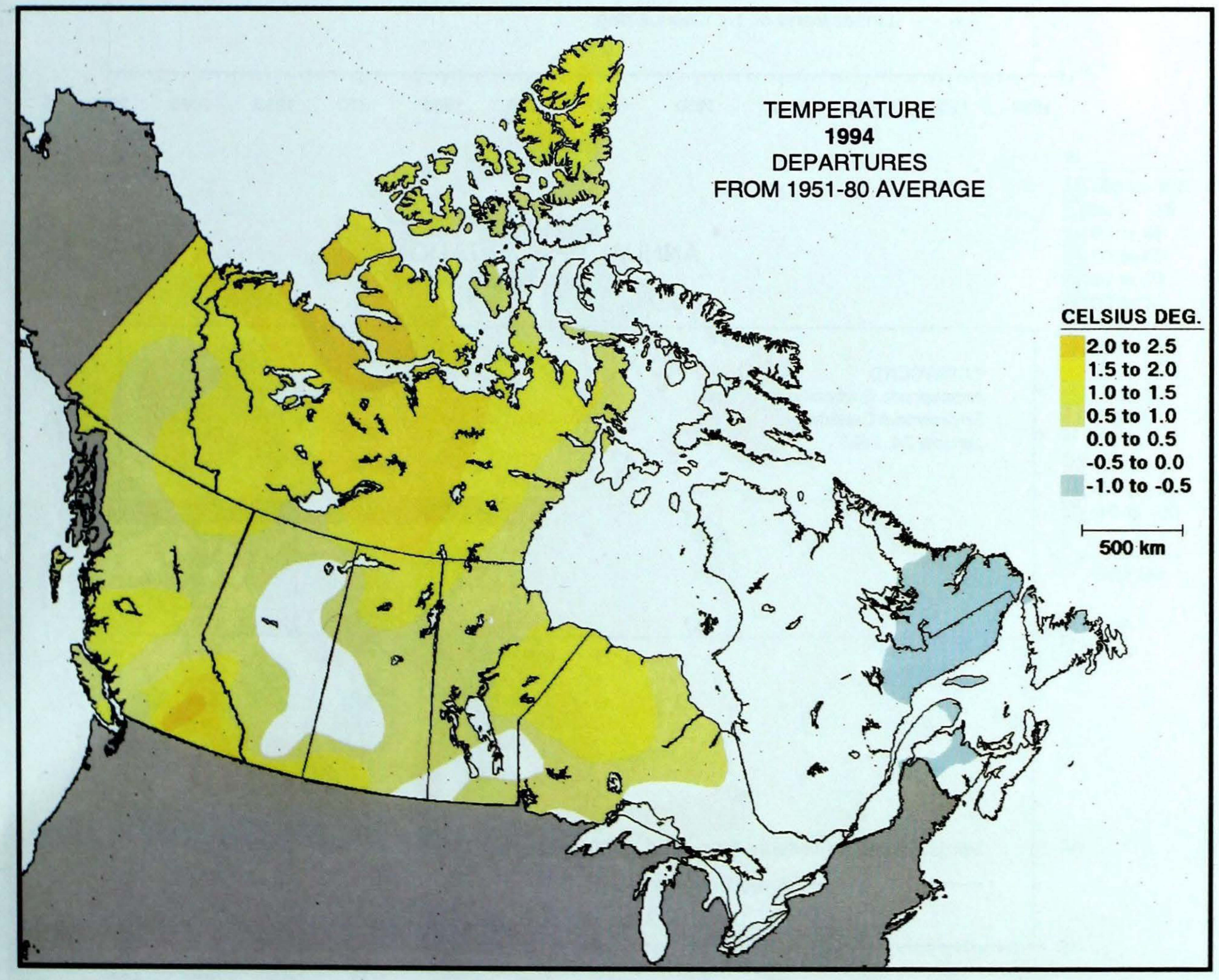
Climatic Perspectives

994 *Annual review of Canadian climate and water* vol. 16

Annual Review (1994) - Historical Perspective

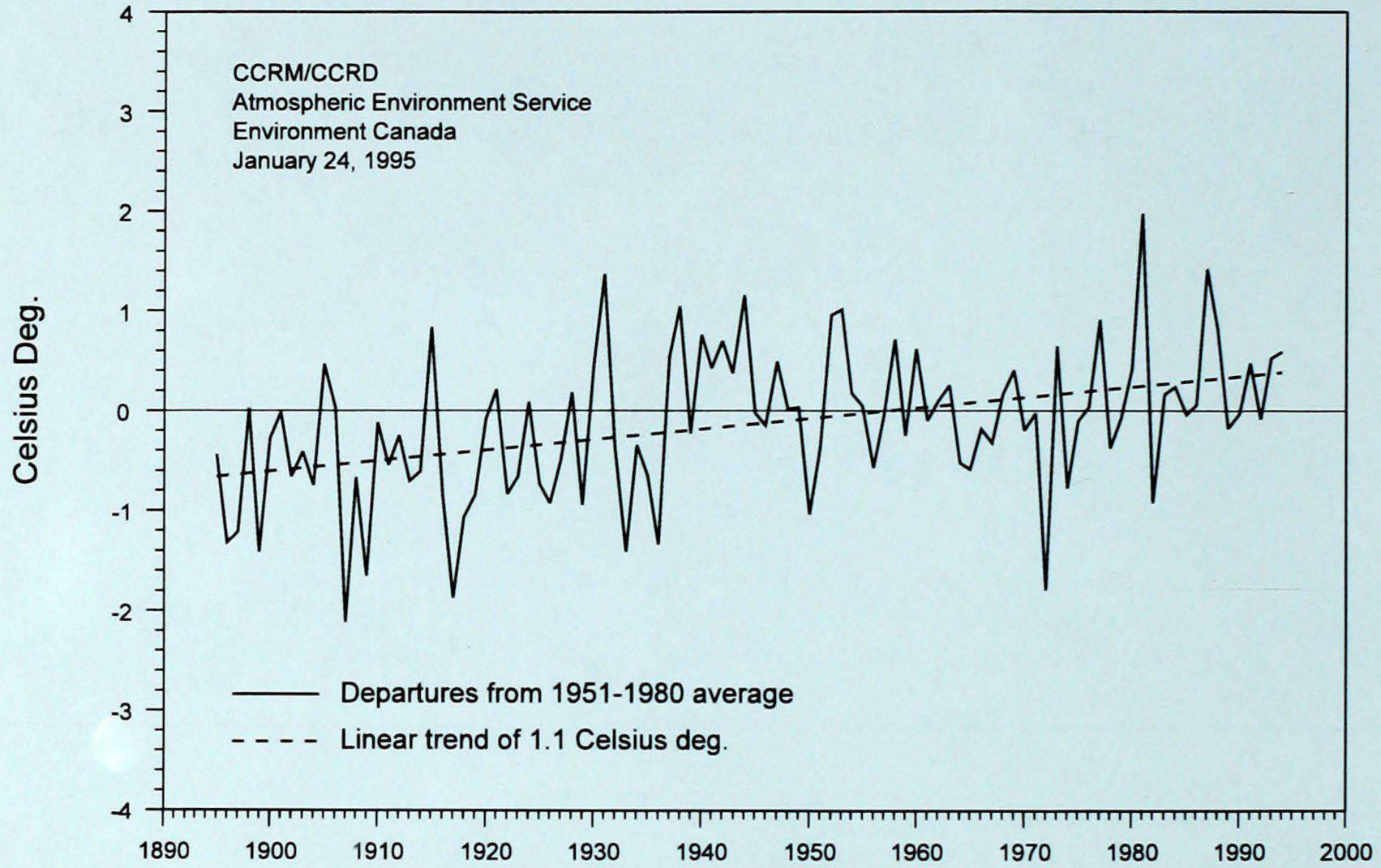
The national average temperature for 1994 (January to December) was 0.6 Celsius degree above the long-term mean. The year was the 16th-warmest for Canada since national temperature records began in 1895. An overall warming trend of 1.1 degrees is indicated for the 100-year period of analysis to the end of 1994.



