Environment Canada / Environnement Canada

Climatic Perspectives

Monthly Review — February 1992 — Vol. 14

CLIMATIC HIGHLIGHTS

The Atlantic Provinces will not soon forget February 1992 as numerous storms pummelled the region, breaking various snowfall records for the month.

The combination of cold, dry, Arctic air and warm, moist air from the Gulf of Mexico, merging over the eastern seaboard, results in the formation of powerful storms. These storms are usually born in the area of Cape Hatteras, North Carolina, and "Hatteras Storms" follow the warm waters of the Gulf Stream to Nova Scotia.

On the 1st of February, moderate to heavy snow, combined with storm-force winds, belted the Maritimes. Mixed precipitation fell over the south coast of Nova Scotia as the low stalled just south of Halifax on the 2nd, generating hurricane-force winds. The greatest snow amounts fell in the areas bordering the Gulf of St. Lawrence. Moncton set a new one-day snowfall record of 83 cm, on the 1st.

Virtually all transportation came to a standstill as even the snow ploughs were unable to keep the roads passable. The local R.C.M.P., near the Nova Scotia-New Brunswick border, recruited 20 snowmobilers to move over 100 stranded motorists to shelter. At the height of the storm, Charlottetown fire fighters fought a major blaze, which destroyed at least three buildings in the downtown area. The bleak conditions were also present over Newfoundland on the 3rd.

Less than a week later, two more storms battered the Atlantic Provinces. Moncton received the brunt of the first storm, on February 5, with 26.4 cm of snow then Sydney received the most snow associated with the second storm, registering 24.8 cm on the 8th.

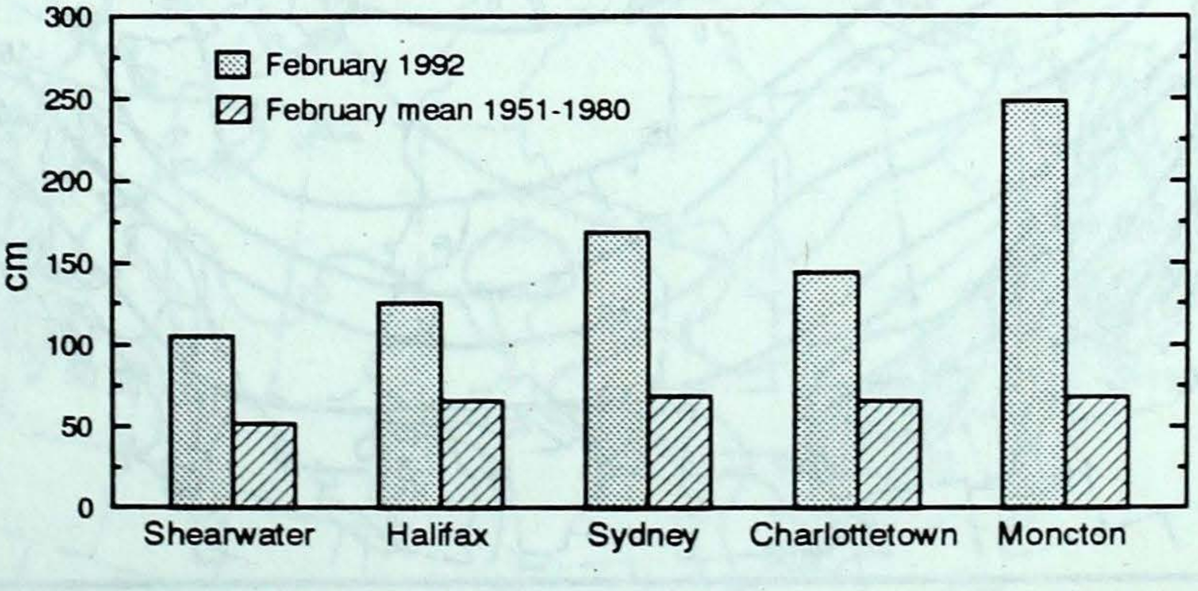
Clearly, three snowstorms in the span of about a week was a heavy burden to the population. The difficulties ranged from school, business and radio station closures to a total halt of road transportation. On February 15 and 16, New Brunswick and Nova Scotia were battered again by strong winds and snow changing to freezing rain. Roads in Halifax were transformed into tractionless slush. Over 100 motor vehicles were disabled.

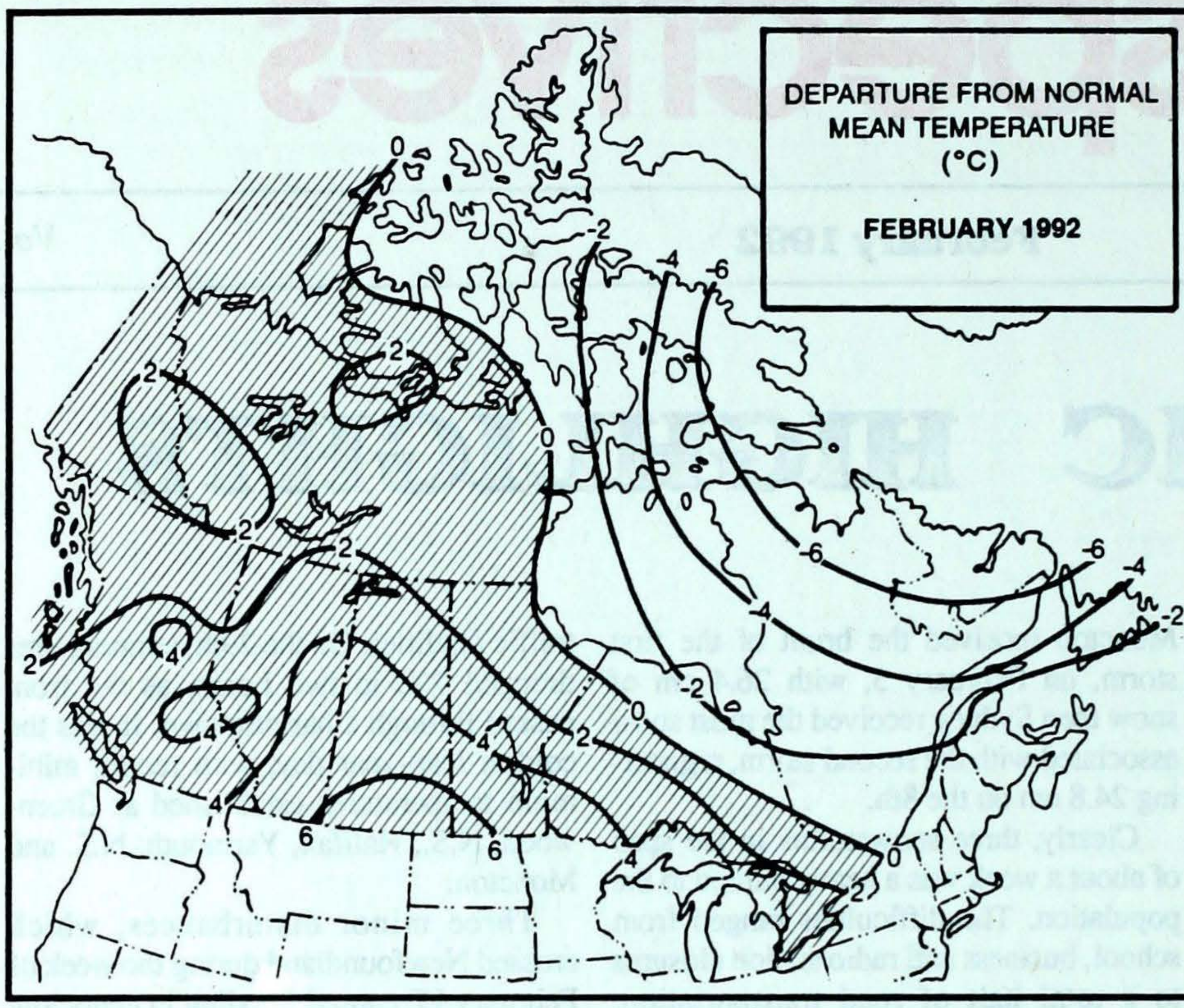
During the last week of the month, a vigorous cold front traversed southwestern Quebec and the Maritimes. Across Quebec, high winds and heavy flurries created poor visibility, resulting in two traffic fatalities. On the 29th, temperatures dropped 7°C in two hours, as the front passed through Charlottetown. It was the coldest leap-year day, with record minimum temperatures established at Greenwood, N.S., Halifax, Yarmouth, N.S. and Moncton.

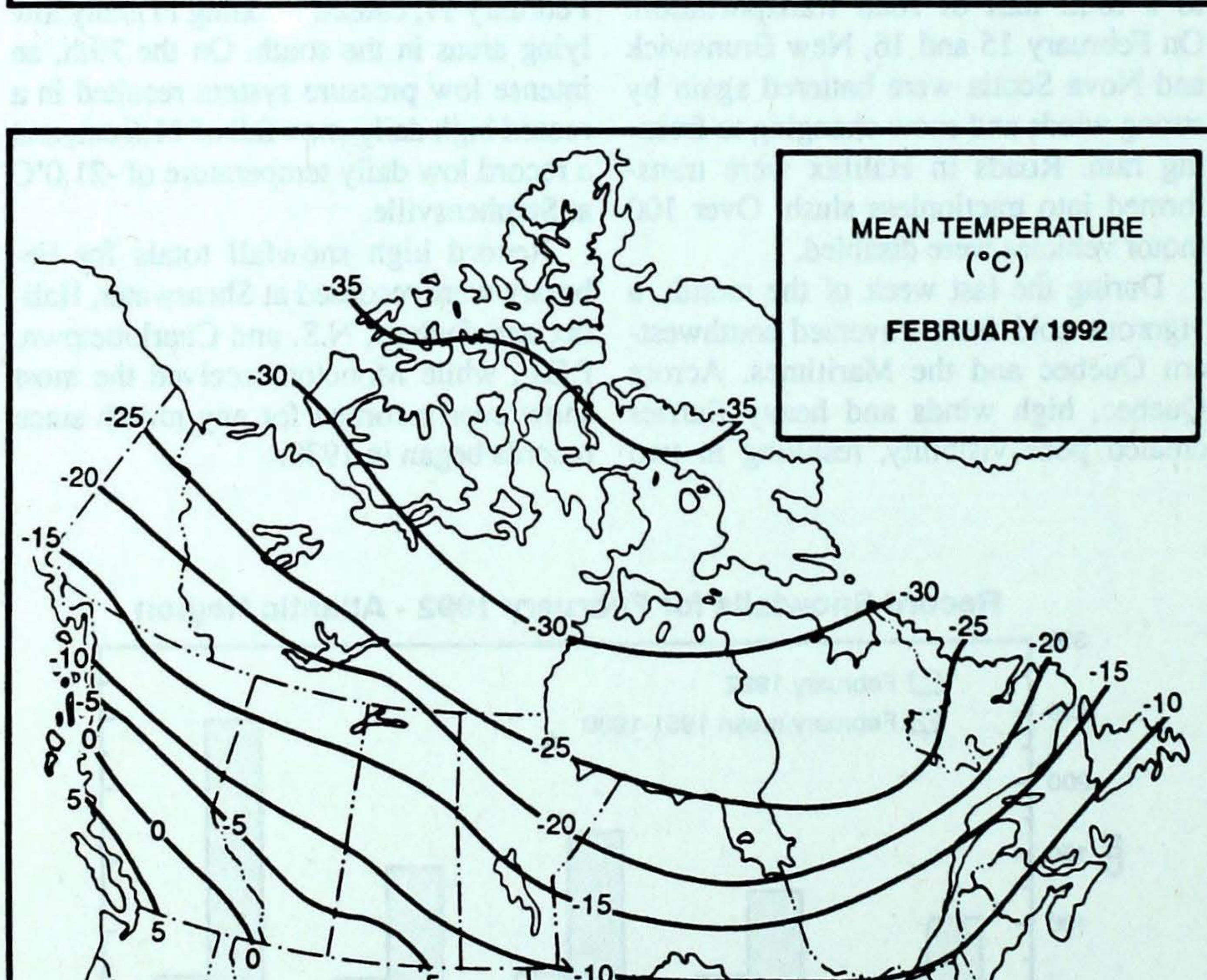
Three minor disturbances, which crossed Newfoundland during the week of February 17, caused flooding in many low lying areas in the south. On the 29th, an intense low pressure system resulted in a record high daily snowfall of 11.6 cm, and a record low daily temperature of -21.0°C at Stephensville.

Record high snowfall totals for February were recorded at Shearwater, Halifax and Sydney, N.S. and Charlottetown, P.E.I., while Moncton received the most snow ever recorded for any month since records began in 1939.

Record Snowfalls for February 1992 - Atlantic Region







Across the country

Yukon

The Yukon region leaped to above normal monthly temperatures, as a flood of warm air from the Gulf of Alaska invaded the region, during the last week of the month. Most locations, as far north as Old Crow, experienced record breaking warm days. Many sites had daily maximums in the low teens. Carmacks and Drury Creek experienced a pleasant 13°C. However, Old Crow and Eagle Plains' monthly maximums only reached -9°C. Ogilvie dipped to -50°C on the 2nd, to claim fame as Yukon's coldest spot. Whitehorse's coldest temperature reading was -32.4°C, recorded on the 21st. In contrast, the record high daily maximums of 8.2°C and 11.5°C were reported on the 25th and 26th, providing the warmest days of the month.

Precipitation was less than half its normal value for the area, including Burwash, Beaver Creek, Tuchitua and Swift River. The rest of the southern Yukon ranged from half to near normal precipitation amounts, in both rain and snowfall. Areas in the north experienced snowfall amounts of 150 percent of normal.

The predominantly south-blowing wind was a little lighter than normal, as the wind speed averaged 13.9 km/h for February; however, maximum wind speeds were depicted at 48 km/h with gusts peaking at 72 km/h. This, coupled with the warm temperatures and sunny skies, melted the snow banks and skiers dreams in one fell swoop. The official location for measuring snow, at the Whitehorse airport, contained only a mere trace of snow on the morning of the last day of the month. Never before has so little snow been left at month's end.

Northwest Territories

Temperatures in the Keewatin region were normal to slightly above normal, but further north and east, temperatures were 1°C to 3°C below normal. The greatest exception was the 4.2°C below normal temperature in Coral Harbour. Monthly mean temperatures varied between -31.4°C at

Rankin Inlet to -38.3°C at Eureka. Daily minimum temperatures dipped to -40°C or colder in all areas, but Clyde's -51.8°C was the lowest minimum temperature in the region. The warmest daily temperature was in Hay River at 9.6°C.

