Environment Canada Environnement Canada

Climatic Perspectives

July 20 to 26, 1992 **A weekly review of Canadian climate and water** Vol. 14 No. 30

Ontario - coldest July this century?

Cool, changeable summer weather continues to be the pattern in Ontario this summer. To add to the summer vacation woes, rainfall totals at many locations are well above normal.

Mean temperatures in Ontario are running approximately 2 to 3 degrees below normal for July, to-date. Also, in contrast to the last five summers in Ontario, maximum readings in the thirties have been almost non-existent this year. Last week on July 14 and 15, record-breaking below zero temperatures were registered at Moosonee, erasing the records previously set in 1933. This week widespread frost was reported as far south as Sudbury, and patchy ground frost even occurred in some areas of south-central Ontario. Currently, July 1992 stands as the coldest July in southern Ontario since 1895!

Precipitation-wise, rainfall has also been more frequent than desirable, hampering both the tourism industry and the agricultural sector. For example, a trace or more of rain has fallen in Toronto on 14 of the last 26 days in July, and last week, some locations in southern Ontario, received more rain than they would normally receive during the whole month of July. Between July 14 and 20, general rainfall totals at a number of locations across southern Ontario ranged between 70 and 110 millimetres.

This moisture would be beneficial if the weather was hot and sunny, but as it stands now, fields are soggy and wet. Harvesting of forage crops, in general, has been delayed significantly and waterlogging is harming the root systems of some crops. Disease and mould is of growing concern. Soybeans and winter wheat are not doing well. Grain crops are showing signs of sprouting. Corn is stunted due to the lack of heat, but is struggling along; there has been good growth in some areas during the few warm, sunny days that there have been. Hay quality is deteriorating and is a concern, but grass and weeds are growing well.

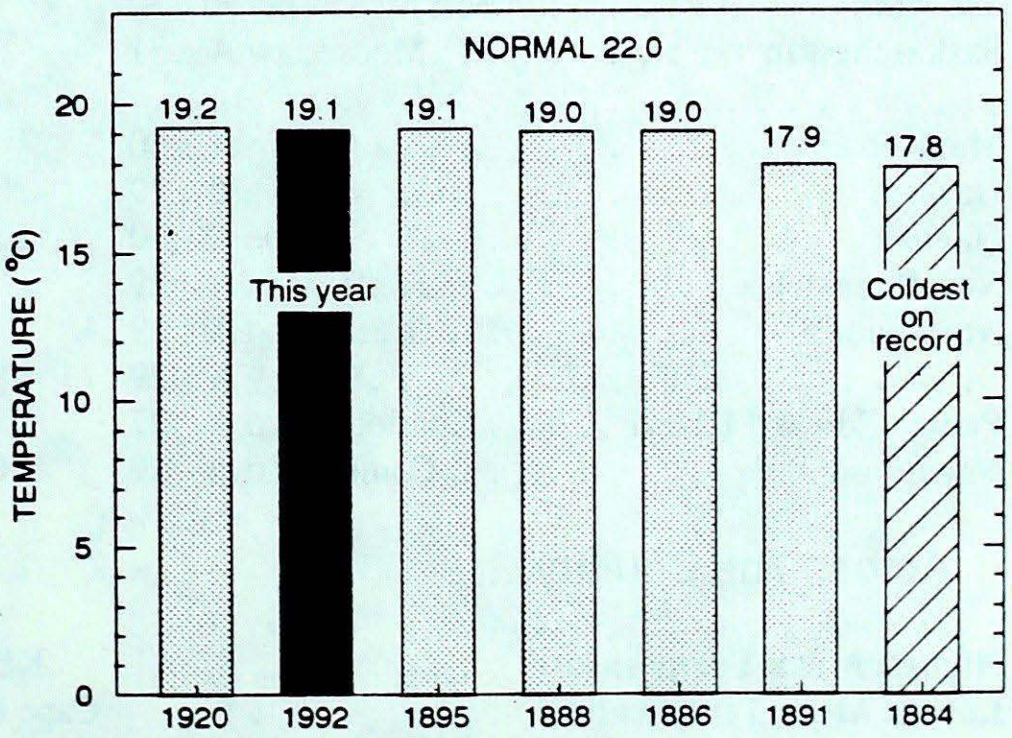
Elsewhere...