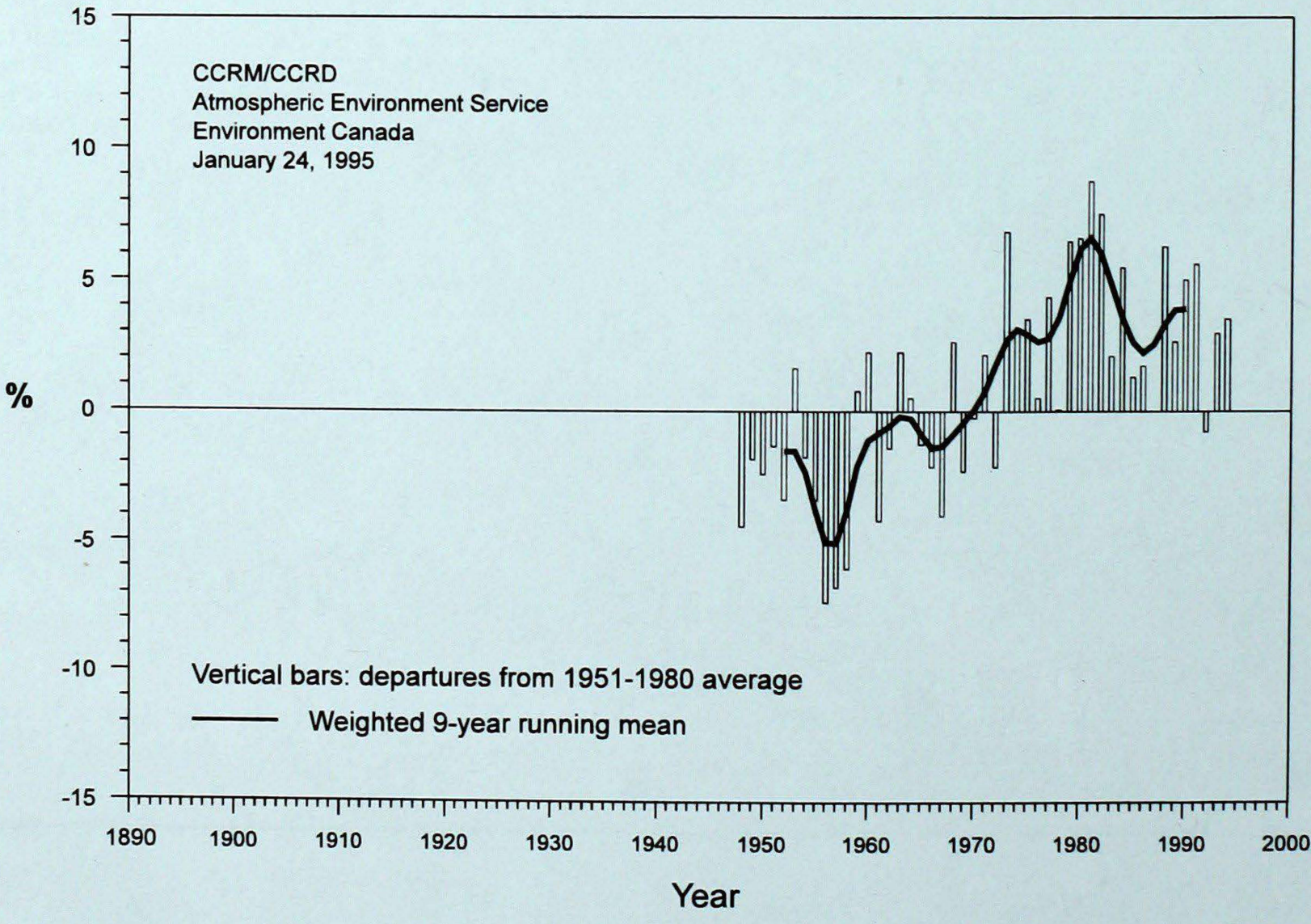
Environment Canada Environnement Canada

Canada

CANADA
ANNUAL TEMPERATURE
1895-1994



CANADA
ANNUAL PRECIPITATION
1948-1994

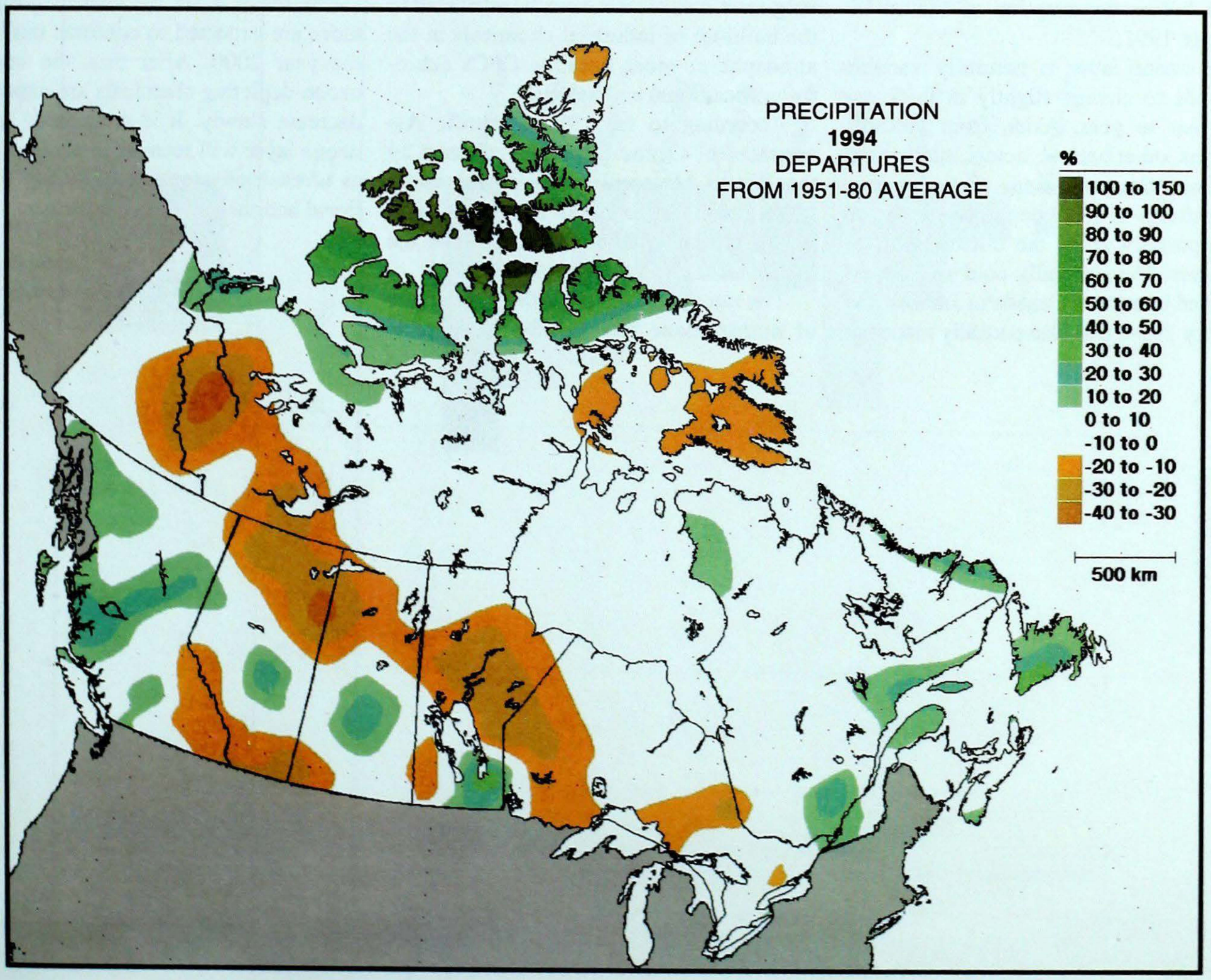


On a regional basis, annual temperatures were above the long-term means in most areas with over 63% of Canada's total land area experiencing substantially warmer-than-average conditions over the year. Exceptions were in the area from the lower Great Lakes to southern Quebec and Labrador, and in Atlantic Canada where 1994 was the 3rd and 4th year respectively, in a row, with below-average temperatures. The area of substantially below-average temperatures was only about 4% of the total Canada-wide land area, however, and the remaining one-third of the country (33%) varied from slightly below to slightly above the long-term means. To the north, the Boreal Forest region of northern Ontario and central Quebec was slightly above average. Century-long warming trends for eastern Canada range from 0.2 degree in Atlantic Canada to 0.5 degree in Ontario and Quebec. Elsewhere in the country, 1994 was considerably warmer than average with the Prairie Provinces marking their 9th year in a row with above-average temperatures. To the north, in the Mackenzie Valley region, it was the 4th consecutive such year. Long-term warming trends over this region range from 0.9 degree in the south to 1.8 degrees in the north. Throughout British Columbia's southern interior and coast, 1994 was among the warmest 10% of years there since 1895, and as with the Prairie Provinces, it was also the 9th year in a row with warmer-than-average temperatures. In northern British Columbia and Yukon Territory, 1994 was the 4th consecutive year with above-average temperatures. Long-term warming trends range from 0.5 degree in southern British Columbia, to about 1.0 degree in the north, over a slightly shorter period. The central Arctic was about one degree warmer than average for the year with a 73-year warming trend of 0.7 degree (since 1922, the first year of available data). The eastern Arctic seaboard was also several tenths of a degree warmer than its long-term mean; however, a cooling trend of 0.6 degree continued over the 49 years since regional records began in 1946.

The national average precipitation amount for 1994 was about 4% above the long-term mean making it the 11th-wettest year for Canada since national precipitation records began in 1948. A continuation of the overall upward trend in annual precipitation is indicated over the period since 1948. With the exception of 1987 and 1992, all years since 1972, on a national basis, have been wetter than the long-term mean.