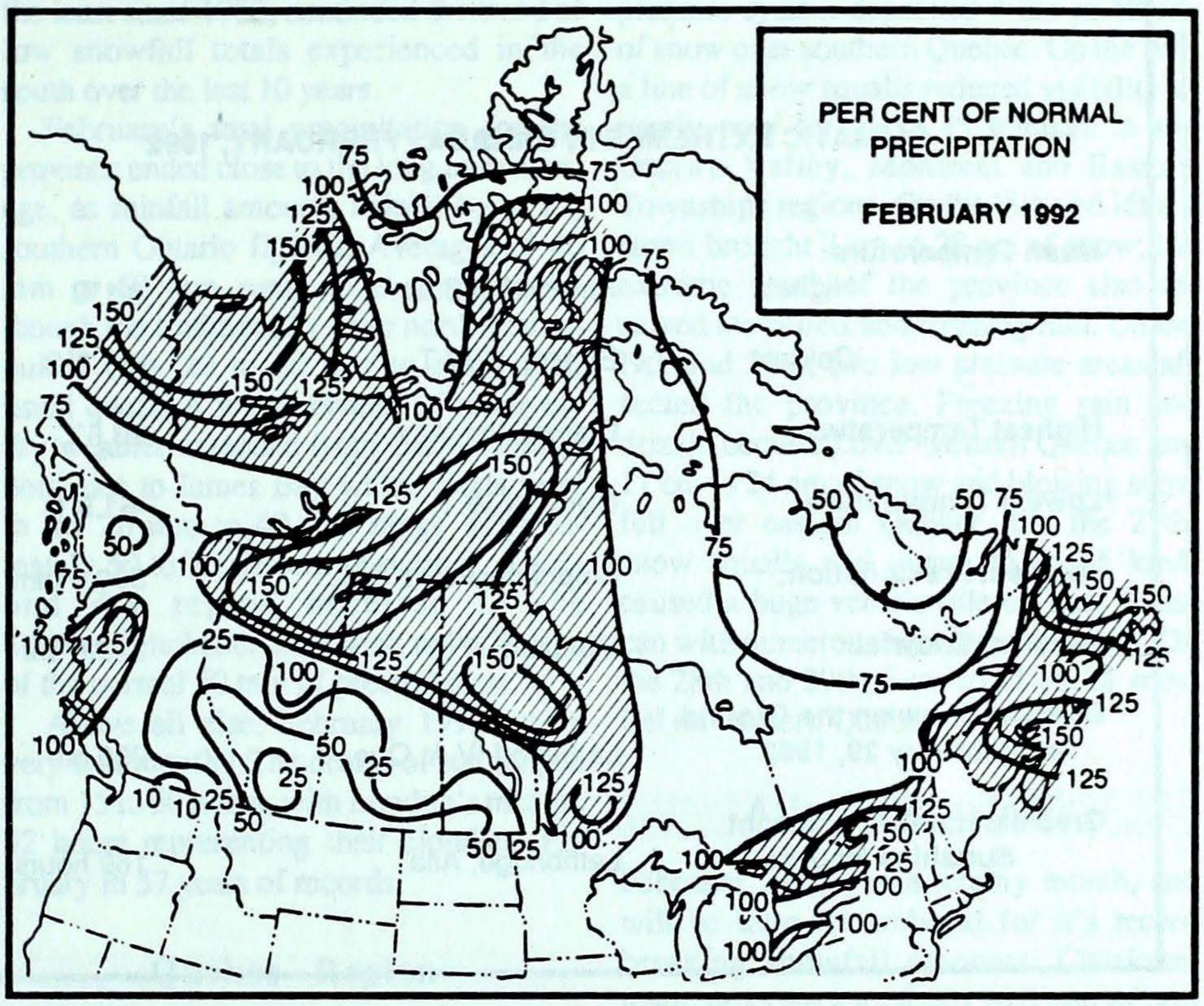
Snowfall amounts were above normal at Baker Lake, Rankin Inlet and Resolute Bay but were below normal elsewhere, although the greatest amounts were not excessive, ranging from a mere 1.6 cm at Eureka to 8.0 cm at Baker Lake.

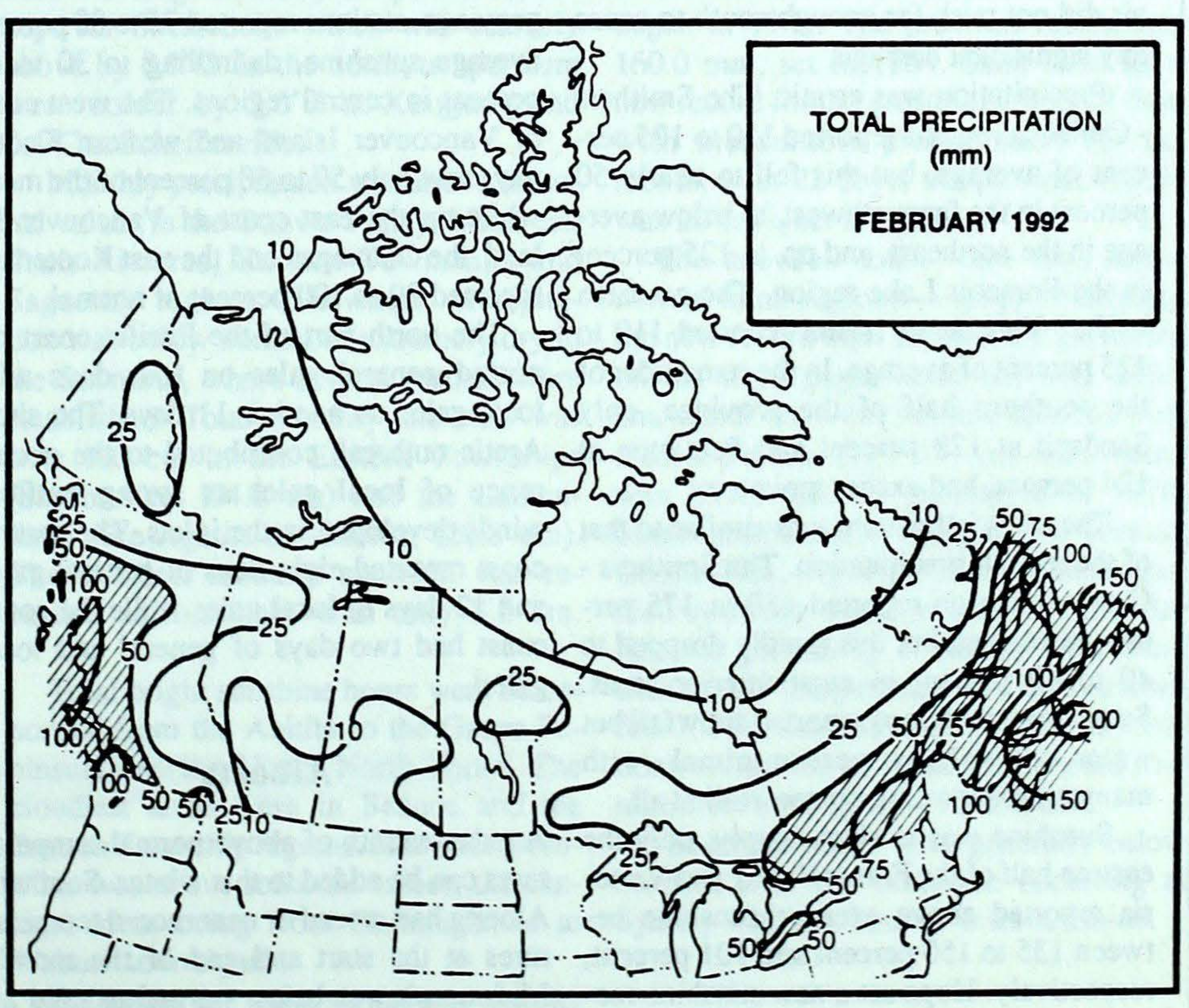
Stations at Eureka and Mould Bay did not measure a single minute of sunshine. Zero sunshine hours at Eureka are common; however, Mould Bay normally anticipates 4.6 hours of sunhine. Resolute Bay's measurement of 33 hours compares favourably to their regular amount of 17.7 hours. Further south, Baker Lake and Coral Harbour tallied less than normal with 60 and 84 hours, respectively.

British Columbia

Where is winter? That is the question being asked by most British Columbians as February turned out to be the third consecutive month with well above average temperatures. Positive departures were around 5°C in the Kamloops - North Thompson region. The exception was in Revelstoke and Williams Lake, about 2°C above average, as the remaining southern and central interior reported a 3°C to 4°C positive deviation. The month started and ended with very mild temperatures but some colder Arctic air did affect the northern sections of the province, holding temperatures barely above normal. The coastal regions reported up to 2.5°C above average. The following stations set or tied new record monthly mean temperatures: Abbotsford, 7.3°C (7.1°C), Blue River, 0.7°C (-1.0°C), Castlegar, 3.1°C (2.0°C), Cranbrook, 0.5°C (0.5°C), Hope, 6.7°C (6.2°C), Kamloops, 3.6°C (1.6°C), Kelowna, 2.6°C (1.6°C), Port Alberni, 6.0°C (6.0°C).

Mild temperatures accelerated the growth of vegetation in many areas of the province, particularly in the southern parts. Spring flowers and shrubs are reported to be two to four weeks ahead of schedule. An





CLIMATIC EXTREMES IN CANADA - FEBRUARY, 1992

Mean Temperature:			
	Highest	Amphitrite, B.C.	8.1°C
	Coldest	Eureka, N.W.T.	-38.3°C
Highest Temperature:		Claresholm, Alta.	23.6°C
Lowest Temperature:		Clyde, N.W.T.	-51.8°C
Heaviest Precipitation:		Amphitrite Point, B.C.	300.9 mm
Heaviest Snowfall:		Moncton, N.B.	248.6 cm
Deepest Snow on the Ground on February 29, 1992		La Grand IV A, Que.	250 cm
Greatest number of Bright Sunshine Hours:		Lethbridge, Alta.	169 hours

Arctic outbreak early in the month raised some concern in the interior but the cold air did not push far enough south to cause any significant damage.

Precipitation was erratic. The Smithers - Omineca regions reported 150 to 175 percent of average, but this fell to nearly 50 percent in the far northwest, to below average in the northeast, and up to 125 percent in the Francois Lake region. The northern half of Vancouver Island reported 110 to 125 percent of average. In the remainder of the southern half of the province, only Sandspit at 128 percent and Penticton at 124 percent, had excess moisture.

The snowfall pattern was similar to that of the overall precipitation. The Smithers - Omineca region reported 150 to 175 percent of normal, but this rapidly dropped to 40 to 80 percent in most interior areas. Some coastal regions reported snowfall but water equivalents were minimal, with many areas reporting no snowfall at all.

Sunshine was in short supply; only the eastern half of the Fraser Valley and Victoria reported above average sunshine between 135 to 150 percent and 101 percent, respectively. Hope set a new sunshine record with 74 hours, breaking the old record of 73.4 hours, set in 1989. North of the province, stations reported 75 to 80 percent average sunshine, dwindling to 30 to 60 percent in central regions. The west coast of Vancouver Island and western Kootenays saw only 50 to 60 percent of the mean while on the east coast of Vancouver Island, the Okanagan and the east Kootenays reported 90 to 100 percent of normal.

The north part of the Pacific coast reported general gales on four days with local gales on another 11 days. The short Arctic outbreak contributed to the occurrence of local gales as strong outflow winds developed in the inlets. The central coast reported eight days of general gales and 12 days of local gales while the south coast had two days of general and local gales.

Alberta

Another month of above normal temperatures can be added to this winter. Southern Alberta had record or near record temperatures at the start and end of the month. Mid-month was below normal as cold air covered the province. The record temperatures during the last week of February included a value of 23.6°C at Claresholm breaking the previous record of 24.4°C at Pekisko, set in 1906. The record breaking temperature in Calgary of 22.6°C on 27th was the third highest February temperature in the province.

Precipitation during the middle of the month was greatest in the northern and central regions. Some of the more significant snowfalls were at Fort Chipewyan with over two and a half times the normal amount, and in Edmonton with almost twice as much as usual received. The largest snowfall for Edmonton was on February 19 when 19.2 cm fell, this was the third largest one day snowfall ever in February. Southern Alberta continued to experience well below normal precipitation.

Manitoba and Saskatchewan

Monthly mean temperatures were above normal throughout the region, with the exception of the Hudson Bay coastal area, where the mean temperature at Churchill was 0.6°C below normal. The positive temperature anomaly increased in the southeast reaching 3°C above normal, and most stations south of the Yellowhead highway were 5°C above normal. Several principal stations reported mean temperatures that ranked among the top 10 for their period of record. These included; Brandon and Regina (10th), Yorkton and Broadview (7th), Swift Current (8th) and Estevan (5th). The highest mean temperature at Swift Current was -3.7°C; however, the greatest departure from normal was at Kindersley where the mean of -4.1°C was 8.4°C above normal. As usual, Churchill was the coldest place with a mean temperature of -26.5°C. The highest daily minimum temperature ever recorded in February for North Battleford was on the 26th with 2.4°C. The old record was 0.9°C in 1899. The minimum of 1.3°C on the 27th is the highest minimum temperature ever recorded at Wynyard for the month.

Total precipitation was less spatially organized. An Alberta Clipper crossed southern Saskatchewan on the 19th, giving 24-hour snowfall totals ranging from 7 cm to over 20 cm in a 300 km-wide band through southern Saskatchewan and south-western Manitoba. Blizzard conditions, with visibilities near zero, stopped highway travel for an eight to 12 hour period. To the south and north, precipitation totals ranged from 14 to 50 percent of normal. Some of the smaller totals were 2.0 mm at Nipawin, 4.3 mm at Swift Current, 5.4 mm at Prince Albert, and 6.2 mm at Hudson Bay. Northern areas tallied higher than normal precipitation as Norway House reported 28.4 mm, being over three times the normal of 8.6 mm.

Sunshine was above normal in the southwest and the northeast, and below normal elsewhere. The highest total was 152 hours at Swift Current (37.5 hours above normal). Frequent fog and low clouds kept Winnipeg's total to 72 hours, exactly half of the normal.

Ontario

Add February 1992 to Ontario's growing list of milder than normal months. The entire province, except for the Ottawa Valley and the Moosonee, experienced these tepid conditions. In fact, a review of recent winters (December - February) indicates that temperate winters have emphatically become the standard. In southern Ontario, nine of the last 10 winters have been mild; while in the north, eight of the last 10 winters qualified as milder than those of 1951-1980 normals.

Monthly mean temperatures achieved values 2°C to 4°C above average in the northwest and 1°C to 2°C above in the rest of the province. The exception to this pattern existed in the Ottawa Valley and extreme northeastern Ontario, including Moosonee, where a pool of cold air kept monthly means upto 3°C below normal.

The snowfall pattern varied significantly this month with light snowfalls in the south (10 cm to 30 cm), heavy snowfalls in central Ontario (40 cm to 90 cm), and normal to a little below normal in the north (25 cm to 50 cm). Ottawa led the way with 89 cm of snow, their most since 1972, while Gore Bay's 81.8 cm was their snowiest February since records began in 1947. At the other extreme, Windsor's 7.6 cm, the least since 1987, and Toronto's 10.2 cm, the least since 1983, continued the trend of low snowfall totals experienced in the south over the last 10 years.

February's total precipitation for the province ended close to the long term average, as rainfall amounts helped boost the southern Ontario figures. Averages of 40 mm to 60 mm were quite common, although the traditionally drier northwest required only 20 to 30 mm to reach their usual quota. A wide corridor of relatively dry weather extended from Lake Superior northeast to James Bay where totals were in the 20 mm to 40 mm range, approximately 50 to 70 percent of normal. A second dry region occurred in the Toronto-Kitchener area with only 30 mm of the normal 50 mm of precipitation.

Above all else, February 1992 was a very dull month ! The dearth of sun ranged from 15 to 50 hours, with London's meagre 52 hours representing their cloudiest February in 57 years of records.

Quebec Region

The majority of the province experienced below average monthly temperatures, except for Sherbrooke which was scarcely above by 0.9°C. In the north, temperature were colder by 5.6°C at Kuujjuaq and 6.4°C at Schefferville.

Monthly precipitation was above seasonal values in the Ottawa Valley, Montreal, Trois-Rivieres, Eastern Townships and Saguenay regions. Elsewhere, precipitation was below normal to extremely dry in the far north, where several records were established. Total monthly snowfall was over 100 cm in the Eastern Townships (Sherbrooke, 104.8 cm) and the Laurentians (Ste-Agathe-des-Monts, 120.8 cm). The smallest monthly snowfall was recorded at Inukjuak, with only 3.6 cm.

Total bright sunshine hours were below normal from the Abitibi to the Gaspe Peninsula and the Upper North Shore. The cloudiest areas were in Beauce and the Eastern Township regions. Elsewhere, sunshine was above seasonal values, the sunniest areas being from Chibougamau to Wabush to Inukjuak.

Following are some significant weather events for the month. On the 4th, a low pressure system deposited 4 cm to 18 cm of snow over southern Quebec. On the 11th, a line of snow squalls reduced visibility to nearly zero for about 15 minutes in the Ottawa Valley, Montreal and Eastern Townships regions. On the 15th and 16th, a storm brought 7 cm to 28 cm of snow; the extreme south of the province also received ice pellets and freezing rain. On the 19th and 20th, two low pressure areas affected the province. Freezing rain and drizzle occurred over western Quebec and 11 cm to 24 cm of snow and blowing snow fell over eastern Quebec. On the 27th, snow squalls and gusts, 45 to 65 km/h caused a huge vehicle pile-up near Batiscan with numerous injuries, some fatal. On the 28th and 29th, 6 cm to 21 cm of snow fell on western Quebec.

Atlantic Provinces

February 1992 was a stormy month, and will be long remembered for it's record breaking snowfall amounts. Charlottetown, reported a total of 176.0 mm of precipitation, the most ever recorded for them in the month of February, since records began in 1944. The previous record was 160.0 mm, set in 1954. Saint John set a new record for the greatest number of days with measurable precipitation for the month, with 22 days; the previous record was 20 days, set in 1952.

The snowfall totals were well above normal in all regions. A graph illustrating the new record high snowfalls is presented on the front page. Moncton, with 248.6 cm, stands out with the most snowfall ever recorded since 1939. The previous record was 231.1 cm, set in December 1970. Mean temperatures were below normal. On the 29th, extremely cold air, accompanied by strong winds, moved into the Maritimes, generating a bitterly cold wind chill as the temperature in Charlottetown fell 7°C in two hours. A number of locations either tied or broke their record low minimum temperatures for this date.