It was mostly sunny and warm across the Mackenzie Valley this week, with just scattered afternoon thundershowers. A heavy rainfall event over southern Baffin Island gave way to sunny and warm weather; readings climbed into the high teens. In the Yukon and northern British Columbia, cloud and rain began and ended the week. Further to the south, sunshine was interspersed with showers and thundershowers. Across the Prairies, sunny and warm weather gave way to some heavy shower and thunderstorm activity later in the period - hail and funnel clouds were reported. The Maritimes started off humid and unsettled then became mainly sunny; a heavy thunderstorm dumped 50 mm of rain in one hour on Charlottetown. Warm summer weather finally arrived in Newfoundland!

Look ahead...

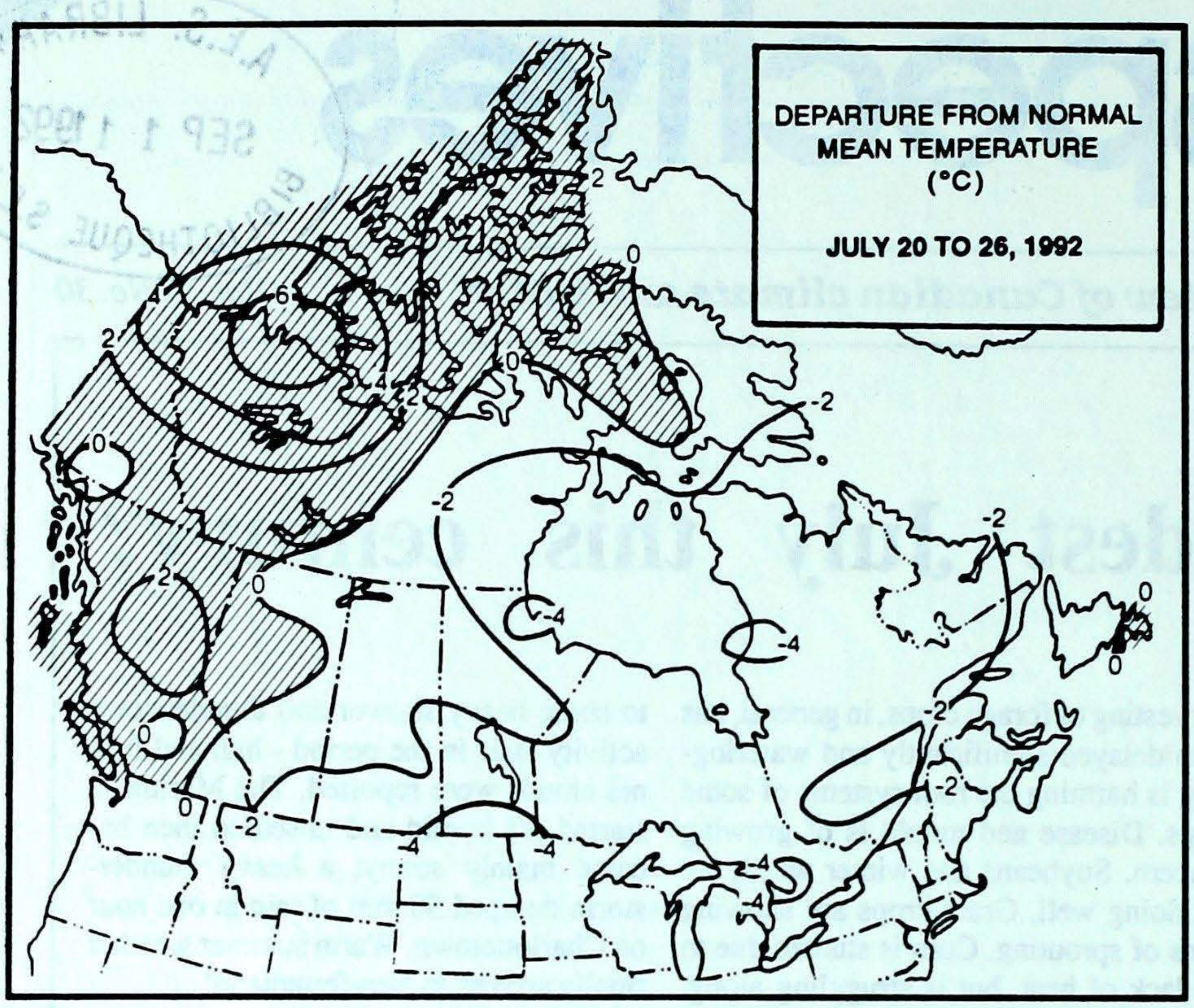
For the week of August 3, below normal temperatures are likely across southern Ontario and Baffin Island. Elsewhere near to above normal temperatures are expected. A return to a more normal summer circulation pattern is indicated.