Regionally, about 22% of the total land area received substantially greater-than-average precipitation while a roughly equal

continued on page 9...



Ozone-thinning over Canada (1994)

The thinning in the ozone layer over Canada showed a slight overall improvement in 1994, with ozone values in the upper atmosphere averaging about 3.1% below normal, compared to an average of 7.7% for 1993. However, according to Environment Canada atmospheric scientists, this increase in ozone thickness is a temporary situation, caused by natural factors and does not indicate a permanent recovery of the ozone layer.

For 1994 and 1993, the average ozone depletion over Canada per three-month period are shown in Table 1. The ozone values observed throughout 1994 are more consistent with the level of depletion recorded before the eruption of Mount Pinatubo in 1991.

The ozone layer is naturally variable and tends to change slightly in thickness from year to year. Aside from volcanic eruptions, other natural factors, such as unusual weather conditions and changing wind patterns in the upper atmosphere, can all temporarily affect the thickness of the zone layer. The unusually-cold weather experienced in eastern Canada in January and February 1994, was also partially responsible for the thicker ozone values observed in the first quarter of 1994. However, ozone values recorded across Canada were consistently below pre-1980 values all year.

Table 1

	1994	1993
January to March	-3.4%	-14.5%
April to June	-5.1%	-10.5%
July to September	-1.6%	-3.4%
October to December	-4.0%	-1.7%

Environment Canada scientists have observed a gradual, long-term thinning of the ozone layer over Canada since 1980. This long-term loss of ozone can be attributed to the build-up of industrial chemicals in the atmosphere, most notably CFCs (chlorofluorocarbons) and halons.

According to the 1994 Scientific Assessment of Ozone Depletion released by the World Meteorological Organization, 1994 global ozone levels are returning to values closer to those expected from the longer-term downward trend.

The rates of build-up in the atmosphere of human-made compounds that deplete the ozone layer have slowed down in recent years. This is a direct result of reductions in global emissions of these compounds following the coming-into-effect of the Montréal Protocol.

Peak global ozone depletions are expected to occur during the next few years. Decreases of 4-5% per decade at mid-latitudes are expected to continue until about the year 2000. After this, the levels of ozone-depleting chemicals are expected to decrease slowly. It is anticipated that the ozone layer will recover in about 50 years as a result of continued, planned international actions to halt the depletion.