Sunshine hours were generally below normal, with the exception occurring at Sydney with one hour of extra sunshine.

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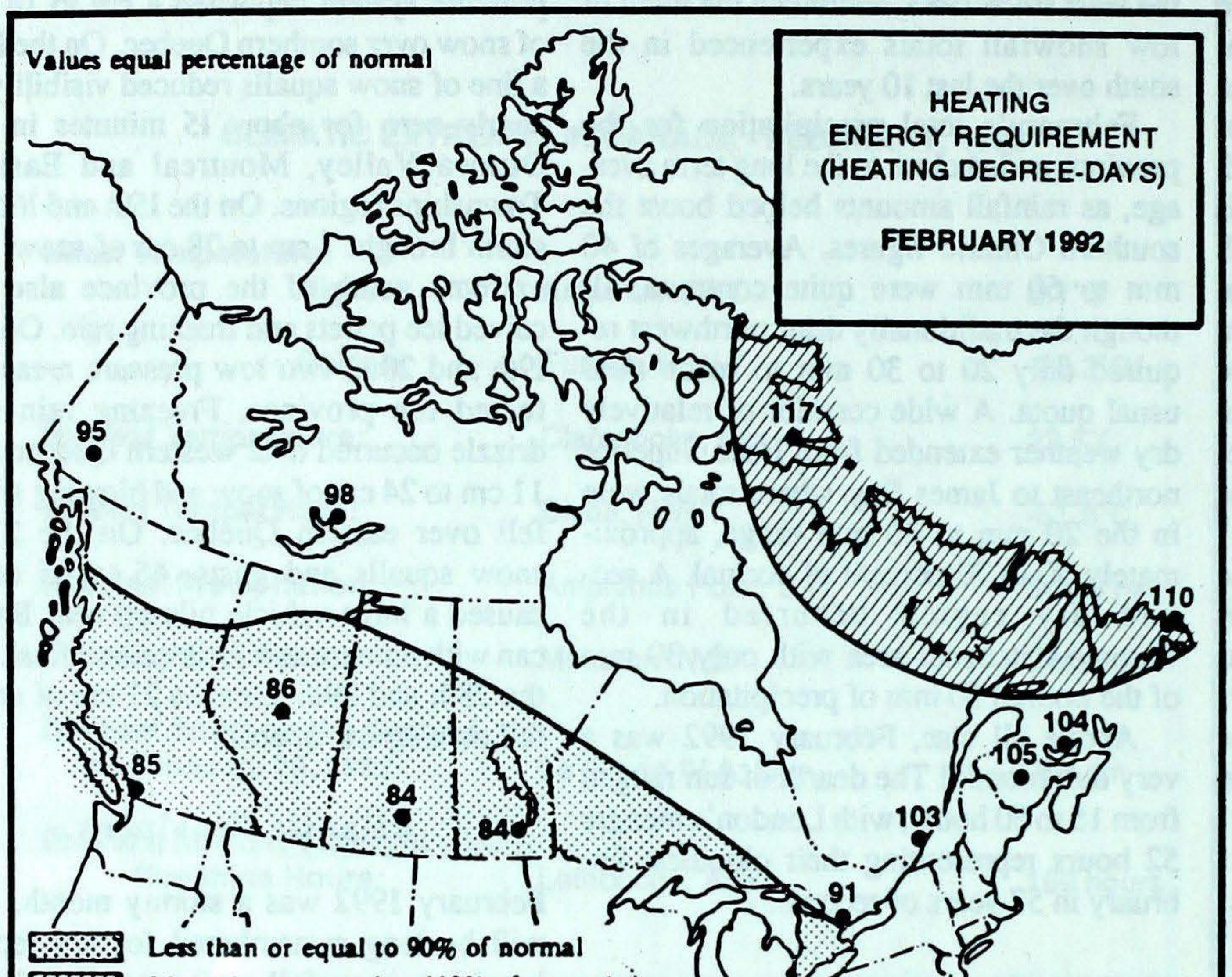
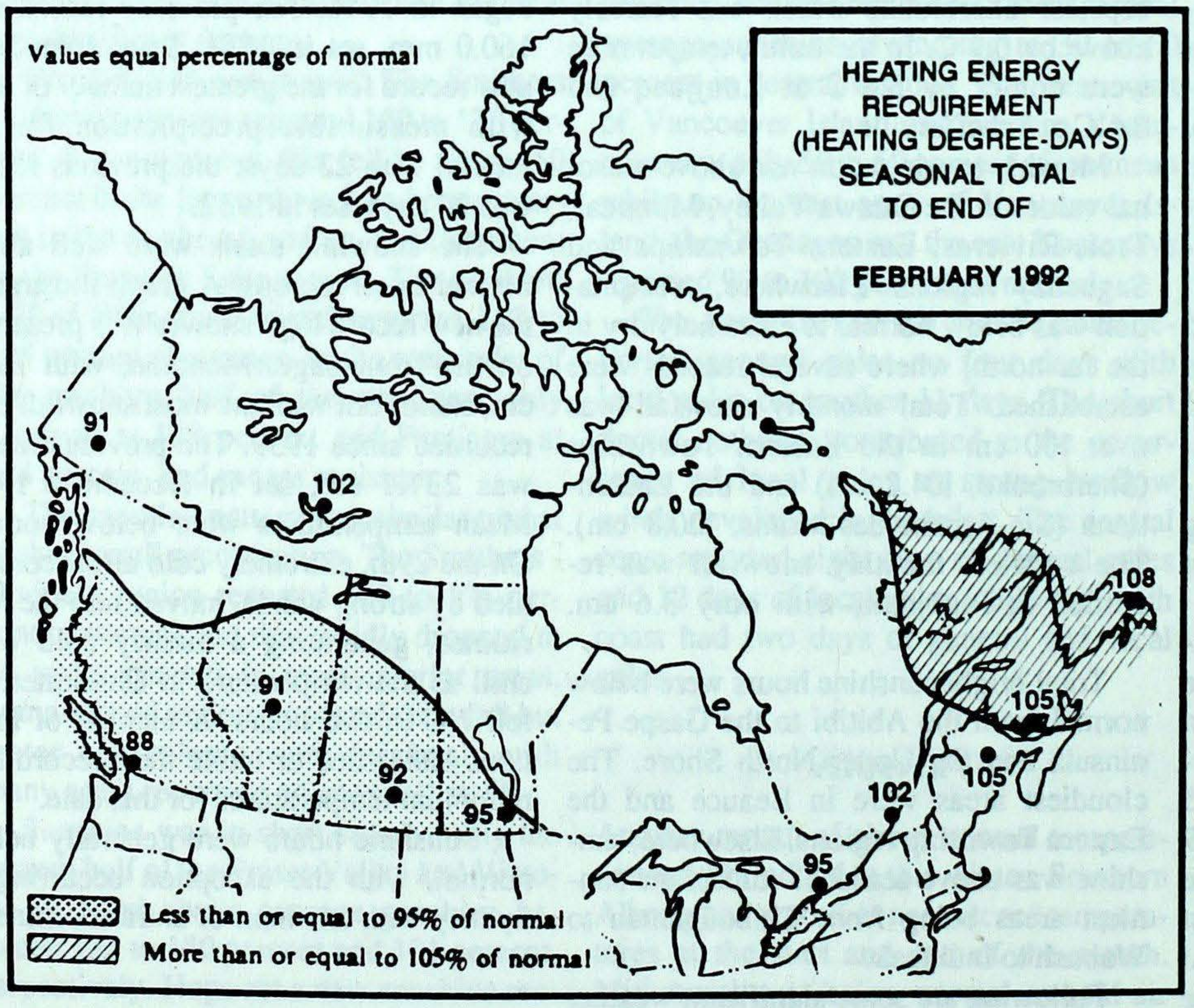


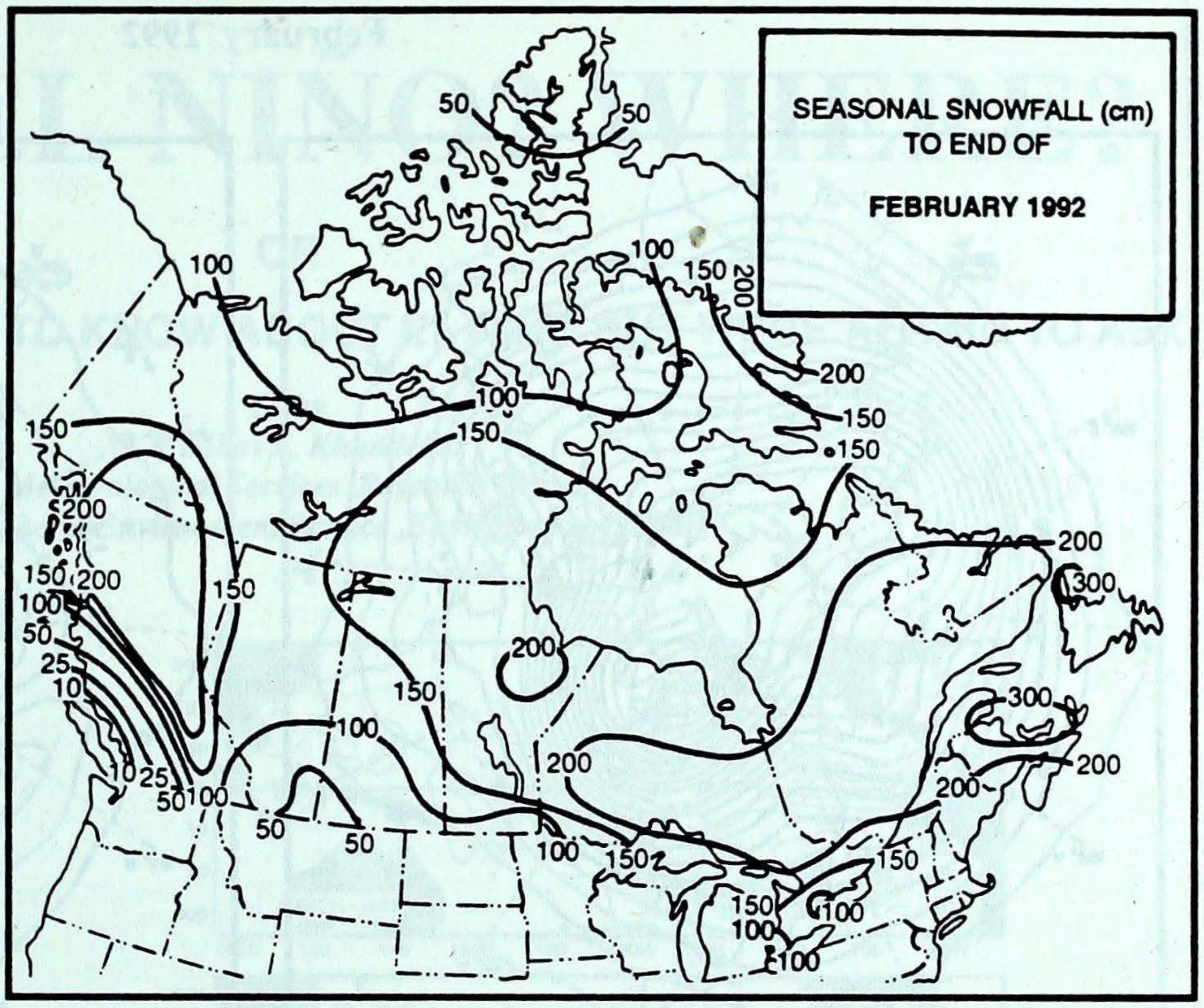


SEASONAL TOTAL OF HEATING DEGREE-DAYS TO END OF FEBRUARY

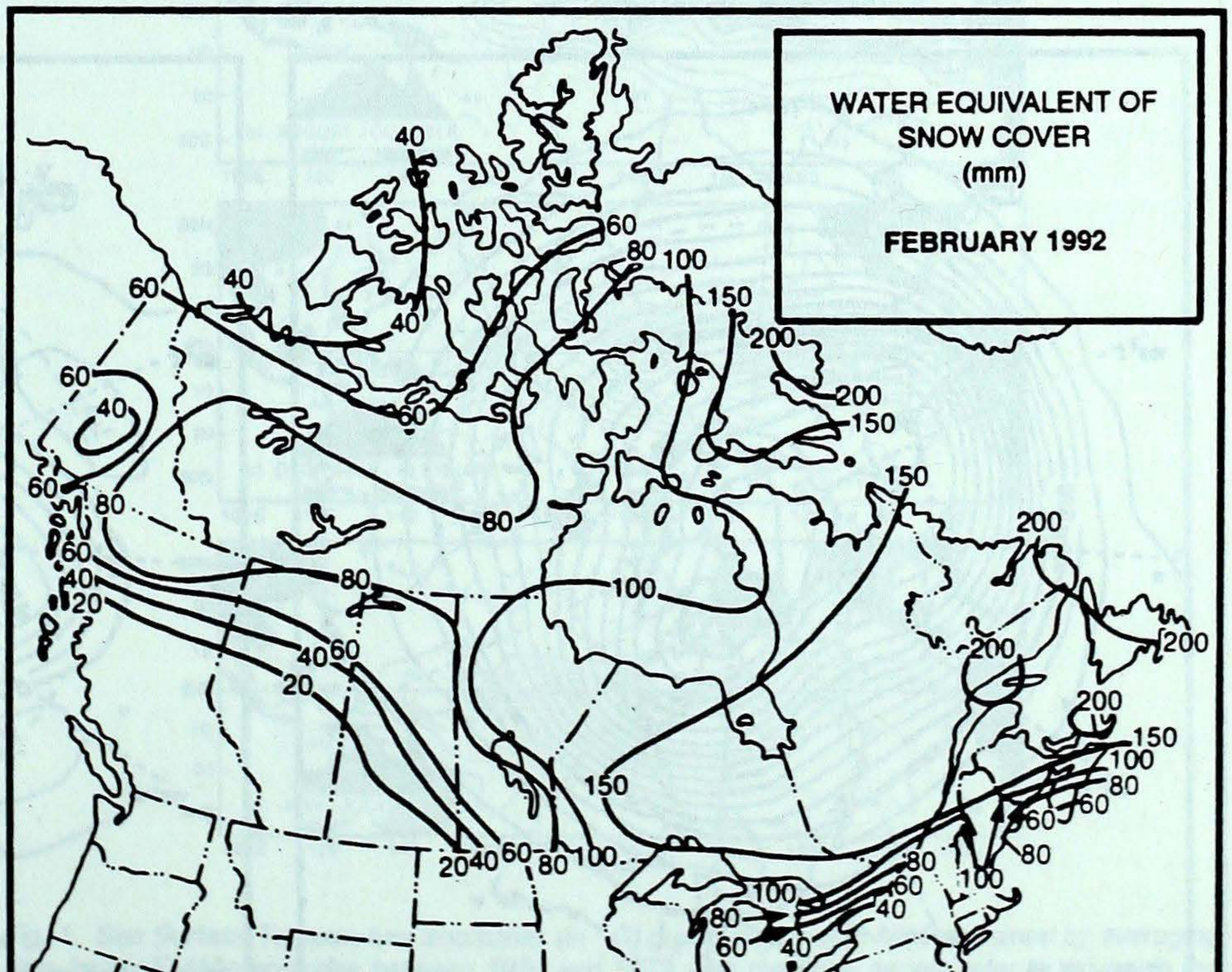
	1992	1991	NORMAL
BRITISH COLUMBIA			
Kamloops	2359	2822	2842
Penticton	2234	2583	2562
Prince George	3201	3860	3823
Vancouver	1846	2023	2087
Victoria	1919	2094	2130
YUKON TERRITORY			
Whitehorse	4648	5173	5128
NORTHWEST TERRITORIES			
Iqaluit	6681	7049	6631
Inuvik	7168	7025	7014
Yellowknife	6187	6391	6073
ALBERTA			
Calgary	3214	3525	3825
Edmonton Mun.	3654	3767	4019
Grande Prairie	4138	4402	4518
SASKATCHEWAN			
Estevan	3761	4034	4020
Regina	3963	4154	4288
Saskatoon	4176	4416	4452
MANITOBA			
Brandon	4439	4511	4482
Churchill	6352	6452	6216
The Pas	4814	4937	5001
Winnipeg	4135	4233	4342
ONTARIO			
Kapuskasing	4622	4600	4593
London	2831	2717	2921
Ottawa	3448	3235	3412
Sudbury	3875	3742	3874
Thunder Bay	4103	4130	4111
Toronto	2791	2690	2923
Windsor	2484	2401	2615
QUEBEC			
Baie Comeau	4332	4308	4218
Montréal	3377	3120	3296
Québec	3856	3641	3690
Sept-Îles	4582	4538	4304
Sherbrooke	3724	3439	3754
Val d'Or	4494	4347	4395
NEW BRUNSWICK			
Fredericton	3455	3226	3344
Moncton	3400	3260	3262
NOVA SCOTIA			
Sydney	3400	2930	2904
Yarmouth	2726	2492	2708
PRINCE EDWARD ISLAND			
Charlottetown	3200	3126	3119
NEWFOUNDLAND			
Gander	3670	3492	3321
St. John's	3326	3140	3074