July Mean Temperature - Toronto City



Toronto has just endured the coldest July this century. The above graph gives a sampling of other cold Julys that have been experienced in Toronto since records began in 1840.

Canada



Weekly normal temperatures (°C)

	max.	min.
Whitehorse A	19.5	7.9
Iqaluit A	12.9	4.7
Yellowknife A	20.2	11.9
Vancouver Int'l A	22.3	13.0
Victoria Int'l A	22.2	10.9
Calgary Int'l A	24.0	9.5
Edmonton Int'l A	22.5	8.9
Regina A	26.6	12.0
Saskatoon A	25.8	11.8
Winnipeg Int'l A	26.3	13.7
Ottawa Int'l A	26.6	15.4
Toronto (Pearson Int'l A)	27.3	15.1
Montréal Int'l A	26.7	16.2
Québec A	25.3	13.6
Fredericton A	26.2	13.1
Saint John A	22.7	11.8
Halifax (Shearwater)	21.9	13.4
Charlottetown A	23.2	13.9
Goose A	21.3	10.4
St John's A	20.1	10.8

Weekly temperature and precipitation extremes

	Maximum temperature (°C)		Minimum temperature (°C)		Heaviest precipitation (mm)	
British Columbia	Kamloops A	34	Dease Lake	2	Cranbrook A	53
Yukon Territory	Old Crow A	27	Sheldon Lake	1	Tuchitua	28
Northwest Territories	Hay River A	31	Cape Hooper	-3	Iqaluit A	35
Alberta	Fort McMurray A	30	Banff (aut)	3	Cold Lake A	30
Saskatchewan	Moose Jaw A	31	Cree Lake	5	North Battleford A	28
			Wynyard	5		
Manitoba	Gillam A	30	Churchill A	-1	Island Lake	52
Ontario	Moosonee	29	Timmins A	2	Moosonee	65
Quebec	Gaspé A	30	La Grande Rivière	0	Kuujjuaq A	42
New Brunswick	Fredericton A	29	St-Léonard A	4	St-Léonard A	42
Nova Scotia	Greenwood A	29	Truro	7	Sable Island	12
	Sydney A	29				
Prince Edward Island	Charlottetown A	27	Charlottetown A	10	Charlottetown A	53
Newfoundland	Comfort Cove	29	Churchill Falls A	2	Cartwright	23

Across The Country...

Highest Mean Temperature	Kamloops A (B.C.)	23
Lowest Mean Temperature	Cape Hooper (N.W.T.)	-2

92/07/20-92/07/26

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VOLUME 14

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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 the Atmospheric Environment Service.