Laurie LeGallais
Communications Directorate

STATE OF CANADA'S OZONE LAYER - ANNUAL AVERAGES

OZONE WATCH INFO-OZONE

ÉTAT DE LA COUCHE D'OZONE AU CANADA - MOYENNES ANNUELLES

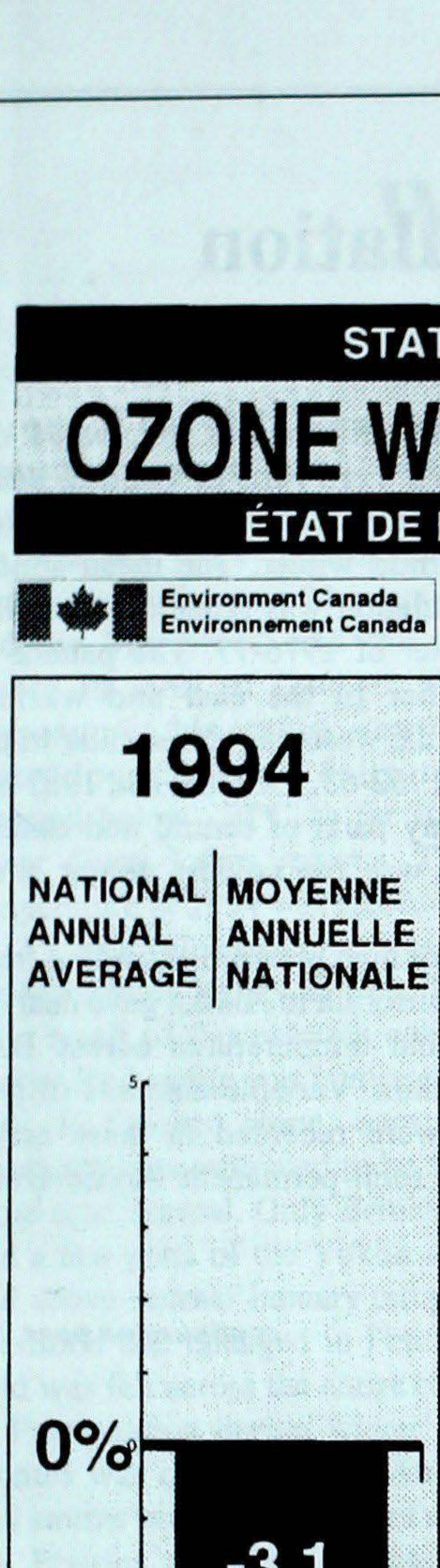
Environment Canada
Environnement Canada

FINAL

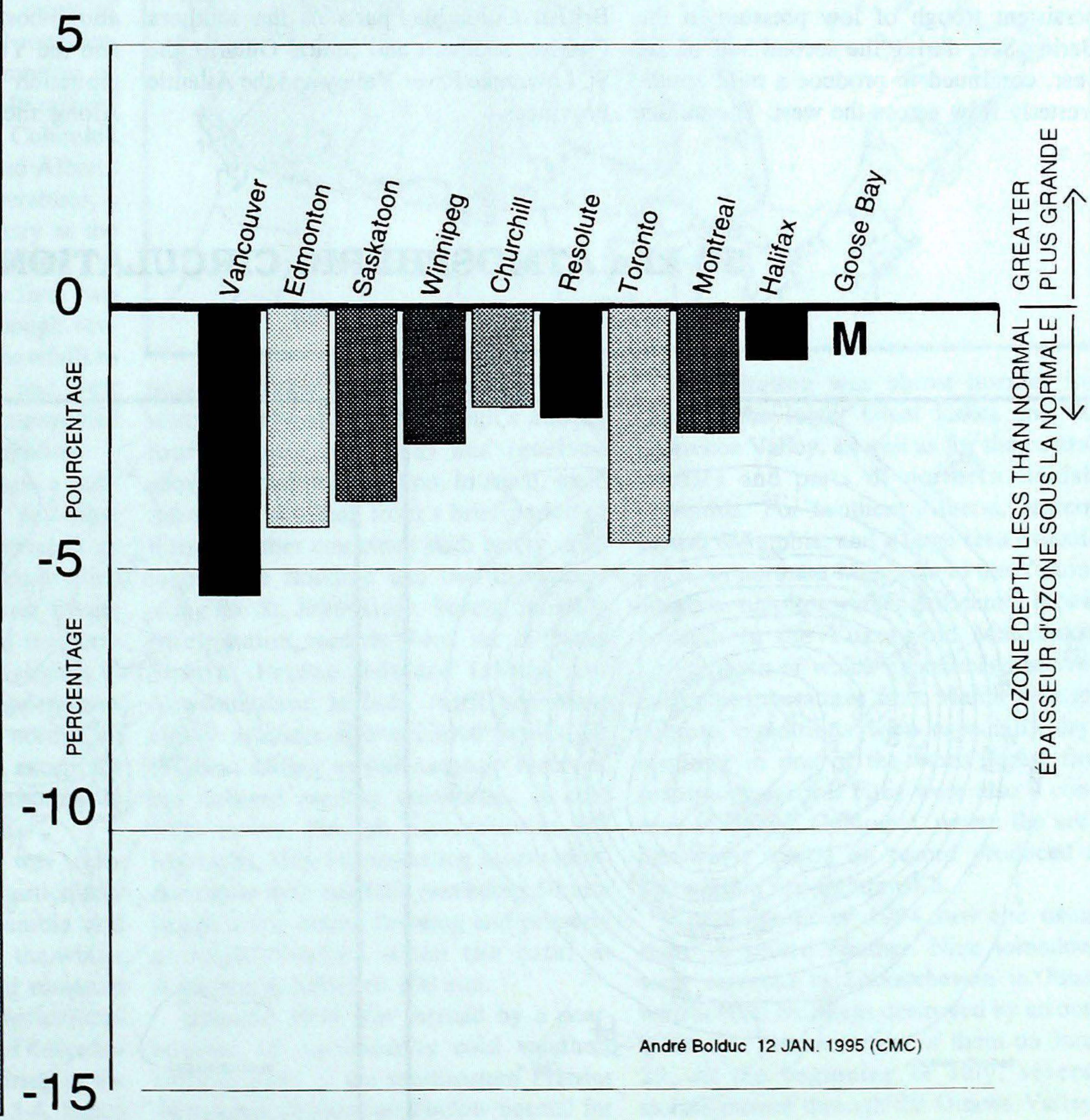
% VALUES ARE FOR WHOLE YEAR
VALEURS EN % POUR L'ANNÉE COMPLÈTE

1994

NATIONAL ANNUAL AVERAGE	MOYENNE ANNUELLE NATIONALE



OBSERVING SITES ANNUAL AVERAGES | POINTS D'OBSERVATION MOYENNES ANNUELLES



André Bolduc 12 JAN. 1995 (CMC)

Annual (1994) Atmospheric Circulation

Southern and central Ontario, Labrador, Quebec and the Atlantic Provinces experienced slightly cooler-than-normal annual temperature departures, while the rest of the country was slightly warmer than normal. The greatest positive departures were experienced across the Northwest Territories and the southeastern corner of British Columbia.

The warmer-than-normal temperatures across the western half of the country were persistent from one season to the next. This may have been partly due to the warm sea-surface temperatures in the Gulf of Alaska, which allowed for the persistence of a ridge of high pressure over the west. A persistent trough of low pressure in the Bering Sea, during the second half of the year, continued to produce a mild south-westerly flow across the west. The milder air also maintained the ridge of high pressure over western Canada.

The slightly-below-normal annual mean temperatures across the east during 1994 were mostly the result of the record-cold winter. Annual temperatures would have been much colder in these areas had it not been for the subsequent mild fall across Canada (possibly due to a maturing El-Niño event), which almost balanced out the annual temperature anomalies.

Precipitation was below normal for most of the country. The general lack of precipitation was due to a dry winter and fall. Near- to above-normal amounts were recorded only across the Arctic islands, British Columbia, parts of the southern Prairies, southern and central Ontario, the St. Lawrence River Valley and the Atlantic Provinces.