SEASONAL SNOWFALL TOTALS (cm) TO END OF FEBRUARY

	1992	1991	NORMAL
BRITISH COLUMBIA			
Kamloops	32	84	87
Port Hardy	1	64	60
Prince George	203	282	200
Vancouver	2	99	54
Victoria	5	59	44
YUKON TERRITORY			
Whitehorse	194	161	106
NORTHWEST TERRITORIES			
Iqaluit	132	120	168
Inuvik	122	124	130
Yellowknife	144	143	107
ALBERTA			
Calgary	52	86	96
Edmonton Namao	123	90	100
Grande Prairie	146	185	141
SASKATCHEWAN			
Estevan	61	69	81
Regina	75	47	83
Saskatoon	95	108	83
MANITOBA			
Brandon	131	81	84
Churchill	181	192	132
The Pas	162	107	117
Winnipeg	82	69	90
ONTARIO			
Kapuskasing	230	197	237
London	182	183	172
Ottawa	185	161	182
Sudbury	196	201	194
Thunder Bay	208	157	158
Toronto	84	78	101
Windsor	88	81	93
QUEBEC			
Baie Comeau	265	330	277
Montréal	235	157	188
Québec	209	268	272
Sept-Îles	263	356	318
Sherbrooke	235	189	236
Val d'Or	207	228	237
NEW BRUNSWICK			
Charlo	296	306	293
Fredericton	184	181	219
Moncton	407	198	243
NOVA SCOTIA			
Sydney	185	117	223
Yarmouth	297	77	168
PRINCE EDWARD ISLAND			
Charlottetown	305	156	240
NEWFOUNDLAND			
Gander	282	342	270
St. John's	272	189	247



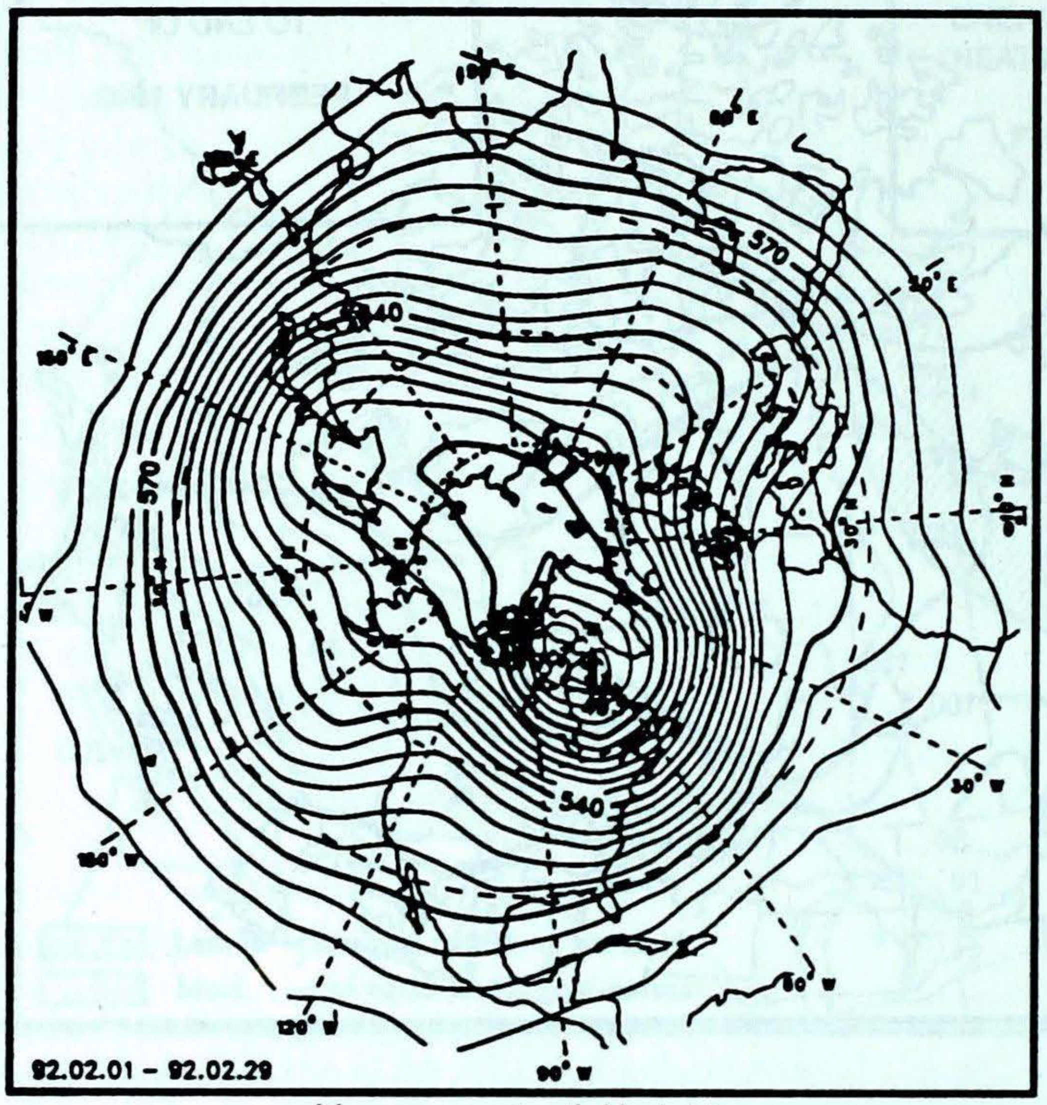
SEASONAL SNOWFALL (cm) TO END OF FEBRUARY 1992



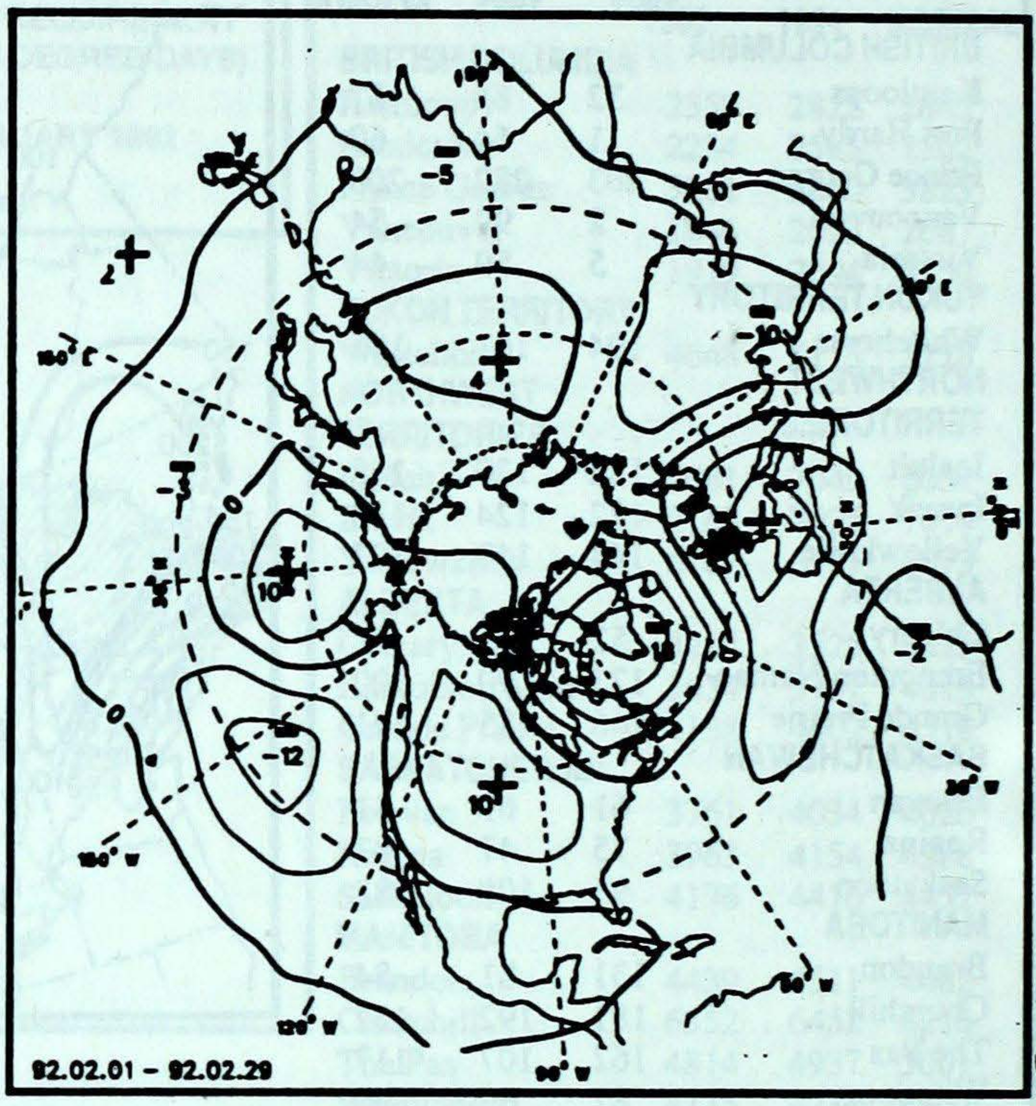
WATER EQUIVALENT OF SNOW COVER (mm) FEBRUARY 1992

50-kPa ATMOSPHERIC CIRCULATION

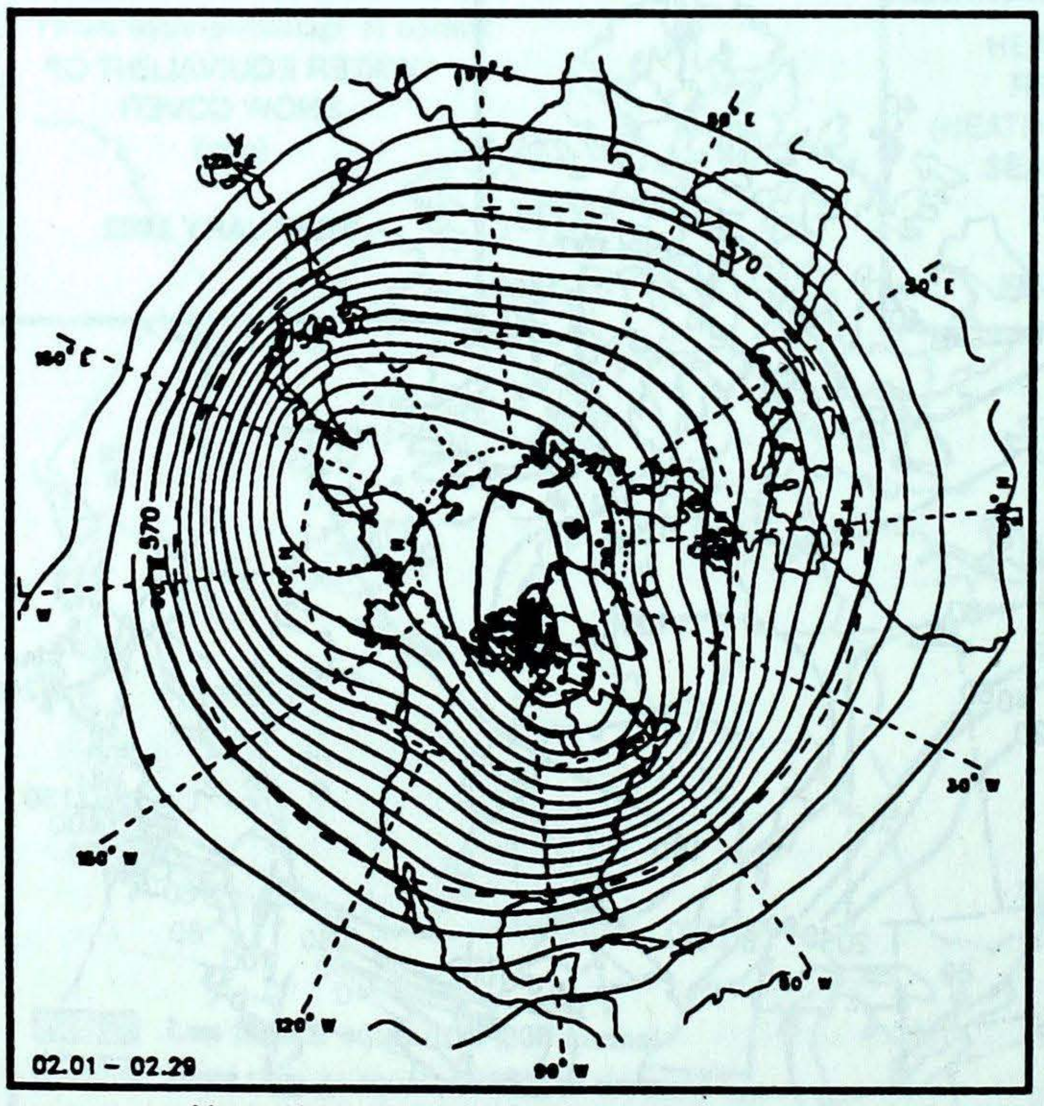
February 1992



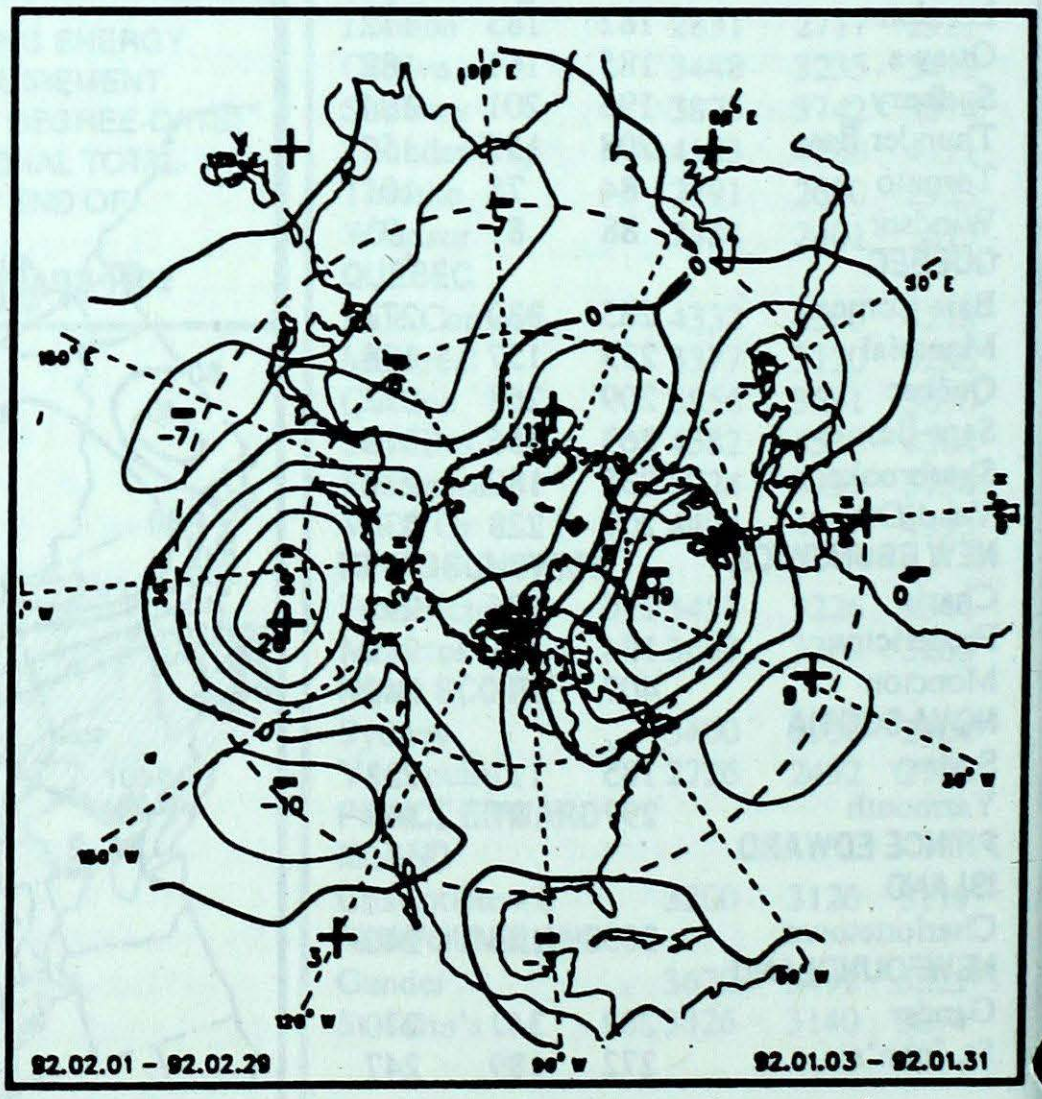
Mean geopotential heights
- 5 decametre interval -



Mean geopotential height anomaly
- 5 decametre interval-



Normal geopotential heights for the month
- 5 decametre interval -



Mean heights difference w/r to previous month
- 5 decametre interval -

WHAT? EL NIÑO? WHERE?