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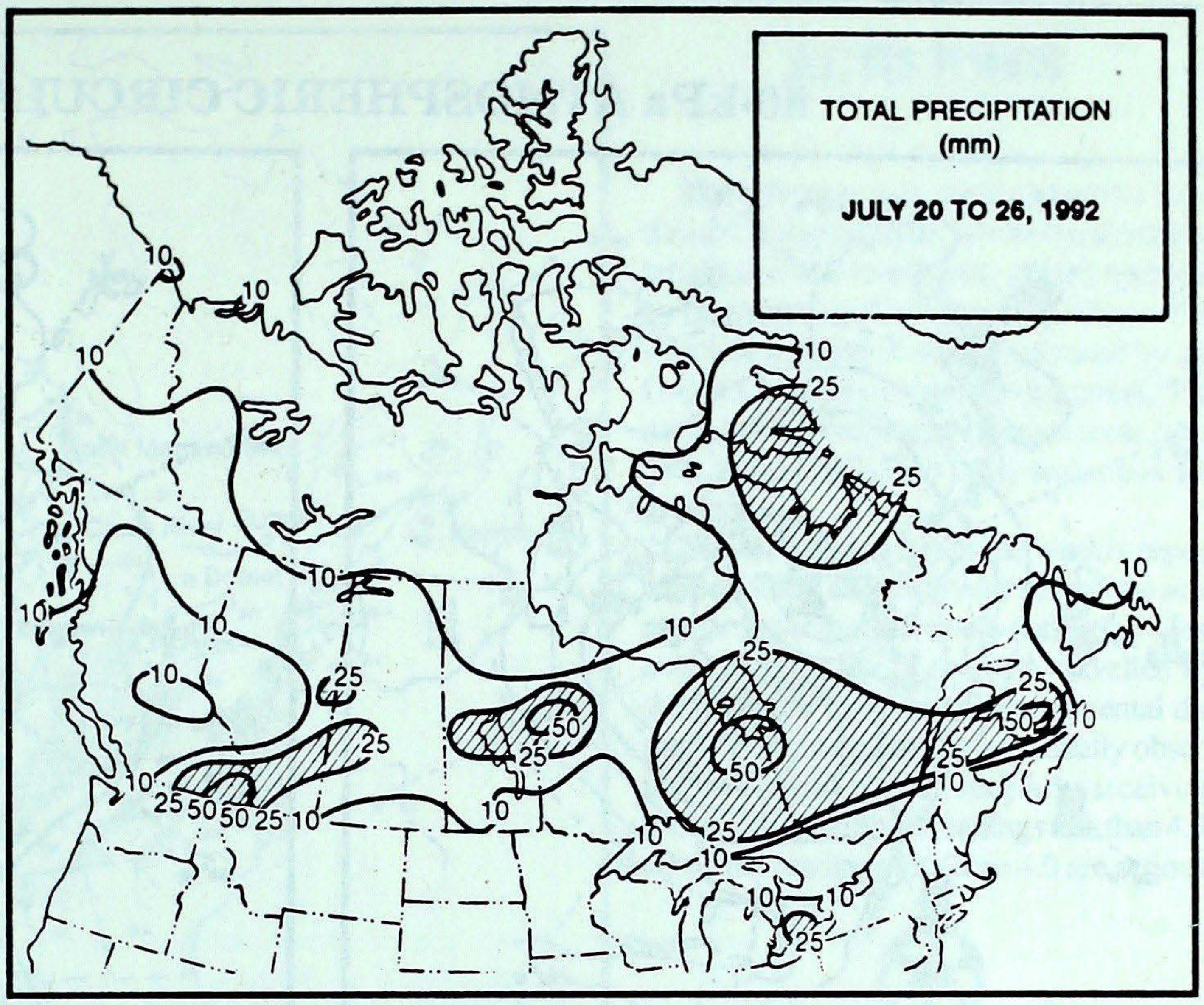