Winter

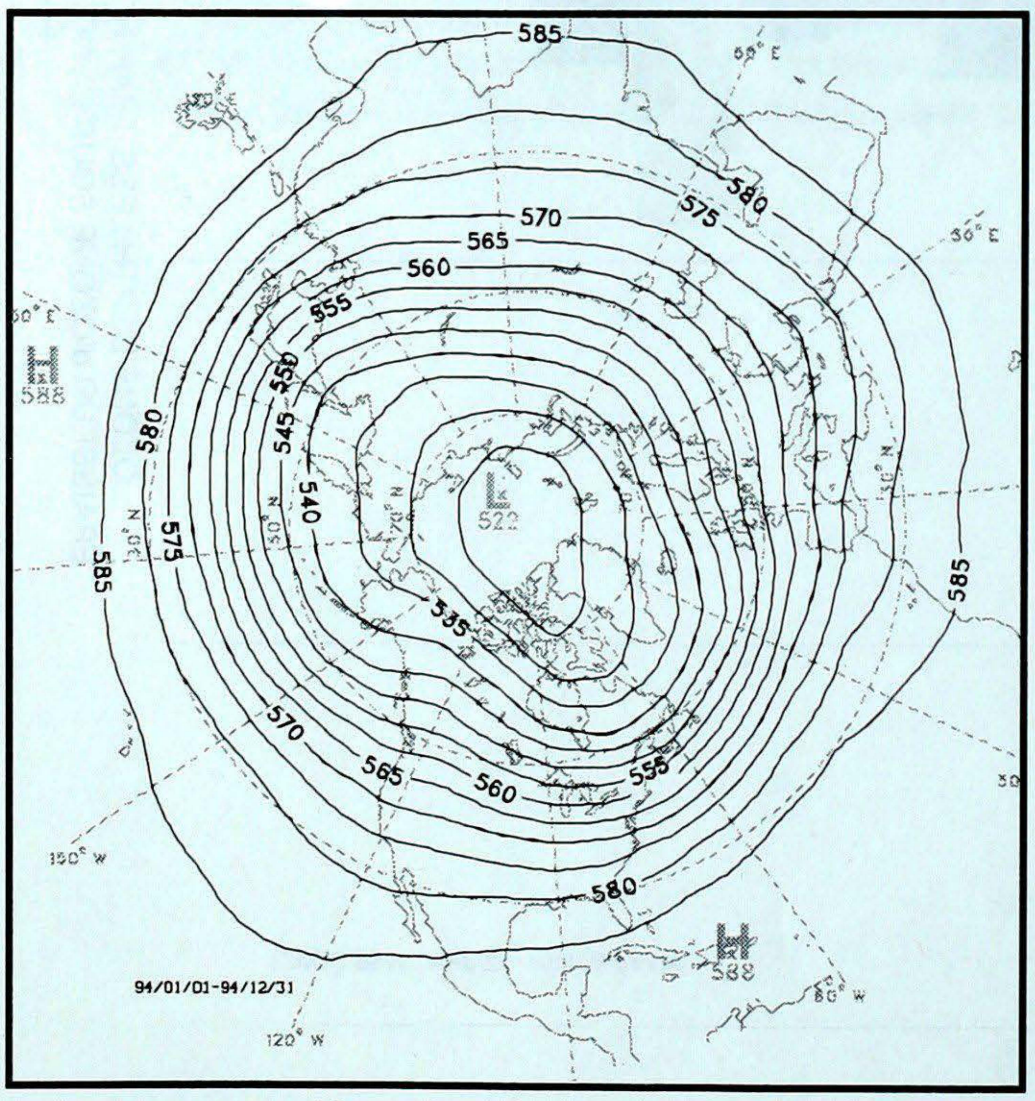
Record-cold temperatures dominated the central and eastern parts of Canada, while most of British Columbia and the Yukon enjoyed a mild winter. The mean atmospheric circulation was remarkably similar to the winter of 1976-77. The pattern of cold weather in the east and warmer weather in the west was also similar to the winters of 1962-63, 1985-86, and 1987-88. Across many parts of central and eastern Canada, it was the coldest winter since 1929.

A ridge of high pressure extending from northern California to Alaska gave near- to above-normal temperatures across B.C. and the Yukon. Variable amounts of precipitation were recorded in these areas. Along the semi-permanent Arctic front,

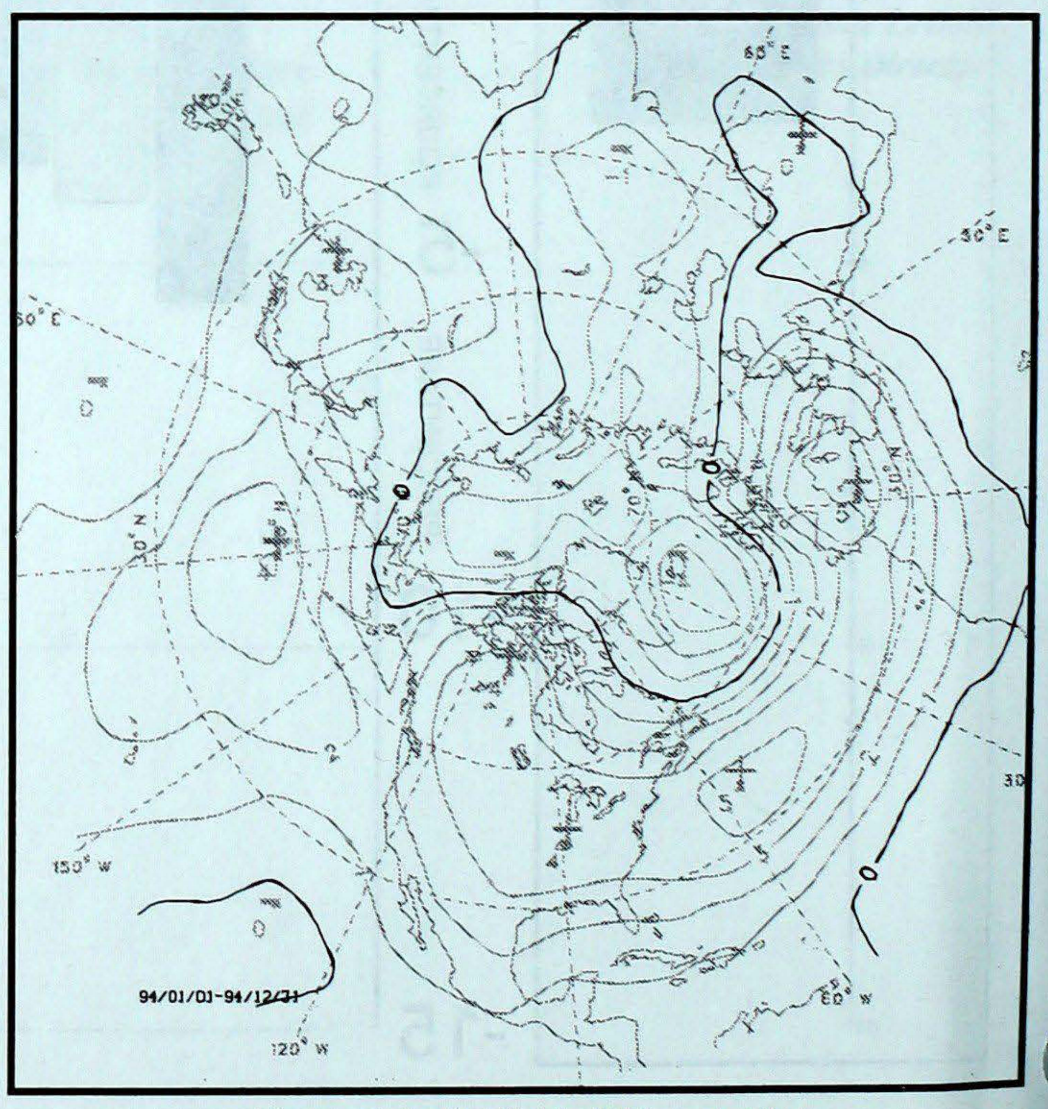
continued on page 9...