OR

EVERYTHING YOU WANTED TO KNOW ABOUT EL NIÑO BUT WERE AFRAID TO ASK

☐ *by*
☐ *Madhav L. Khandekar*
☐ *Meteorological Services ,Research Branch*
☐ *Atmospheric Environment Service ,Environment Canada*

WHAT IS EL NIÑO?

El Niño is a Spanish word meaning the boy-child, or by extension, the Christ-child. It refers to the occasional encroachment of excessively warm water off the coast of Peru, South America, close to the end of the year. The appearance of warm water coincides with the southern hemisphere summer, when the southeasterly trade winds are weak and the subsurface upwelling of cold, nutrient-rich water off the coast of Peru is reduced.

Originally, El Niño referred to the warm ocean current that moves southward each year along the coast of southern Ecuador and northern Peru, during the southern hemisphere summer. At varying intervals of two to 10 years, the current is extraordinarily strong (in excess of 0.5 m/s) and carries unusually warm surface water inshore and hundreds of kilometres farther south. Associated with this warm water flow, the sea and air temperatures frequently remain anomalous for a year or more, and return to normal levels by January or March of the following year. The term El Niño is now reserved by meteorologists to signify these unusual events, that is, those associated with geographically extensive Sea Surface Temperature (SST) anomalies of one standard deviation or more, for extended periods.

The SST anomalies over the equatorial Pacific, during El Niño conditions, can be seen in Fig. 1. It should be noted that the warm water, as represented by SST anomalies, covers an area of about five million

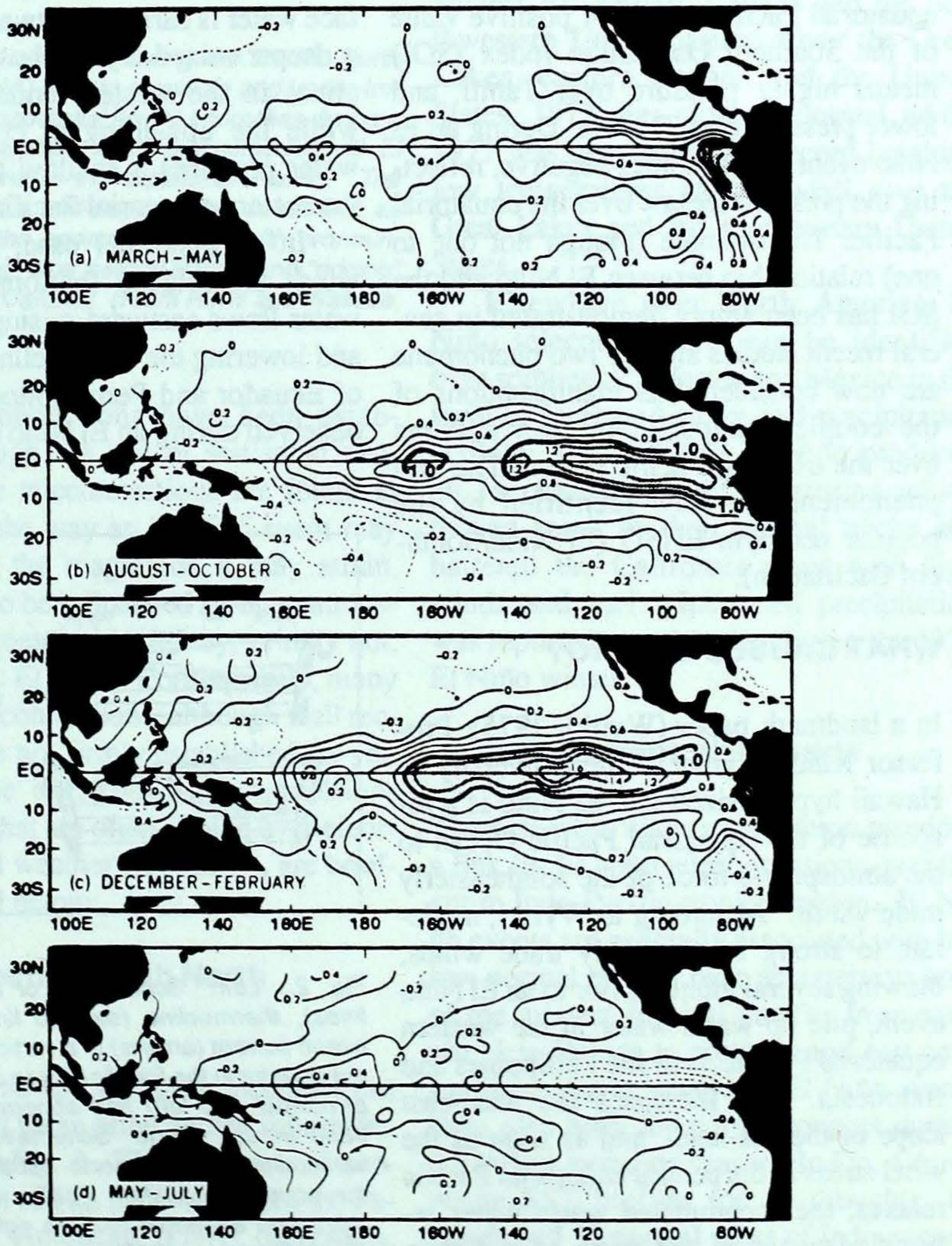


Fig. 1. Sea Surface Temperature anomalies (in °C) during a typical El Niño ,obtained by averaging data for six El Niño episodes between 1950 and 1973. The top three panels refer to the peak, the transition and the mature phases , respectively; the bottom panel refers to the period May-July, more than a year after an El Niño onset.(From Rasmusson and Carpenter, 1982)

square kilometres during the transition and mature phases of an El Niño event, (for comparison, the area of Canada is about 9.8 million square kilometres).

The atmospheric counterpart of El Niño is the Southern Oscillation phenomenon, which can be defined by size in various ways, the most commonly accepted index is the difference in standardized sea-level pressure between Tahiti (17°33'S, 149°37'W) and Darwin (12°24'S, 130°52'E). Some pioneering work by Sir Gilbert Walker, on correlating the Indian monsoon and world-wide weather elements, led Walker and his co-worker Bliss to define an atmospheric index as a measure of pressure distribution over the equatorial Pacific basin. A positive value of the Southern Oscillation Index (SOI) means higher pressure over Tahiti, and lower pressure over Darwin. During an El Niño event SOI becomes negative, reflecting the pressure seesaw over the equatorial Pacific. The intimate (though not one to one) relationship between El Niño and the SOI has been amply demonstrated in several recent studies and the two phenomena are now considered as manifestations of the coupled atmosphere-ocean systems over the tropical, Pacific region. The two phenomena are now identified by the popular acronym ENSO (El Niño/Southern Oscillation).

WHAT CAUSES EL NIÑO?

In a landmark paper (Wyrtki, 1975), Professor Klaus Wyrtki of the University of Hawaii hypothesized that El Niño is a response of the equatorial Pacific Ocean to the atmospheric force of the southeasterly trade winds. According to Wyrtki, moderate to strong southeasterly trade winds, blowing several months prior to an El Niño event, pile up warm water in the western equatorial Pacific, near the Philippines and Indonesia. This increases the west-east slope of the sea-level, and as soon as the wind stress in the central equatorial Pacific relaxes, the accumulated warm water returns eastward in the form of a Kelvin wave. This Kelvin wave leads to the accumulation of warm water off the coasts of Ecuador and Peru, and to a depression of the usually shallow thermocline. (A thermocline is a narrow zone with a sharp temperature gradient which separates the warm surface waters from the colder waters at depth.)

Fig. 2 shows the schematic flow patterns in the equatorial Pacific with and without the westward wind stress. The two left hand sketches of Fig. 2 show isotherms, the thermocline and the upper ocean current, in a vertical section along the equator in the Pacific Ocean during normal (top left) and abnormal (bottom left) trade winds. The two right hand sketches of Fig. 2 show the flow components in a north-south profile across the equator in the eastern Pacific.

Normally, with easterly winds, the surface water is carried westward, resulting in a deeper mixed layer (above the thermocline) in the western equatorial Pacific, while the upwelling of cold subsurface water produces a shallow thermocline in the eastern equatorial Pacific (top right).

In an abnormal case, when easterly winds are relaxed (bottom right), warm water flows eastward raising the sea-level and lowering the thermocline off the coast of Ecuador and Peru (bottom right), as is observed during an El Niño event.

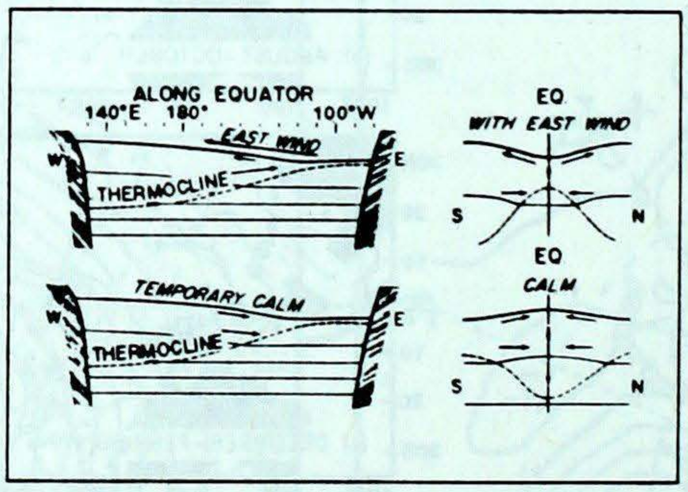


Fig. 2. Left: Schematics of isotherms (solid lines), thermocline (dashed lines) and upper ocean current (arrows) in a vertical section along the equator in the Pacific Ocean under conditions of normal (top left) and abnormal (bottom left) trade winds. Right: Schematics of the transverse circulation in a north- south section across the equator in eastern Pacific with normal (top right) and abnormal (bottom right) trade winds. (From Bjerknes, 1966)

Several numerical modelling studies have attempted to simulate Wyrtki's hypothesis by relaxing the easterly winds over an idealized tropical ocean basin. They have obtained eastward propagating Kelvin waves in the equatorial waveguide (a region within 5° North and South latitude from the equator). It is now generally accepted that an El Niño event begins with the relaxation of the southeasterly trades in the central equatorial Pacific, following the prolonged period of excessively strong trade winds, which leads to accumulation of water in the western equatorial Pacific. Once the El Niño event develops, it normally goes through the various phases as defined in Fig. 1. During the mature phase, a perturbation in the form of a heat source is introduced in the western equatorial Pacific, and this initiates a sequence of events which eventually produce an inverse El Niño called La Niña (the girl in Spanish).

As summarized by Philander (1990) the tropical Pacific Ocean oscillates between two complementary phases of the Southern Oscillation: El Niño, the warm phase (negative SOI) and La Niña, the cold phase (positive SOI). During La Niña, the surface pressure is high over the eastern Pacific (over Tahiti), but low over the western Pacific (over Darwin), while southeasterly trades are intense and SST anomalies are negative in the eastern and central Pacific. According to Philander, the oscillation between the two phases of the Southern Oscillation can be attributed to an unstable interaction between the tropical ocean and the atmosphere.

Coupled atmosphere-ocean models developed during last few years, have achieved reasonable success in simulating the two phases of the ENSO cycle, and in predicting the onset of an El Niño event. However, these models do not adequately represent the complex ocean-atmosphere interaction and the associated feedback mechanism. As such, these models cannot yet predict how an El Niño event will evolve, or what amplitude it will attain.

IMPACT OF EL NIÑO ON LOCAL/REGIONAL WEATHER AND ANOMALIES

As the warm water spreads off the coasts of Ecuador and northern Peru during an El Niño event, it leads to a considerable reduction in upwelling of cold, nutrient-rich subsurface water. This change can have disastrous effects on fish populations (anchovy in particular) and on coastal birds, which feed upon fish.

The onset of El Niño leads to heavy and widespread convective activity over the eastern equatorial Pacific. The usually arid regions of Ecuador and northern Peru receive high amounts of rain, during an El Niño event. The 1982-83 El Niño, (which was exceptional because of the large amplitude and the unusual way it developed), brought unheard of amounts of rain to coastal Ecuador and northern Peru, resulting in flash floods and extensive damage to roads, bridges and agriculture. During the very strong El Niño of 1925-26, Trujillo (a coastal town in northern Peru) received about 400 mm of rain in March 1925, while less than 20 mm of rain fell in the preceding five years!

IMPACT OF EL NIÑO ON GLOBAL WEATHER AND ANOMALIES

The dramatic impact of an El Niño event on weather and climate anomalies in different parts of the world is perhaps the single most important reason why El Niño has received so much attention. The teleconnections between an El Niño event and world-wide weather and climate anomalies have been studied extensively in the last ten years. The physical basis of these teleconnections was laid down by Professor Jacob Bjerknes of the University of California in two important papers (Bjerknes, 1966, 1969). In his 1966 paper, Bjerknes proposed that positive SST anomalies in the equatorial eastern Pacific would strengthen the north-south Hadley circulation, which in turn would maintain stronger than normal westerlies in the middle latitudes. In his 1969 paper, Bjerknes proposed an east-west circulation in the vertical equatorial plane, which he named as "Walker Circulation", in honour of Sir Gilbert Walker. This circulation is now recognized as the link between El Niño and weather and climate, over the entire Indo-Pacific region.

