
After abundant snowfall in December and frigid conditions in January, February was a springtime month in Ontario and most of Québec. At Toronto, there

January 1984: Bitter cold in Ontario and Québec.

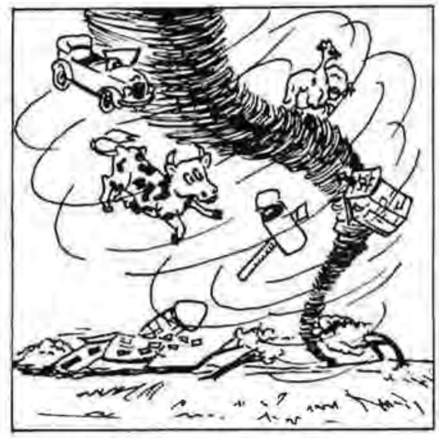
were ten consecutive days without freezing temperatures and the monthly mean temperature was 0.5°C, the warmest in 144 years of record. Kenora and Sault Ste. Marie in northern Ontario reported the mildest winter month ever. Similar mild conditions were experienced in Québec, but winter returned to the southern portion of both provinces on February 28–29 as the entire region was battered by the worst snowstorm in years. Extremely cold weather then prevailed for a few weeks - it was the coldest March in 25 years in much of southern Ontario; and at Montréal, March was colder than February, the first time this has occurred in over a century of weather records.

SEVERE STORMS - WINTER, SPRING AND SUMMER

December 1983 was a particularly stormy month in eastern Canada. On December 6–7, eastern Québec was lashed by a storm that moved through the Atlantic Provinces on December 7 accompanied by heavy snow and high winds. A week later, southwestern Québec was hit by a severe ice storm considered to be the worst such storm in at least 22 years at Montréal. Mention has already been made of the severe snowstorm sweeping southern Ontario and Québec on February 28–29, which continued on through the Atlantic Provinces on March 1st. March was particularly stormy in the Maritime Provinces with a bad spring blizzard at the end of the month.



March: Storms batter Atlantic Provinces while chinooks bring spring to Alberta.



June and July: Tornadoes hit all provinces from Alberta eastward to the Maritimes.

In mid-April, southwestern British Columbia was raked by a heavy windstorm that caused millions of dollars worth of damage. Two major storms swept the Prairie Provinces in April, which gave much needed precipitation to some areas: on April 11, heavy precipitation fell in eastern Saskatchewan and southern Manitoba, while a blizzard on April 27–28 swept southern Saskatchewan and Manitoba closing highways and downing transmission lines. This storm continued throughout northern Ontario. Earlier, on April 13, a severe ice storm occurred in the Avalon Peninsula of Newfoundland and a month later on May 13, an unusually late snowfall made for a white Mother's Day in most of southern Ontario. In June, several severe local storms in the Prairie Provinces included a series of tornadoes on June 21–22. Hurricane *Diana* passed to the south of Nova Scotia on September 15–16, producing strong winds across the Maritimes.

EARLY WINTER IN THE WEST

September was cool in British Columbia with killing frosts reported by the end of the month in most interior valleys. Cold weather moved over the Prairie Provinces during the third week of September with freezing temperatures and widespread, killing frosts. On September 22, rain changed to snow and between 5 and 15 cm were reported in many localities, snarling traffic and breaking power lines. Pleasant mild weather prevailed across the West early in October but by the end of the month, frigid Arctic air covered British Columbia and a series of storms moved northward into the Prairies bringing snow to Alberta and Saskatchewan. New October snowfall and low temperature records were established at many locations in the three westernmost provinces and 30% of the crops were left unharvested when snow cover came to the Peace River area.

During the last two weeks of October, the cold centre was in Alberta with temperatures 8–10°C below normal. By the first week of November, temperatures were averaging 16–20°C below normal in northern Alberta, northern British Columbia, and the Yukon. By the second week of November, conditions were moderating somewhat in the south but continued to average 8–10°C below normal in northern Alberta and the Mackenzie Valley. However, by the week of November 20–26, milder than normal weather prevailed across all of Canada from the Great Lakes west and north.

September: Early winter across the Prairies.

ACKNOWLEDGEMENTS

In this article extensive use has been made of information published in *Climatic Perspectives* from December 1983 to November 1984. *Climatic Perspectives* is an AES periodical produced in the Canadian Climate Centre under the general editorship of Amir Shabbar, and more recently Michael J. Newark with Allain Caillet and Andy Radomski serving as French and English editors, respectively. The original drawings were provided by W. Johnson.

Morley Thomas has had a long and distinguished career with the Atmospheric Environment Service and the World Meteorological Organization. He is a former Director General of the AES Canadian Climate Centre and is currently Archivist for the Canadian Meteorological and Oceanographic Society.

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1. Content, Language and Readership
Articles on topics of general interest in meteorology and oceanography, written in either English or French and suitable for a high school readership, are invited. The responsibility for the opinions expressed in the articles rests with their authors.

2. Length and Format
The suggested article length is in the range of 1500 to 3000 words with two to four figures (and captions). Clear illustrations and photographs are particularly encouraged. Contributors are also asked to provide a 100-200 word summary, preferably but not necessarily in the other language. Summaries will be translated (if necessary) and published in the other language only.

3. References
Literature citations within the text are discouraged. Instead, it is suggested that credit for results and ideas be given by naming the authors or their institutions in the text, and including references at the end of the text in the form of a short "Suggested Reading" list. A reference to a journal article should include the authors' names and initials, year of publication, full title of article, and journal name, volume number and page numbers. A reference to a book should include the authors' names and initials, year of publication, title of book, and the publisher's name and address. All references should be listed in the alphabetical order of the first authors' surnames.

4. Procedure for Submission
Two double-spaced typewritten copies of the manuscript should be sent to: *Chinook* Editor, c/o Canadian Meteorological and Oceanographic Society, 151 Slater Street, Suite 805, Ottawa, Ontario, Canada K1P 5H3. Finished line drawings and good quality black-and-white photographs (one original and two photocopies of each) should be included. Colour illustrations or photographs are welcome as candidates for the front cover of each issue. Contributors are also asked to provide a short description (about 50 words) of their professional affiliation (if any) and their meteorological and oceanographic interests, and to indicate whether their contribution has been or will be published elsewhere.

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