50-kPa ATMOSPHERIC CIRCULATION

Annual 1994

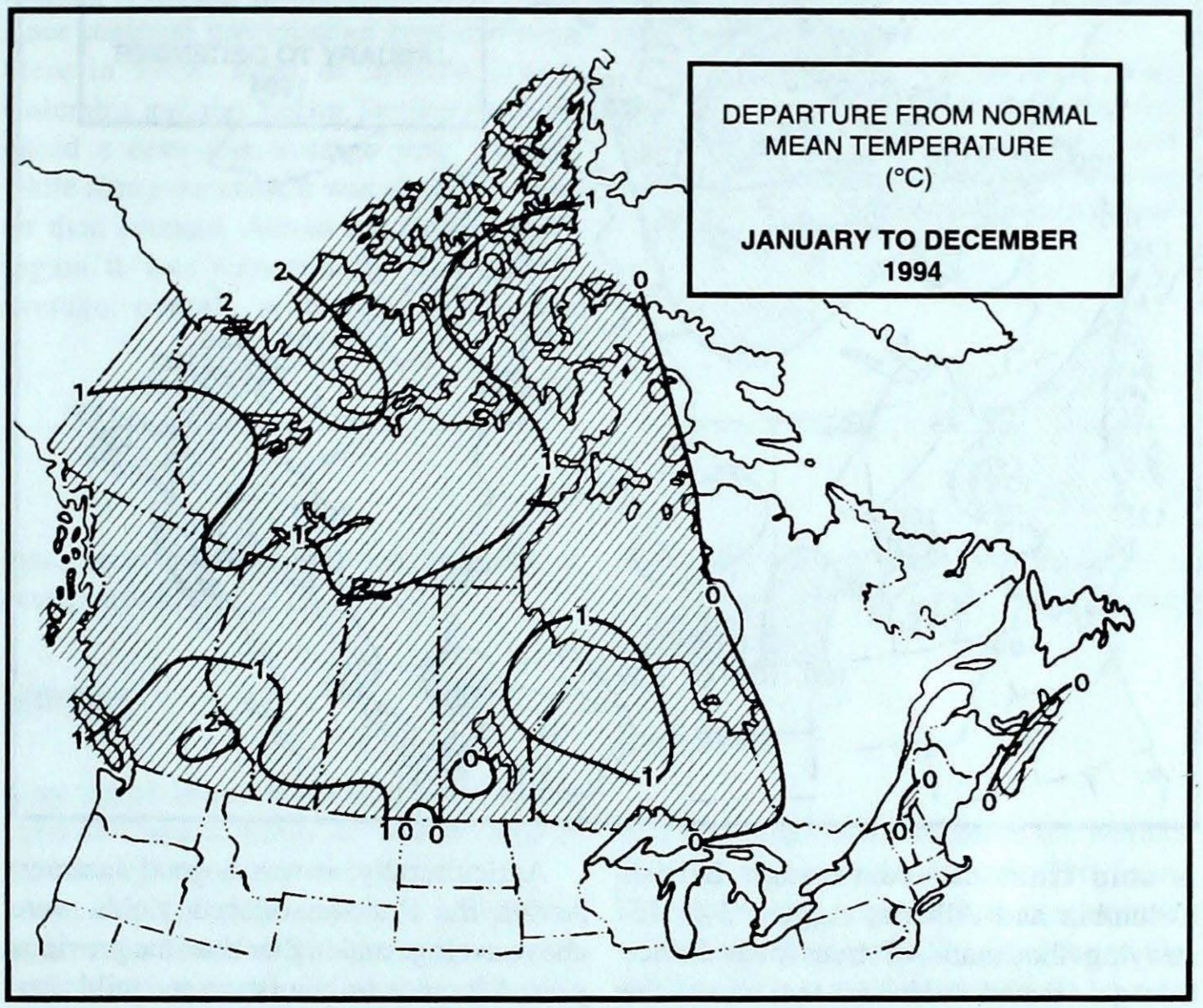


Mean geopotential heights
5-decametre interval



Mean geopotential height anomaly
1-decametre interval

Weather and Climate Impacts (1994)



In contrast to 1993's warm ending, 1994 opened on a cold note, across most of Canada. January 1994 was the coldest in the past ten years in Saskatchewan and Manitoba, in the past 74 years in Ontario and the Maritimes, and the coldest on record in most of Quebec. The lowest temperatures this century were recorded in many locations, as daily minimums dropped below -30°C as far south as the lower Great Lakes regions. The coldest temperature of 1994 was recorded on January 13, as a value of -53°C was reached in the Mackenzie Valley, at Fort Good Hope. As a result of this extreme cold, usage of energy for heating was increased considerably. In Quebec alone, consumption of electricity was estimated to be $40 million more than normal. Only British Columbia and a few parts of the Yukon and Alberta had above-normal January temperatures, a condition that changed in February as the cold was felt across the entire country.

Precipitation during winter's final two months was quite variable. Although several storms brought significant snowfalls to the Prairies and both the east and west coasts, many other parts of the country had below-normal amounts of precipitation.

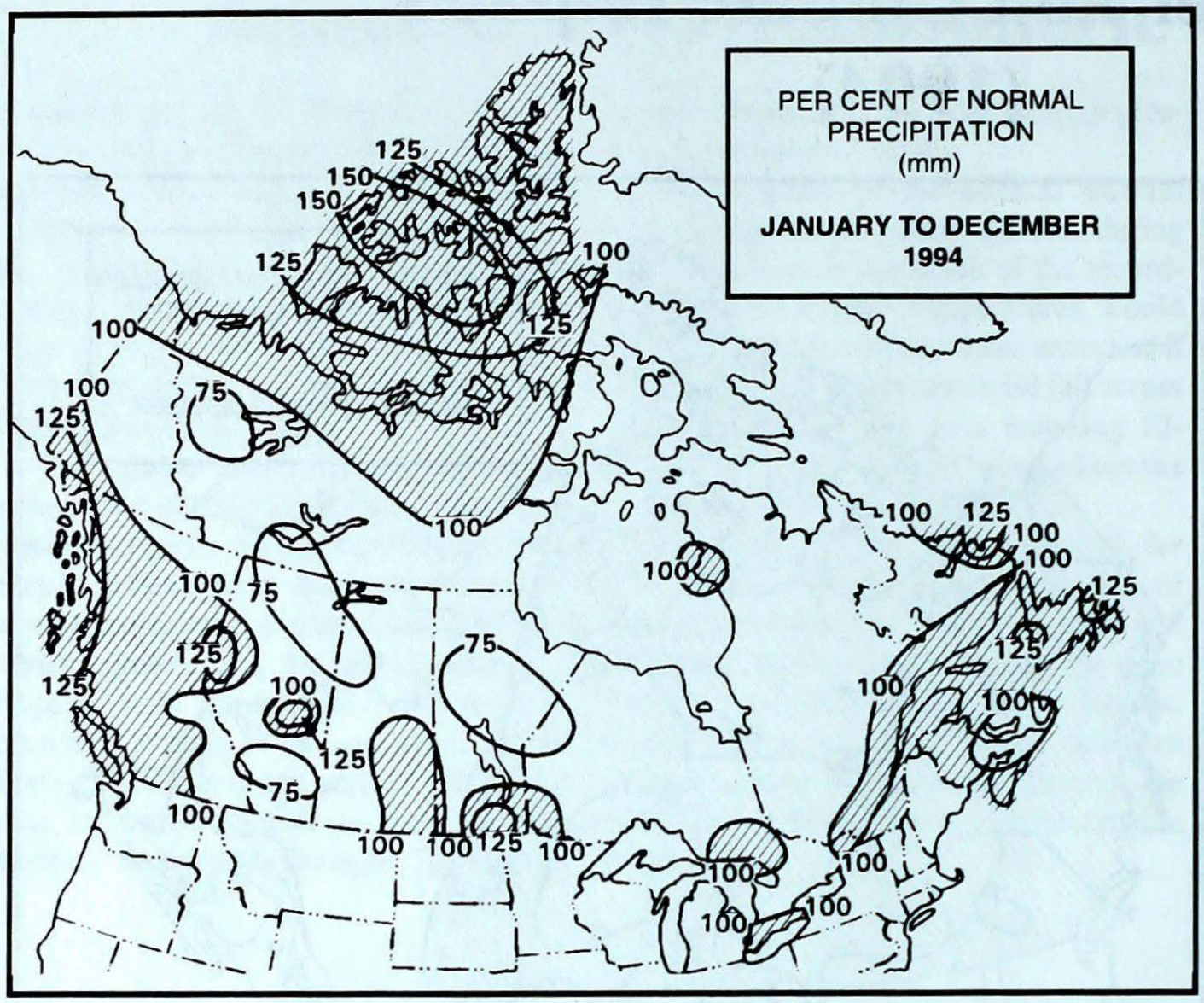
Spring's entrance in March saw a radical turnaround in temperatures. Although cool conditions continued to prevail in an area extending from the northeastern Arctic to Newfoundland, the rest of the country recorded above-normal temperatures. This change was tempered slightly in the following two months as temperatures were a degree or two below normal in many eastern areas in April and, except for some High Arctic warmth, near normal in all areas in May.