Since the publication of Bjerknes' papers, several hundred studies have been done on El Niño and its possible connection to global weather and climate anomalies. Although these teleconnections have dynamical and thermodynamical bases,

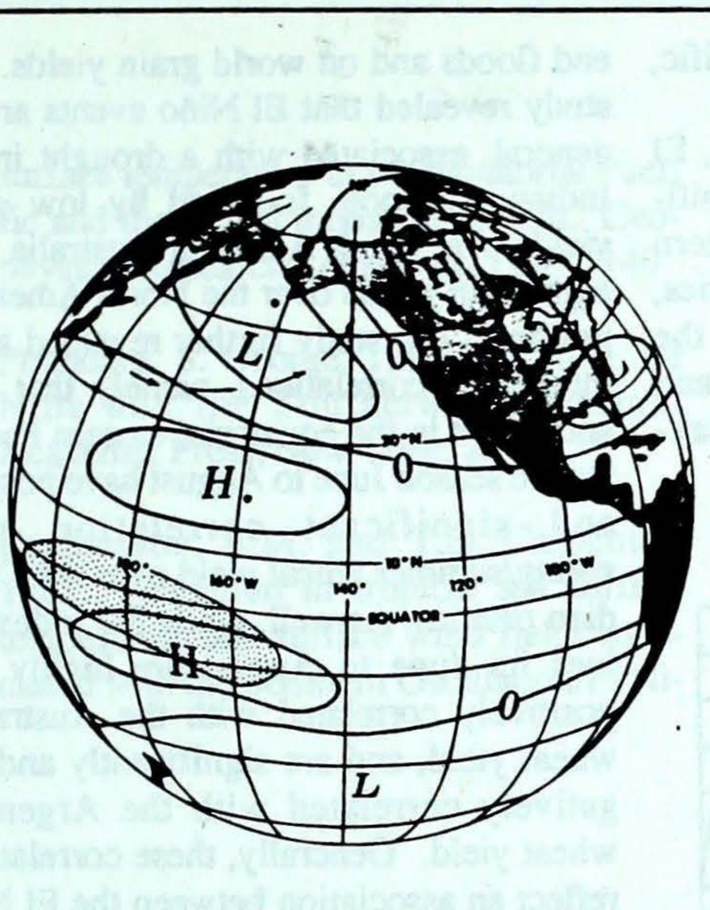


Fig. 3. A schematic showing the Pacific North American (PNA) pattern of middle and upper-tropospheric geopotential height anomalies during a northern hemisphere winter that coincides with El Niño conditions in the equatorial Pacific. The arrows depict a mid-tropospheric streamline as distorted by the anomaly pattern with pronounced "troughing" over central Pacific and "ridging" over western Canada. (From Horel and Wallace, 1981)

most teleconnections have been established through the use of statistical analysis. These teleconnections are found to depend on the way an El Niño event may evolve and the magnitude it may attain, and may also be influenced by other atmospheric parameters which may, or may not, be related to El Niño. Consequently, many of these teleconnections, although well recognized, are not firmly established, as yet. Some of the well-known teleconnections of El Niño that are often quoted by meteorologists and weather forecasters, are briefly discussed below:

Teleconnections with North America

The North American teleconnections can be described by an often quoted schematic, as shown in Fig. 3. The geopotential anomaly pattern of Fig. 3 characterizes the Pacific North American (PNA) oscillation, determining, in a broad sense, the weather pattern that would normally prevail over western Canada during a winter coinciding with an El Niño event. Typically, a high pressure ridge establishes itself over British Columbia and Alberta, while Aleutian lows follow a northerly track and travel southeastward along a mid-continental trough through the eastern Prairie provinces. Such a flow pattern produces in general, mild winter weather for western Canada and the northwestern United States. The weather pattern over eastern Canada and United States is not well defined. Depending on the position of the mid-continental trough, the Great Lakes and the downstream regions could experience either a significantly colder or significantly milder winter weather. Examples are the 1971/72 and 1976/77 winters, which were associated with moderate to strong El Niño events producing milder winters for western Canada and the northwestern United States. Over the Great Lakes, eastern Canada and the United States, 1972 was close to normal while, 1977 was very cold with record breaking low temperatures and snowfall over the Great Lakes and the southeastern United States.

Elsewhere over North America, El Niño teleconnections can be identified over southern California and Mexico in the form of increased storm and precipitation activity. The 1982-83 El Niño produced an increased number of storms which moved south of their normal tracks and battered the California coast with high winds and surf. Increased precipitation was reported over Mexico during the 1977 El Niño winter.

Teleconnections world-wide

The east-west Walker circulation provides a link for El Niño teleconnections over the entire Indo-Pacific tropical region. El Niño events are generally associated with below normal rainfall over an extensive area of the western tropical Pacific, from eastern New Guinea to northern and east central Australia to Malaysia. El Niño events have also been linked to droughts during the Indian monsoon season. In Fig. 4 composite SST profiles for 10 droughts, 10 floods and 30 normal years of Indian monsoon, are shown; the figure also includes SST profiles for an extreme drought and an extreme flood year of the Indian monsoon. These profiles indicate clearly a link between the Indian monsoon and SST anomalies, in the eastern equatorial Pacific, during an El Niño (La Niña) event.

Outside of the Indo-Pacific region, El Niño events have been linked to significantly reduced rainfall in northeastern Brazil and adjacent Caribbean countries, and southeast Africa. In addition, the strongly seasonal rainfall of Morocco and the sub-Saharan zone is shown to be weakly related to the ENSO variation.

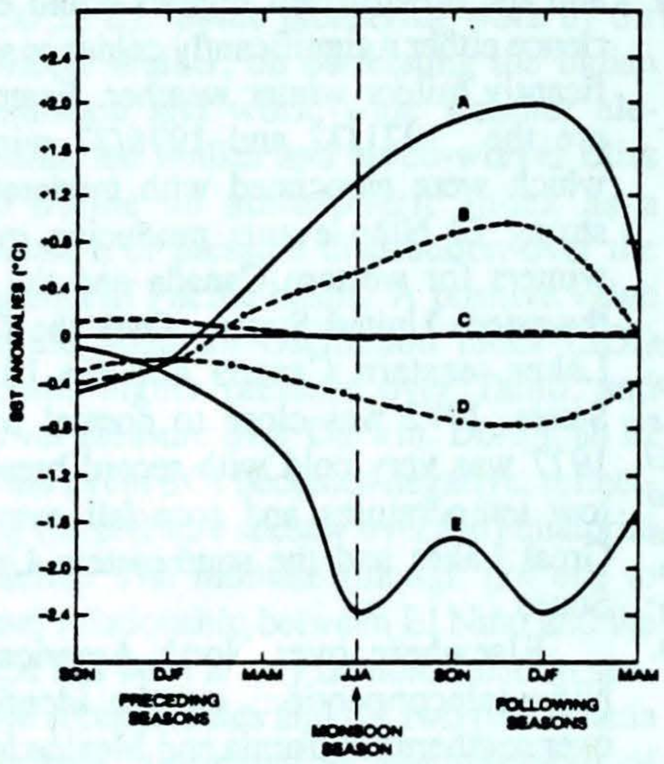


Fig. 4. SST anomaly composites for drought, flood and normal years of Indian monsoon based on data from 1901 to 1980. Curve A: SST anomaly for an extreme drought year (1972), Curve B: SST composite for 10 severest drought years between 1901 & 1980, Curve C: SST composite for 30 normal years between 1901 and 1980, Curve D: SST composite for 10 severest flood years between 1901 and 1980, Curve E: SST composite for an extreme flood year (1916). (From Khandekar and Neralla, 1984)

EL NIÑO AND WORLD GRAIN YIELDS

Since El Niño events have been shown to influence rainfall in different parts of the world, it is natural to inquire whether grain yields in different parts of the world are influenced by these events. A few studies reported in the 1980's have attempted to correlate the corn yield in the United States with SST anomalies in the equatorial Pacific. A recent statistical study (Garnett and Khandekar, 1992) examined the impact of large-scale atmospheric circulation and anomalies on Indian monsoon droughts and floods and on world grain yields. The study revealed that El Niño events are, in general, associated with a drought in the Indian monsoon, followed by low grain yields over south Asia and Australia, and high grain yields over the North American prairies. The study further revealed some interesting correlations, namely that SST anomalies in the equatorial eastern Pacific for the season June to August have positive and significant correlation with spring/summer wheat yield over the Canadian prairies. As well, while SO index values for June to August are highly and positively correlated with the Australian wheat yield, and are significantly and negatively correlated with the Argentine wheat yield. Generally, these correlations reflect an association between the El Niño teleconnections and precipitation anomalies, in different parts of the world.

WHAT IS IN STORE FOR 1991/92 EL NIÑO?

The 1991/92 El Niño event has been monitored over the last 12 months. Since February, 1991, the SOI value has been gradually dropping, reaching a value of -3.4°C for January, 1992. The SST anomaly pattern continues to have a large positive tongue extending from the dateline to about 100°W with anomalies around 2°C. The present El Niño appears to be much stronger than the 1986/87 El Niño event, and has so far behaved like a classical El Niño, as defined by the four panels of Fig.1.

Based on the SO index analogues, the present El Niño appears to be similar to the 1972 El Niño event. If so, the present SST anomalies and SOI values will continue to build up for the next several weeks, before starting to weaken during spring.

Western Canada has been enjoying a much milder winter, this year, with temperatures 8°C to 10°C above normal. Over Ontario and southern Quebec, temperatures have been oscillating between milder and colder spells. The Atlantic provinces are experiencing a rather severe winter this year, with record breaking snowfalls in parts of New Brunswick. The weather patterns so far resemble those during the winter of 1976/1977, (an El Niño winter when SST anomalies peaked in early January, 1977). Western Canada and the northwestern United States enjoyed a mild winter, while the Great Lakes region and southeastern United States experienced a very severe one.

The positive SST anomalies, throughout 1991, appear to have produced sufficient rain for crops over the Canadian prairies during the spring and summer. As a result, the 1991 grain yield, for western Canada, was close to normal. If the present SST anomalies continue, there may again be adequate rain over the Canadian prairies, during the 1992 spring season.

Outside of North America, northern Australia has been experiencing very dry weather for the past three months. Morocco, and the adjoining regions of North Africa, are experiencing an exceptionally dry winter thus far.

Looking ahead to the 1992 summer (June - September), monsoons over India and southeast Asia could be adversely affected by the presence of El Niño. The possibility of a good monsoon (110 percent of normal) over India is almost certainly ruled out at this time. The Indian rice crop and the Australian wheat crop are expected to be lower this year, while the corn and wheat yields over the North American prairies are expected to be normal or better for 1992.

Acknowledgement

I wish to thank Ray Garnett of the Canadian Wheat Board, Winnipeg, for providing useful information on North American grain yields and their relation to rainfall patterns over the prairies.

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Newfoundland and Labrador

February was a stormy month across much of Newfoundland, as a series of intense low pressure areas affected the region. Frequent snowfalls, mixed occasionally with rain or freezing rain and strong winds, prevailed throughout most of the month. Temperatures varied significantly with a maximum of 5.6°C at St. Lawrence and -36°C in central Newfoundland, late in the month. Overall temperatures were 2°C to 4°C below normal; as seen at Deer Lake with a mean of -12.3°C, normal is -9.0°C.

Snowfall amounts were well above normal, especially at central and western locations (Gander 144.0 cm, normal 76.2 cm). Several intense storms brought very strong winds to the region. Notably on February 1, wind gusts in excess of 100 km/h were common, with Burgeo reporting gusts to 154 km/h, resulting in major damage to buildings. Another storm on February 9 forced most businesses and schools in eastern Newfoundland to close, as wind gusts to 120 km/h reduced visibility to near zero in snow and blowing snow. Heavy packed ice and strong winds caused disruptions for marine shipping. Sunshine hours across the region were close to 85 hours.

Labrador remained in the firm grip of winter for most of the month, with record breaking low temperatures and very light snowfalls over most sections. Minimum temperatures of -35°C were common, as Churchill Falls recorded a minimum of -40.6°C. Mean temperatures were 5°C to 7°C below normal, with Goose Bay establishing a new monthly record of -21.6°C, normal is -14.5°C.

Snowfall was significantly lower than usual (Wabush Lake 16.5 cm, normal 53.0 cm), except in extreme eastern locations (Mary's Harbour 111.4 cm was about 50 cm above normal).

Sunshine was abundant across much of the region with Churchill Falls recording a total of 161 hours, about 35 hours above normal. The cold spell had its impact as schools and business as they were forced to close on some days, due to the bitterly cold wind chill factor.

FEBRUARY 1992

STATION	Temperature C Mean	Difference from Normal	Maximum	Minimum	Snowfall (cm)	% of Normal Snowfall	Total Precipitation (mm)	% of Normal Precipitation	Snow on ground at end of month (cm)	No. of days with Precip 1.0 mm or more	Bright Sunshine (hours)	% of Normal Bright Sunshine	Degree Days below 18 C
BRITISH COLUMBIA													
ABBOTSFORD A	7.3	2.9	18.5	-3.8	0.0	0	138.1	87	0	16	103	134	311.8
ALERT BAY	6.6	2.0	15.8	5.5	0.0	0	181.2	135	0	17	*	*	311.8
AMPHITRITE POINT	8.1	2.0	15.0	1.0	0.0	0	300.9	87	0	22	*	*	288.1
BLUE RIVER A	0.7	5.4	9.7	-11.6	26.0	42	33.6	53	77	11	35	60	*
CAPE ST JAMES	6.4	1.6	12.8	0.7	5.4	72	124.9	91	0	21	53	*	337.1
CAPE SCOTT	7.1	2.0	17.1	0.8	0.9	9	270.5	109	0	20	0	*	315.5
CASTLEGAR A	3.1	3.7	11.3	-3.4	15.2	35	52.0	89	0	15	39	58	432.1
COMOX A	5.6	1.6	8.4	3.2	0.0	0	146.6	117	0	16	49	*	352.2
CRANBROOK A	0.5	4.3	11.5	-9.7	16.4	64	14.5	67	0	4	102	99	506.3
DEASE LAKE	-11.6	1.3	11.6	-33.6	12.4	40	10.6	43	81	4	86	81	858.0
FORT NELSON A	-16.4	0.5	13.0	-34.3	19.4	84	17.4	89	48	7	74	*	995.8
FORT ST JOHN A	-10.0	1.4	12.5	-28.0	37.2	122	26.3	96	3	8	46	*	812.1
HOPE A	6.7	3.3	17.2	-0.1	4.7	15	98.7	50	0	10	74	154	326.8
KAMLOOPS A	3.6	4.9	12.4	-5.2	2.6	20	8.6	54	0	3	58	62	417.8
KELOWNA A	2.6	4.6	11.7	-5.7	8.2	55	13.0	53	0	5	56	81	446.7
MACKENZIE A	-5.7	4.6	11.1	-23.9	58.6	114	50.8	90	57	12	46	64	687.3
PENTICTON A	3.7	3.1	13.8	-6.0	8.6	75	24.6	124	0	9	49	65	415.9
PORT ALBERNI A	6.0	2.6	16.5	-0.2	4.0	16	224.7	90	0	17	27	*	347.9
PORT HARDY A	6.4	2.5	16.7	-1.0	0.0	0	169.1	106	0	15	52	69	335.5
PRINCE GEORGE A	-2.4	3.7	12.3	-19.4	37.2	104	33.3	85	0	9	51	58	591.1
PRINCE RUPERT A	4.6	2.0	18.9	-4.0	4.2	18	118.2	51	0	16	62	98	388.8
PRINCETON A	0.7	3.7	8.8	-8.7	14.2	58	15.8	53	0	4	88	*	*
REVELSTOKE A	-0.2	2.6	8.6	-4.7	42.2	55	61.0	70	3	10	18	32	466.1
SANDSPIT A	5.2	1.7	11.5	-2.4	10.2	66	144.5	128	0	16	59	72	372.8
SMITHERS A	-2.6	2.7	10.9	-13.9	52.9	172	50.6	160	25	10	35	42	601.2
TERRACE A	0.1	1.5	7.4	-9.7	57.4	80	121.6	99	0	14	60	83	520.0
VANCOUVER INT'L A	6.6	2.0	15.3	-1.0	0.0	0	87.8	77	0	11	84	97	329.6
VICTORIA INT'L A	6.9	2.1	16.0	-3.0	0.0	0	96.5	97	0	12	87	102	321.5
VICTORIA MARINE	7.0	1.5	16.5	0.0	0.0	0	115.3	85	0	14	0	*	318.9
WILLIAMS LAKE A	-1.9	2.3	9.1	-14.9	16.0	63	17.4	72	0	4	50	46	576.7
YUKON TERRITORY													
DAWSON A	-21.9	*	9.5	-42.0	29.0	*	17.6	*	*	*	*	*	*
MAYO A	-17.3	2.6	*	*	17.2	96	27.2	166	*	*	*	*	*
WATSON LAKE A	-16.6	2.1	12.2	-40.6	29.2	91	24.8	98	40	8	62	73	1006.8
WHITEHORSE A	-11.6	1.6	11.5	-32.4	20.2	133	12.5	94	0	3	87	96	859.8
NORTHWEST TERRITORIES													
BAKER LAKE A	-31.6	1.0	-16.3	-41.9	8.2	152	8.0	163	35	1	60	56	1439.7
CAMBRIDGE BAY A	-32.5	1.9	-18.2	-42.3	3.6	78	3.0	75	35	1	51	98	1463.6
CAPE PARRY A	-29.5	0.2	-13.8	-38.6	12.9	157	11.4	215	18	4	*	*	1375.1
CLYDE A	-34.3	-6.6	-18.5	-51.8	3.0	48	2.8	45	45	1	37	92	1516.9
COPPERMINE A	-27.7	3.4	-10.3	-38.3	10.0	156	7.6	123	54	2	37	48	1325.3
CORAL HARBOUR A	-33.6	-4.2	-14.3	-45.4	7.6	83	7.6	86	33	3	84	74	1496.3
EUREKA	-38.3	-0.3	-23.6	-47.5	1.6	62	1.6	67	18	0	*	*	1633.9
FORT SIMPSON A	-19.6	2.9	5.8	-36.4	16.3	86	11.7	73	66	5	74	77	1130.1
FORT SMITH A	-18.8	3.0	8.4	-41.3	23.8	129	15.0	94	54	5	87	76	1072.2
IQALUIT	-33.4	-7.5	-13.6	-44.3	8.2	34	8.2	35	23	3	93	96	1489.6
HALL BEACH A	-33.7	-1.6	-18.8	-46.4	1.8	21	1.8	22	34	1	*	*	1606.0
HAY RIVER A	-20.4	1.3	9.6	-38.0	17.8	92	16.6	92	74	5	*	*	1113.8
INUVIK A	-28.2	0.7	-11.8	-39.3	17.2	137	14.8	141	47	5	28	43	1340.1
MOULD BAY A	-35.2	0.0	-21.7	-43.7	2.0	61	1.8	60	14	0	*	*	1542.8
NORMAN WELLS A	-25.7	0.5	-3.1	-41.4	31.1	180	24.3	151	17	8	65	86	1267.8
POND INLET A	-37.0	*	-23.8	-44.7	6.6	*	4.8	*	15	3	51	*	1595.3
RESOLUTE A	-34.2	-1.0	-21.5	-41.1	5.0	161	4.7	157	13	1	33	183	1514.4
YELLOWKNIFE A	-24.3	0.8	-7.7	-42.6	18.7	143	13.7	122	61	3	89	87	1227.9
ALBERTA													
BANFF	-1.6	4.7	14.7	-18.2	13.8	42	10.2	37	2	5	*	*	567.5
CALGARY INT'L A	-2.6	4.7	22.6	-22.4	7.8	41	3.6	23	0	1	138	108	595.0
COLD LAKE A	-8.8	4.8	12.4	-30.7	12.2	67	11.3	72	2	4	99	79	777.6
CORONATION A	-8.5	3.2	8.0	-24.1	22.0	110	14.8	87	7	4	120	90	767.6