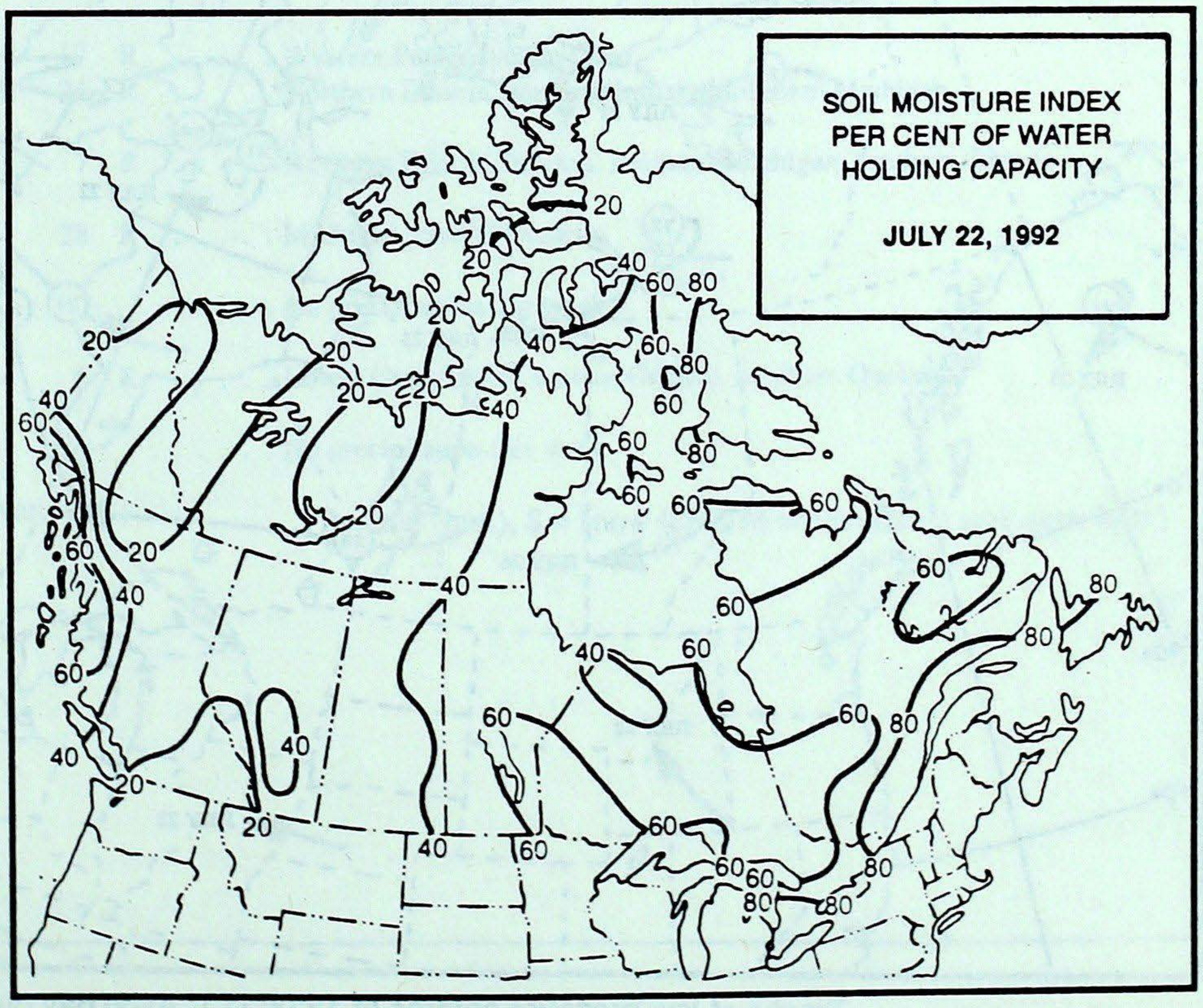
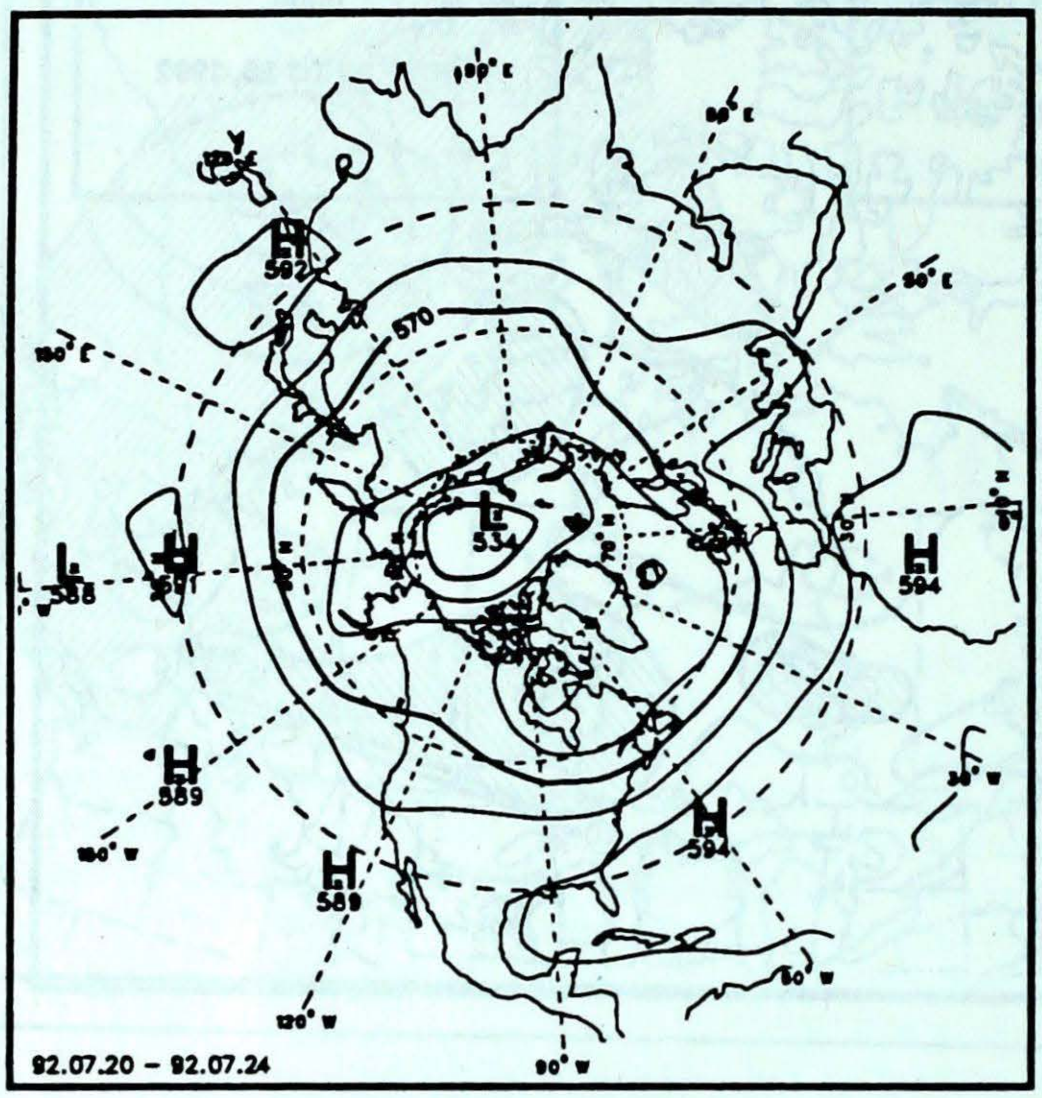