For most of Canada, spring was relatively dry. Precipitation was particularly sparse in central British Columbia and across the Prairies. Fortunately, the winter snowfalls had ensured that soil moisture would be sufficient for most agricultural interests. In contrast to the rest of the country, it was a particularly wet spring in the Atlantic Provinces. On March 3-4, heavy snow fell in the St. Lawrence Valley and a combination of snow, freezing rain, and rain was responsible for flooding and power outages in Nova Scotia. More storms followed, and by month's end all four Atlantic provinces had received above-normal precipitation. In April, rapid snow melt resulting from a brief period of warm weather combined with heavy rains to produce flooding and two drownings along the St. John River. Several monthly precipitation records were set in Nova Scotia, Prince Edward Island and Newfoundland in both April and May. Heavy rainfalls also occurred across the Prairies, adding to soil-moisture reserves, but delayed seeding operations. A cold front moved through Saskatchewan and Manitoba, May 18, producing severe thunderstorms with rainfalls exceeding 50 mm in just a few hours; flooding and property damage resulted when the total at Winnipeg approached 100 mm.

Summer 1994 was marked by a near-absence of significantly cold weather. Only in parts of the southeastern Prairies were mean temperatures below normal for the June to August period. The highest value recorded this summer was 41°C, at Lytton, July 22.

Precipitation was above normal for most of the lower Great Lakes and St. Lawrence Valley, as well as for the central Prairies and parts of northern British Columbia. For southern Alberta, eastern British Columbia, and a large area extending from northern Manitoba to the Yukon, moisture supplies were significantly below normal. In the Yukon and Mackenzie Valley, both of which experienced above-average temperatures from March through August, conditions were especially dry, resulting in one of the worst forest fire seasons on record. Fires were also a concern in British Columbia, where the second-worst season on record produced a $70 million fire-fighting bill.

The summer of 1994 saw the usual share of severe weather. Nine tornadoes were reported in Saskatchewan in June, with several buildings destroyed by an outbreak that produced five of them on June 29. At the beginning of July, several storms moved through the Ottawa Valley, resulting in localized flooding, the destruction of several houses and factories, and five deaths - four due to lightning strikes.



A cold front moved through British Columbia and Alberta, August 3-4, destroying thousands of trees near Prince George, created mudslides that closed the Trans-Canada Highway, and inflicted $10 million of hail-related damage at Salmon Arm, B.C. Cars and greenhouses on northern Vancouver Island were damaged by golf-ball-sized hail on August 18; on the same day hail destroyed entire fields of crops in southern Manitoba. Baker Lake, N.W.T., experienced an unusual two-day rainfall that exceeded 80 mm, July 22-23, contributing to above-normal precipitation for the summer.

Agriculturally, it was a good summer. Across the Prairies, oilseed yields were above average and higher than the previous year. Adequate soil moisture and mild temperatures had given early signs of another bumper crop of wheat (1993 had produced record amounts). Unfortunately, hot, dry conditions in August reduced the crop to merely average. In general, Prairie crop quality was significantly better than in 1993. Severe weather in Manitoba reduced crop yields slightly, but also contributed to that area's above-average soil moisture conditions at the end of the year. In Ontario, crop yields and quality were generally good to excellent. Despite the extreme cold of January and February, winter wheat yields were above average, largely as a result of the protection and moisture afforded by plentiful snowfalls.

Above-normal conditions continued into the fall, in most of the country. However, unlike the preceding part of the year, the most significantly - warm departures from the long-term average were found in the extreme north and parts of eastern Canada. The only areas with below-normal mean temperatures were in the Yukon. Precipitation totals were heaviest along the Pacific coast as a continuing series of storms dropped as much as 1000 mm of precipitation in some areas. A major storm moving up the Atlantic coast, September 5-6, produced 50-90 mm rainfalls and high seas that sank a fishing boat, drowning the four crew members. This storm seemed to signal the start of another wet season. However, there were only a few more storms during the next couple of months, and Fall 1994 precipitation amounts for the Maritimes were only three-quarters of their usual amounts. For much of the rest of the country, it was a dry fall.

During the final month of the year there was little real sign of the coming winter season. Temperatures were generally above normal, and there were only a few significant snowfalls. In southern Canada, the only recipient of severe winter weather was the island of Newfoundland. From December 6-9, several locations set new daily snowfall records and travel came to a standstill. In addition, one death occurred as high winds swept a crew member off a fishing boat.

Malcolm Geast

... continued from page 3

area (23%) received considerably below-average amounts. The remaining half of the country received values ranging from slightly above to slightly below the long-term means. From the lower Great Lakes to Altantic Canada, areally-averaged precipitation for 1994 was 5 to 10% above average, while farther north, across northern Ontario and central Quebec, it was slightly below. In Altantic Canada the year was among the wettest 10% of years there since 1895. In contrast, much of western Canada was generally drier than average during 1994 with the prairie provinces averaging 1 to 6% drier, overall. Farther north, the Mackenzie Valley region was generally 10 to 20% drier than average for the year, making it among the driest 20% of years since regional precipitation records began there in 1928. Most of interior British Columbia and the Yukon Territory experienced a drier-than-average year, overall, while along the coast it was about 5% wetter than average. Across the Arctic tundra region it was substantially wetter than-average, overall, with 1994 among the wettest 10% of years there since 1948. In fact, it was the 16th consecutive year in this region with above-average precipitation amounts, whereas along the eastern Arctic seaboard, 1994 was about 2% drier than the long-term mean.

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Data Interpretation Division
Climate Research Branch

... continued from page 6

which stretched from south-central Yukon to southern Saskatchewan, precipitation was above normal.