FEBRUARY 1992

STATION	Temperature C				Snowfall (cm)	% of Normal Snowfall	Total Precipitation (mm)	% of Normal Precipitation	Snow on ground at end of month (cm)	No. of days with Precip 1.0 mm or more	Bright Sunshine (hours)	% of Normal Bright Sunshine	Degree Days below 18 C
	Mean	Difference from Normal	Maximum	Minimum									
EDMONTON INT'L A	-8.3	3.1	13.3	-29.2	31.6	148	24.8	141	20	6	127	106	762.7
EDMONTON MUNICIPAL	-6.3	3.3	14.0	-26.1	38.8	*	32.0	170	15	5	130	112	721.2
EDMONTON NAMAO A	-7.3	3.6	12.7	-27.3	36.8	172	25.4	123	17	4	*	*	731.7
EDSON A	-6.5	3.8	18.1	-31.1	18.0	60	9.4	57	7	4	129	111	709.1
FORT CHIPEWYAN A	-18.4	1.7	8.0	-42.0	40.0	220	40.0	292	*	*	*	*	*
FORT MCMURRAY A	-10.7	4.7	14.5	-36.6	23.5	107	13.2	70	14	5	96	74	831.2
GRANDE PRAIRIE A	-10.0	2.1	11.8	-29.7	21.6	82	17.5	74	15	4	69	*	810.4
HIGH LEVEL A	-15.4	2.9	14.6	-41.4	32.3	157	29.7	184	22	7	55	44	969.8
JASPER	-2.3	4.2	16.5	-21.9	0.4	2	1.0	5	0	0	116	*	587.8
LETHBRIDGE A	-0.1	5.3	21.8	-17.1	4.6	21	3.4	18	0	2	169	138	523.6
MEDICINE HAT A	-2.0	5.7	21.1	-17.9	8.6	47	6.9	42	0	2	162	132	583.4
PEACE RIVER A	-10.1	3.4	11.2	-28.3	22.3	86	22.6	108	2	5	*	*	814.3
RED DEER A	-6.3	4.4	12.4	-28.9	16.6	85	14.1	80	4	5	*	*	713.8
ROCKY MTN HOUSE A	-6.1	1.3	19.0	-28.2	16.2	70	9.1	46	25	3	*	*	699.5
SLAVE LAKE A	-8.2	4.3	12.8	-31.0	20.2	93	12.8	63	0	4	97	85	761.1
SUFFIELD A	-2.7	*	21.6	-20.3	7.5	*	6.9	*	0	3	156	*	599.1
WHITECOURT A	-6.6	3.6	17.6	-26.5	30.0	113	15.6	65	0	5	*	*	709.0
SASKATCHEWAN													
BROADVIEW	-9.5	5.4	5.4	-31.8	16.4	109	12.6	103	12	4	134	99	796.3
CREE LAKE	-16.5	3.6	10.2	-40.7	32.4	180	21.8	160	40	9	96	71	999.7
ESTEVAN A	-5.1	6.9	17.0	-23.0	7.2	41	5.8	34	0	2	149	110	704.9
HUDSON BAY A	-11.6	*	11.0	-28.9	14.2	*	8.2	*	23	1	107	*	860.3
KINDERSLEY	-4.1	8.4	10.7	-25.9	13.6	87	9.2	57	7	3	13	*	764.5
LA RONGE A	-13.5	4.1	14.0	-39.1	13.2	56	12.5	80	43	6	*	*	913.2
MEADOW LAKE A	-11.1	*	8.0	-37.6	7.6	*	6.2	*	19	3	112	*	843.9
MOOSE JAW A	-5.4	6.1	16.9	-25.8	*	*	15.3	99	0	3	136	109	977.6
NIPAWIN A	-12.5	*	9.8	-38.3	3.6	*	2.0	*	25	1	112	*	883.8
NORTH BATTLEFORD A	-10.2	3.9	8.6	-27.6	10.2	66	9.4	65	12	3	*	*	815.5
PRINCE ALBERT A	-11.1	5.4	10.9	-36.8	6.6	40	*	*	94	1	117	96	844.7
REGINA A	-8.5	5.1	9.3	-26.2	14.8	81	13.0	81	3	4	131	108	768.1
SASKATOON A	-9.8	4.8	6.3	-27.0	13.2	72	10.4	63	7	3	*	*	807.7
SWIFT CURRENT A	-3.7	6.6	17.2	-22.6	5.8	32	4.3	25	0	1	152	133	629.3
YORKTON A	-9.7	5.8	6.0	-35.9	22.2	116	19.6	109	26	3	122	94	849.0
MANITOBA													
BRANDON A	-11.1	4.6	3.8	-32.9	12.8	65	10.0	53	20	2	92	*	845.5
CHURCHILL A	-26.5	-0.6	-3.7	-38.1	17.4	119	11.0	84	48	5	147	112	1299.1
DAUPHIN A	-10.6	5.0	8.4	-32.6	22.0	118	11.1	63	17	4	*	*	830.4
GILLAM A	-23.2	0.1	-1.9	-39.6	34.8	156	20.8	115	62	7	*	*	1195.0
ISLAND LAKE	-19.3	0.6	1.1	-36.6	32.8	155	27.4	173	57	8	*	*	1083.5
LYNN LAKE A	-19.6	2.1	2.5	-37.7	34.0	225	21.4	143	37	6	102	77	1090.0
NORWAY HOUSE A	-16.8	*	4.4	-32.4	38.6	*	28.4	*	27	6	*	*	1006.9
PORTAGE LA PRAIRIE	-9.3	5.3	9.1	-31.4	23.6	99	9.4	44	18	3	*	*	790.9
THE PAS A	-14.3	3.7	8.1	-32.2	26.0	126	15.3	99	34	3	105	79	936.8
THOMPSON A	-20.1	1.7	4.3	-36.3	29.6	264	20.9	187	58	6	122	85	1106.3
WINNIPEG INT'L A	-10.1	5.5	5.5	-29.7	18.6	98	11.8	67	10	4	72	50	815.1
ONTARIO													
BIG TROUT LAKE	-20.9	0.5	-3.6	-37.0	22.8	110	19.7	104	42	8	123	*	1129.9
EARLTON A	-14.0	0.1	2.0	-32.0	51.8	110	43.1	91	49	12	*	*	928.1
GERALDTON A	-15.6	*	-0.6	-38.0	32.6	*	24.8	*	52	8	*	*	976.0
GORE BAY A	-8.4	1.3	2.2	-28.2	81.8	218	49.0	114	67	13	*	*	764.8
HAMILTON RBG	-2.5	*	7.0	-19.0	3.0	*	53.8	*	0	5	83	*	*
HAMILTON A	-3.7	2.6	5.3	-20.7	17.8	59	55.4	115	1	8	*	*	629.6
KAPUSKASING A	-16.4	-0.2	-1.4	-34.0	29.0	66	24.8	58	91	7	*	*	999.1
KENORA A	-10.3	4.1	4.5	-32.6	28.9	113	26.1	113	52	8	*	*	821.0
KINGSTON A	-6.1	1.8	4.1	-27.3	27.4	77	60.0	105	5	13	87	68	700.0
LONDON A	-4.4	1.7	4.0	-23.4	27.4	70	66.3	110	2	12	52	53	649.3
MOOSONEE	-21.1	-2.6	-2.7	-35.3	23.2	77	18.2	61	45	6	138	113	1133.0
MUSKOKA A	-8.8	0.8	3.9	-29.0	75.1	146	79.3	127	52	13	*	*	774.2
NORTH BAY A	-11.7	-0.4	1.5	-28.6	68.4	135	57.8	103	56	14	124	100	861.0
OTTAWA INT'L A	-9.6	-0.1	1.2	-26.8	88.6	176	78.2	130	72	13	114	95	801.7
PETAWAWA A	-12.0	0.1	4.4	-35.2	80.2	176	74.3	143	0	12	*	*	872.0
PETERBOROUGH A	-6.0	2.8	4.1	-25.4	28.8	91	47.0	99	10	9	*	*	719.4
PICKLE LAKE	-16.4	2.3	-3.1	-35.3	35.6	130	29.4	115	50	9	*	*	996.5
RED LAKE A	-14.0	2.8	3.9	-34.9	19.6	85	16.4	82	44	7	95	*	929.0
ST CATHARINES A	-2.1	2.9	6.5	-16.2	10.8	48	43.0	95	*	9	66	*	582.2
SARNIA A	-2.1	3.8	5.7	-18.3	11.6	49	41.8	96	4	11	82	77	583.8
SAULT STE MARIE A	-8.9	2.6	3.1	-28.2	42.6	67	31.8	58	29	10	93	83	779.9
SIOUX LOOKOUT A	-12.6	3.1	1.9	-35.7	36.5	130	36.3	132	71	13	*	*	887.1
SUDBURY A	-11.4	1.1	2.5	-28.3	63.0	141	52.2	111	63	12	113	86	852.3
THUNDER BAY A	-9.4	3.6	4.2	-30.0	28.4	93	20.8	73	31	6	92	63	795.7
TIMMINS A	-14.8	0.8	0.4	-32.0	35.3	66	32.5	71	59	10	*	*	952.4
TORONTO	-2.0	*	6.4	-17.8	10.2	*	35.4	*	0	7	*	*	579.3
TORONTO INT'L A	-3.9	2.2	4.9	-19.2	10.0	38	35.0	76	*	6	*	*	635.7
TORONTO ISLAND A	-2.7	*	4.9	-17.4	9.4	38	41.0	*	0	6	*	*	600.6
TRENTON A	-5.6	0.9	4.6	-22.6	32.4	92	46.0	81	3	10	*	*	682.8
WATERLOO WELLINGTON	-5.0	2.9	4.5	-22.2	13.4	43	33.4	65	2	7	*	*	665.8
WAWA A	-10.7	*	2.2	-33.3	52.6	*	43.2	*	58	10	*	*	833.7
WIARTON A	-5.5	2.0	1.4	-24.0	76.6	127	71.1	111	26	13	76	74	679.5
WINDSOR A	-1.3	2.5	7.8	-13.7	7.6	33	50.2	100	0	8	*	*	559.9

FEBRUARY 1992

STATION	Temperature C				Snowfall (cm)	% of Normal Snowfall	Total Precipitation (mm)	% of Normal Precipitation	Snow on ground at end of month (cm)	No. of days with Precip 1.0 mm or more	Bright Sunshine (hours)	% of Normal Bright Sunshine	Degree Days below 18 C
	Mean	Difference from Normal	Maximum	Minimum									
QUEBEC													
BAGOTVILLE A	-16.2	-2.4	-0.6	-31.2	82.5	135	68.8	123	82	15	*	*	990.8
BAIE COMEAU A	-14.8	-1.7	-1.9	-28.7	52.6	72	49.2	69	60	12	128	106	951.7
BLANC SABLON A	-15.7	-5.0	0.4	-26.9	102.6	101	102.6	100	18	16	120	*	978.6
CHIBOUGAMAU CHAPAIS	-20.6	*	-4.9	-36.5	34.4	*	25.6	*	79	10	146	117	1119.1
GASPE A	-13.1	*	0.9	-26.5	92.7	*	76.5	*	24	10	82	*	961.3
INUKJUAK A	-29.2	-4.2	-13.0	-38.7	3.6	41	3.0	35	16	*	125	116	1368.0
KUUJJUAQ A	-28.0	-5.6	-12.8	-38.0	7.6	22	7.6	23	27	2	107	99	1334.6
KUUJJUARAPIK A	-26.0	-3.4	-7.9	-39.3	9.2	38	9.0	38	30	3	123	99	1275.1
LA GRANDE IV A	-27.1	*	*	*	14.0	*	12.8	*	250	60	144	*	*
LA GRANDE RIVIERE A	-24.7	*	-7.3	-38.1	8.8	*	8.8	*	48	5	123	*	1246.6
MANIWAKI	-13.1	-0.9	4.2	-33.9	97.2	213	80.0	159	77	13	118	93	990.1
MONT JOLI A	-13.7	-3.2	-0.6	-26.9	72.8	96	68.6	92	35	14	107	94	918.5
MONTREAL INT'L A	-9.7	-0.7	1.0	-26.2	80.2	150	90.4	139	32	14	91	71	804.9
MONTREAL MIRABEL I/	-11.2	*	0.8	-28.7	88.6	*	97.2	*	47	13	129	*	846.8
NATASHQUAN A	-15.5	-4.2	-2.3	-29.4	54.4	97	49.0	62	48	9	127	97	960.8
QUEBEC A	-12.5	-1.7	0.4	-27.6	76.2	109	71.2	91	95	16	86	77	883.9
ROBERVAL A	*	*	0.7	-31.9	39.8	66	39.2	66	89	10	109	*	990.6
SCHEFFERVILLE A	-27.6	-6.4	-11.8	-43.3	5.6	12	4.4	10	67	3	130	114	1323.9
SEPT-ILES A	-16.7	-4.2	-3.2	-29.4	45.0	61	35.0	44	51	9	119	86	1041.9
SHERBROOKE A	-10.6	0.9	7.6	-31.4	104.8	186	89.8	149	60	15	83	*	829.4
STE AGATHE DES MONT	-12.4	-0.1	1.7	-29.7	120.8	146	84.8	113	118	14	119	95	880.6
ST HUBERT A	-10.0	-1.0	1.0	-25.3	73.2	*	80.0	111	34	14	97	*	813.1
VAL D'OR A	-16.2	-1.3	0.1	-33.9	39.8	79	31.0	61	60	10	112	83	992.6
NEW BRUNSWICK													
CHARLO A	-12.4	-1.0	0.1	-25.1	110.9	150	80.6	126	92	13	118	86	883.4
FREDERICTON A	-9.5	-1.1	2.6	-24.8	96.7	153	104.9	117	57	14	118	*	796.8
MONCTON A	-9.1	-1.4	2.4	-23.5	248.6	363	230.8	233	114	17	92	75	787.2
SAINT JOHN A	-8.0	-0.5	3.8	-28.3	135.0	214	141.6	122	48	20	109	87	755.1