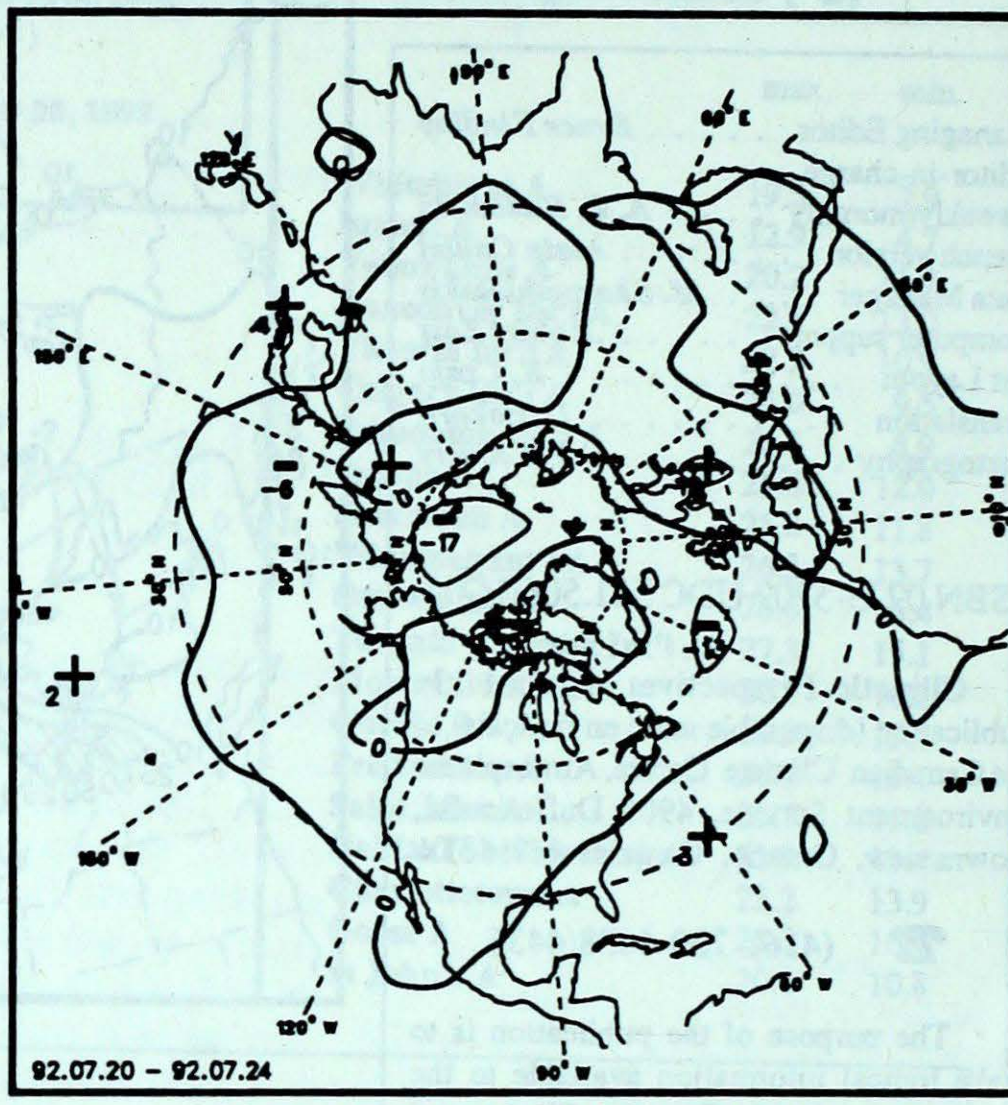