The warm sea-surface temperatures in the Gulf of Alaska resulted in the formation of the persistent western ridge of high pressure. The warmer-than-normal sea-surface temperatures in the Gulf were a remnant and an extension of the prolonged El-Niño event which occurred during 1991-93. This pool of water warmed the air above it and helped to maintain a ridge of high pressure, which persisted from the fall of 1993 through much of 1994. East of the ridge, the general wind direction was from the northwest, allowing Arctic air to flood the central and eastern parts of Canada and helping to establish a persistent cold trough over Hudson Bay.

The pronounced trough of low pressure stretching from the southernwestern tip of Baffin Island to Lake Ontario resulted in a record-cold winter for most of eastern and central Canada. The stronger-than-normal ridge/trough pattern over Canada, from west to east, resulted in extended outbreaks of cold air over central and eastern Canada. Except as noted earlier, precipitation was well below normal. The western ridge effectively blocked Pacific low pressure systems from penetrating western Canada. Also, the cold air associated with the stronger-than-normal trough of low pressure over the eastern half of Canada pushed low pressure systems farther south, into the eastern half of the United States. Consequently, most of central and eastern Canada, with the exception of Newfoundland, received below-normal amounts of precipitation.

Spring

Cool temperatures dominated northeastern parts of Canada, while the western half of the country enjoyed a warmer spring.

An ampified ridge extending from Montana to the Beaufort Sea gave above-normal temperatures to the Northwest Territories, British Columbia and most of the Prairies. West of, and in the vicinity of the ridge, precipitation was above normal for most of B.C., the Arctic islands, northeastern Alberta and northern Saskatchewan. Warmer-than-normal sea-surface temperatures in the Gulf of Alaska may have played a role in maintaining the upper ridge over western Canada.

An amplified upper trough of low pressure stretching from the Davis Strait to western Nova Scotia resulted in a cool spring across Labrador and central Quebec. The winter of 1993-94 yielded above-normal ice and snow cover over the Northwest Territories, including Hudson Bay. As a result, Arctic air moving southeastwards was kept cool as it passed over the ice and snow-covered areas farther to the south. Extensive ice off the east coast of Canada hindered shipping operations.

At the base of the trough, where the upper level winds were west-southwesterly, precipitation was above normal across the Atlantic Provinces and the Gaspé Peninsula. Winds from the southwest are usually associated with above-normal precipitation amounts as moisture is pushed up from the warm, moist subtropical regions.

Summer

Warm temperatures dominated the western parts of Canada and Atlantic Provinces. Elsewhere, temperatures were near normal.

A broad ridge extending from the southwestern U.S. to the western Arctic islands, gave warm temperatures to most of the Northwest Territories, the Yukon, British Columbia and most of the Prairies. Warmer-than-normal sea-surface temperatures in the Gulf of Alaska, once again, may have halped maintain the upper ridge over western Canada.

An upper trough of low pressure stretching from the Davis Strait to northern Quebec did not make an impact on the temperatures. A cold pool of air over the polar regions did not cause any significant cold spells across the northeast, mainly because the arctic and polar streams never phased, a condition which would have allowed the cold air to penetrate southwards.

Precipitation was above normal across northern British Columbia and the Arctic islands due to weak troughing. The southern Prairies, Great Lakes, St. Lawrence Basin and northern Newfoundland also recorded above-normal precipitation. A possible explanation for the increase in moisture over the St. Lawrence Basin could be attributed to a high pressure cell south of Newfoundland and warmer sea-

surface temperatures in the Gulf Stream, which may have allowed moisture to be pushed up from the south.

Fall

Mild temperatures dominated all of Canada, with the exception of the Yukon, the western half of British Columbia and the Atlantic Provinces, where temperatures averaged near normal.

The upper atmospheric circulation was remarkably zonal, or westerly, across the entire country, when averaged over the season. It is possible that the overall pattern was the result of warmer waters adjacent to eastern North America. Above-normal sea-surface temperatures were observed in the Gulf of Mexico, along the Gulf Stream and Hudson Bay. Collectively, the warm waters not only raised average land-surface temperatures, but also displaced the jet stream and tracks of low pressure systems, farther north. This, in turn, yielded a dry fall for most of the southern half of Canada. Sea-surface temperatures in the north-eastern Pacific were warmer than normal in the early fall. However, by the end of the season, water temperatures in that region became colder than normal and a series of stationary (cold) low pressure systems formed in the northeast Pacific, off Vancouver Island.

There were, of course, month-to-month variations of the circulation as fall marched on. During September, most of Canada, except for the High Arctic, enjoyed above-normal temperatures, with below-normal precipitation across the southern half of the country. These conditions were due to an upper level ridge of high pressure that stretched from Texas to the central Northwest Territories, which pushed the jet stream farther north. The northerly excursion of the jet stream, in combination with a trough of low pressure in the Bering Strait, spawned several low pressure centres in the Northeast Pacific. This gave above-normal amounts of precipitation to the northern half of the country as well as to coastal British Columbia. A weak trough of low pressure stretching from the Gulf States to Newfoundland yielded above-normal amounts of precipitation across the Atlantic Provinces as low pressure systems passed through the region.

By mid-October, the colder air made some intrusions in the West along a path extending from the Yukon to the south-western U.S. This was due to the persistent trough of low pressure in the Bering Strait, which had merged, on occasion, with a trough that extended from southern B.C. to northern California. Across the rest of the country, temperatures remained near to above normal under the influence of an upper ridge that extended from Great Slave Lake to the Carolinas. The greatest above-normal temperature departures during October were across the central and eastern Northwest Territories.

In November, the colder-than-normal air from the High Arctic plunged southwards across the Yukon, the District of Mackenzie, British Columbia and Alberta. By the end of the month, the cold air managed to pulse eastwards across Ontario and Quebec, briefly intruding on the mild weather across the eastern half of the country. Elsewhere, temperatures were above normal, due to the persistent upper level ridge of high pressure building over the central parts of Canada. Mild and dry weather continued across all of Canada during most of December. It appeared that the onset of yet another ENSO (El-Niño/ Southern Oscillation Index) event was responsible for the mild weather. A persistent trough in the Bering Sea funnelled milder air from the north-central Pacific into North America.

CLIMATIC PERSPECTIVES
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The purpose of the publication is to make topical information available to the public concerning the Canadian climate and its socio-economic impact.

The data in this publication are based on unverified reports from approximately 225 Canadian synoptic weather stations. Information concerning climatic impacts is gathered from AES contacts with the public and from the media. Articles do not necessarily reflect the views of Atmospheric Environment Service.

INDEX
1994 Climatic Perspectives

MONTHLY

SEASONAL/ANNUAL

Summer	Summer 1994 National Summary (D. Gullett, T. Jang, L. Malone, J. Reycraft) 1994 Summer in Review Summer 1994 (Malcolm Geast)
Fall	Fall 1994 National Summary (D. Gullett, T. Jang, L. Malone, J. Reycraft) Fall 1994 Atmospheric Circulation Fall 1994 in Review (Malcolm Geast)
Annual	Annual Review (1994) - Historical Perspective (D. Gullett, T. Jang, L. Malone, J. Reycraft) Weather and Climate Impacts (1994) (Malcolm Geast) Annual (1994) Atmospheric Circulation Ozone-thinning over Canada (1994) (Laurie LeGallais)