STATION	Temperature C				Snowfall (cm)	% of Normal Snowfall	Total Precipitation (mm)	% of Normal Precipitation	Snow on ground at end of month (cm)	No. of days with Precip 1.0 mm or more	Bright Sunshine (hours)	% of Normal Bright Sunshine	Degree Days below 18 C
	Mean	Difference from Normal	Maximum	Minimum									
NOVA SCOTIA													
GREENWOOD A	-6.6	-1.2	8.4	-25.3	108.8	174	119.3	132	18	16	*	*	711.9
HALIFAX INT'L A	-6.2	-0.1	5.5	-21.3	125.7	192	161.4	121	9	16	*	*	701.9
SABLE ISLAND	-1.2	-0.2	8.0	-12.5	32.1	101	185.2	157	0	15	76	104	555.6
SHEARWATER A	-5.0	-0.5	4.8	-19.8	105.2	202	170.8	139	16	13	99	77	667.7
SYDNEY A	-7.1	-1.2	4.7	-22.6	168.8	246	220.7	179	45	16	111	101	727.7
YARMOUTH A	-3.6	-0.4	4.8	-14.8	98.7	183	123.2	108	0	17	80	86	627.5
PRINCE EDWARD ISLAND													
CHARLOTTETOWN A	-8.5	-1.0	4.4	-22.8	144.6	220	176.0	181	72	17	*	*	769.8
NEWFOUNDLAND													
BONAVISTA	-7.4	-2.2	4.2	-21.5	115.8	257	146.8	170	91	19	*	*	736.3
BURGEO	-7.0	-1.3	-2.0	-19.0	71.7	141	89.7	69	49	13	*	*	702.0
CARTWRIGHT	-19.1	-6.5	-2.5	-29.3	72.0	110	72.0	106	148	10	112	106	1075.4
CHURCHILL FALLS A	-25.8	-6.1	-10.0	-40.6	13.0	22	12.2	22	95	5	161	130	1269.5
COMFORT COVE	-10.2	-2.5	4.1	-25.2	112.0	153	122.0	148	95	17	*	*	818.5
DANIELS HARBOUR	-12.1	-4.4	1.7	-27.0	134.4	180	134.4	165	72	18	85	114	872.6
DEER LAKE A	-12.3	-3.1	1.6	-31.7	138.6	212	108.2	155	102	19	*	*	887.6
GANDER INT'L A	-9.6	-2.8	4.1	-24.5	144.0	189	153.8	154	42	17	88	89	798.3
GOOSE A	-21.6	-7.1	-6.4	-34.5	25.4	42	17.2	29	49	5	141	121	1148.9
MARY'S HARBOUR	-16.3	-6.2	0.0	-31.0	111.4	176	110.6	141	138	12	*	*	995.7
PORT AUX BASQUES	-7.2	-1.5	2.0	-19.3	98.6	142	107.6	92	79	22	71	*	733.4
ST ANTHONY	-14.2	-3.0	-0.6	-27.5	132.1	218	122.8	149	95	14	*	*	934.0
ST JOHN'S A	-6.6	-2.1	5.1	-20.6	109.4	147	173.2	124	33	18	84	101	713.7
ST LAWRENCE	-5.4	-0.9	5.6	-17.2	60.0	124	136.2	126	24	17	*	*	680.0
STEPHENVILLE A	-9.2	-3.0	4.3	-23.4	98.0	129	94.3	105	63	18	70	97	784.7
WABUSH LAKE A	-25.8	-5.0	-9.6	-40.1	-16.5	-31	14.0	29	61	5	142	129	1253.7

AGROCLIMATOLOGICAL STATIONS

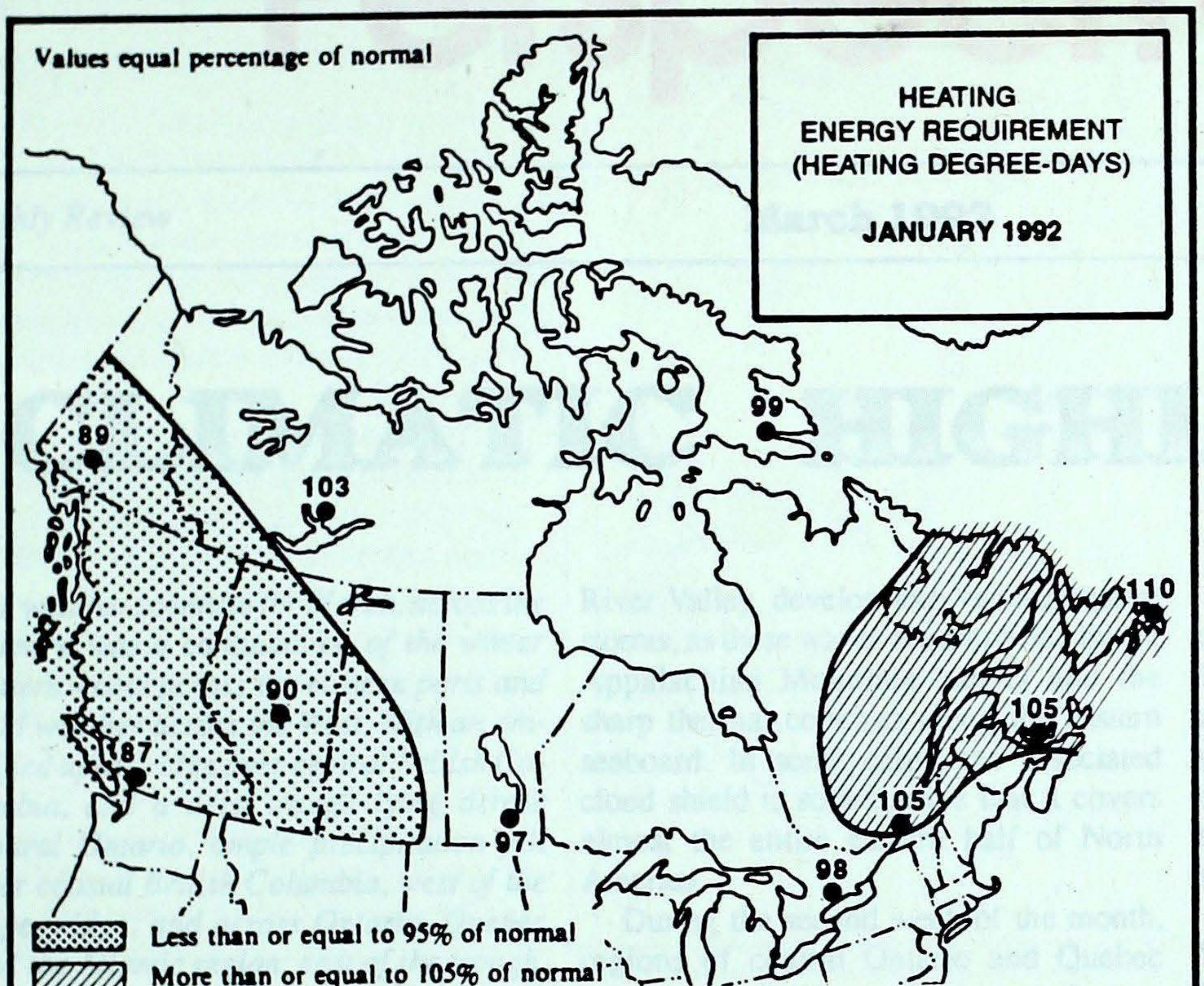
FEBRUARY 1992

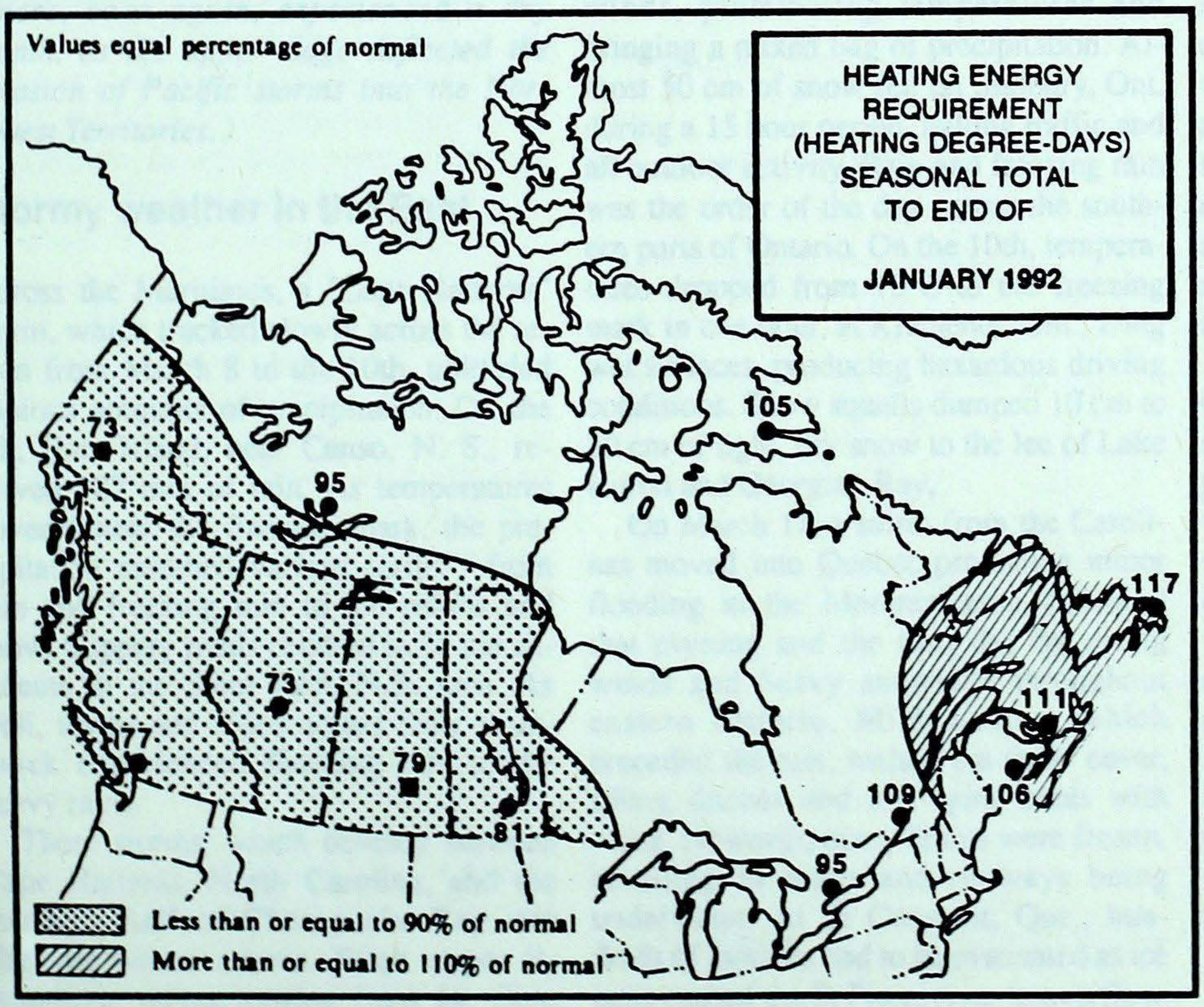
STATION	Temperature C: Mean	Temperature C: Difference from Normal	Temperature C: Maximum	Temperature C: Minimum	Snowfall (cm)	Total Precipitation (mm)	% of Normal Precipitation	Snow on ground at end of month (cm)	No. of days with Precip 1.0 mm or more	Bright Sunshine (hours)	Degree days above 5 C: This month	Degree days above 5 C: Since jan. 1st
BRITISH COLUMBIA												
AGASSIZ	7.8	3.3	18.5	-1.5	0.0	100.7	57	0	13	109	145.8	117.6
SUMMERLAND	3.0	2.9	12.0	-3.5	6.0	20.6	110	0	7	61	5.8	18.1
ALBERTA												
BEAVERLODGE	-8.7	1.5	12.0	-27.0	20.5	21.0	83	8	5	67	9.8	10.3
LACOMBE	-6.6	3.9	13.0	-29.5	14.0	9.1	51	8	3	104	0.0	0.0
SASKATCHWAN												
INDIAN HEAD	-8.9	4.9	8.0	-32.0	15.8	14.6	82	34	3	**	0.0	0.0
MELFORT	-11.4	4.9	6.0	-37.0	4.2	4.2	26	37	2	90	0.0	0.0
REGINA	-9.1	4.7	10.0	-29.0	11.5	11.4	77	10	5	**	0.0	0.0
SCOTT	-10.8	3.6	6.0	-27.0	20.3	16.2	125	6	4	125	0.0	0.0
SWIFT CURRENT	-3.3	7.1	18.0	-22.5	2.8	2.3	15	0	0	148	16.0	17.0
MANITOBA												
BRANDON	-10.4	4.8	6.1	-36.4	8.9	9.7	48	35	2	**	0.0	0.0
MORDEN	-8.7	7.7	9.0	-28.0	22.8	35.0	128	5	6	96	0.0	0.0
GLENLEA	-11.0	2.4	3.0	-33.5	13.1	13.1	69	50	5	75	0.0	0.0
ONTARIO												
DELHI	-1.2	4.2	4.5	-23.0	11.7	64.6	114	0	9	**	0.0	0.0
ELORA	-5.3	2.0	4.2	-24.2	1.5	27.3	56	7	4	**	0.0	0.0
GUELPH			4.3	-24.6	26.2	43.5	86	7	*	**	0.0	0.0
HARROW	-0.7	3.1	9.0	-13.0	1.4	57.4	108	0	9	65	0.0	0.0
KAPUSKASING	-16.5	-0.2	-1.0	-36.5	33.9	26.9	65	60	7	90	0.0	0.0
OTTAWA	-9.2	0.3	1.5	-28.8	90.1	73.3	134	36	13	114	0.0	0.0
SMITHFIELD	-4.4	2.2	5.1	-25.2	34.3	62.6	87	6	10	**	0.0	0.0

Courtesy of Agriculture Canada

STATION	Temperature C: Mean	Temperature C: Difference from Normal	Temperature C: Maximum	Temperature C: Minimum	Snowfall (cm)	Total Precipitation (mm)	% of Normal Precipitation	Snow on ground at end of month (cm)	No. of days with Precip 1.0 mm or more	Bright Sunshine (hours)	Degree days above 5 C: This month	Degree days above 5 C: Since jan. 1st
QUEBEC												
LA POCATIERE	-11.8	-1.6	0.0	-28.0	66.7	63.0	89	90	11	100	0.0	0.0
L'ASSOMPTION	-10.6	0.0	1.0	-29.0	73.8	78.3	127	36	2	109	0.0	0.0
NORMANDIN	-18.5	-2.4	-1.0	-38.0	34.0	25.8	48	42	7	136	0.0	0.0
NEW BRUNSWICK												
FREDERICTON	-8.9	-0.6	2.5	-25.0	84.3	117.6	135	27	14	118	0.0	0.0
NOVA SCOTIA												
KENTVILLE	-5.7	-0.5	8.5	-22.0	108.5	151.9	142	27	19	90	0.0	0.8
NAPPAN	-8.2	-1.3	6.0	-28.0	129.2	146.9	165	65	20	89	0.0	0.5
PRINCE EDWARD ISLAND												
CHARLOTTETWN	-8.1	-1.1	4.0	-22.5	108.5	132.0	163	0	15	**	*.*	0.0
NEWFOUNDLAND												
ST.JOHN'S WEST	-6.8	-2.5	5.0	-20.5	117.4	213.7	129	52	15	78	0.0	0.0

Courtesy of Agriculture Canada





SEASONAL TOTAL OF HEATING DEGREE-DAYS TO END OF JANUARY

	1992	1991	NORMAL
BRITISH COLUMBIA			
Kamloops	1940	2446	2281
Penticton	1813	2161	2056
Prince George	2611	3383	3234
Vancouver	1517	1715	1698
Victoria	1596	1794	1745
YUKON TERRITORY			
Whitehorse	3789	4461	4224
NORTHWEST TERRITORIES			
Iqaluit	5192	5740	5362
Inuvik	5828	5724	5661
Yellowknife	4960	5226	4833
ALBERTA			
Calgary	2620	3047	3091
Edmonton Mun.	2931	3243	3218
Grande Prairie	3328	3804	3644
SASKATCHEWAN			
Estevan	3056	3392	3146
Regina	3196	3489	3370
Saskatoon	3369	3712	3506
MANITOBA			
Brandon	3595	3727	3506
Churchill	5064	5281	4943
The Pas	3878	4089	3899
Winnipeg	3320	3441	3367
ONTARIO			
Kapuskasing	3624	3746	3602
London	2181	2150	2224
Ottawa	2647	2568	2617
Sudbury	3023	2970	2996
Thunder Bay	3309	3341	3210
Toronto	2156	2123	2225
Windsor	1918	1879	1983
QUÉBEC			
Baie Comeau	3381	3440	3310
Montréal	2575	2469	2516
Québec	2972	2875	2856
Sept-Îles	3539	3618	3421
Sherbrooke	2896	2728	2900
Val d'Or	3503	3532	3440
NEW BRUNSWICK			
Fredericton	2655	2525	2581
Moncton	2614	2527	2517
NOVA SCOTIA			
Sydney	2313	2262	2213
Yarmouth	2098	1947	2094
PRINCE EDWARD ISLAND			
Charlottetown	2432	2422	2381
NEWFOUNDLAND			
Gander	2872	2744	2603
St. John's	2613	2486	2424