50-kPa ATMOSPHERIC CIRCULATION

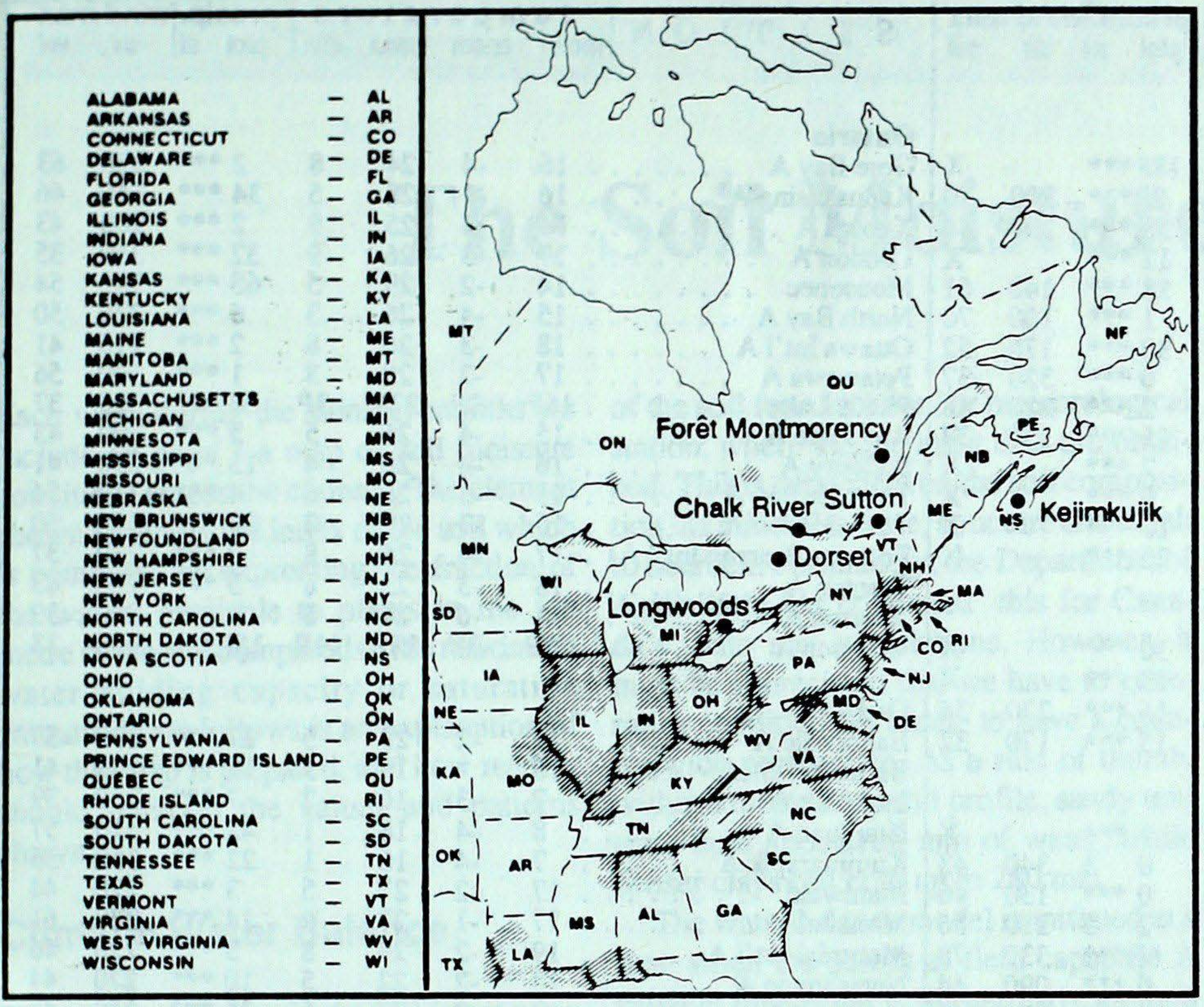


Mean geopotential height
50-kPa level (10 decametre intervals)



Mean geopotential height anomaly
50-kPa level (10 decametre intervals)

Tracks of low pressure centres at 12:00 U.T. each day during the period.



ACID RAIN

The reference map (left) shows the locations of sampling sites, where the acidity of precipitation is monitored. All are operated by Environment Canada except Dorset (*), which is a research station operated by the Ontario Ministry of the Environment. The map also shows the approximate areas (shaded), where SO_2 and NO_x emissions are greatest.

The table below gives the weekly report summarizing the acidity (or pH) of the acid rain or snow that fell at the collection sites, and a description of the path travelled by the moisture laden air. Environmental damage to lakes and streams is usually observed in sensitive areas regularly receiving precipitation with pH readings less than 4.7, while pH readings less than 4.0 are serious.

July 19 to 25 1992

SITE	day	pH	amount		AIR PATH TO SITE
Longwoods	22	4.0	17	R	..... Western Pennsylvania, Ohio
	25	4.2	36	R	..... Northern Illinois, northern Indiana, southern Michigan
Dorset *	19	4.3	7	R	..... Northern Illinois, Indiana, southern Michigan, southern Ontario
Chalk River	19	5.1	28	R	..... Michigan, central Ontario
Sutton					..... No precipitation this week
Montmorency	20	4.4	5	R	..... Lower Great Lakes, eastern Ontario, southern Quebec
Kejimkujik					..... No precipitation this week

R= rain (mm), S = snow (cm), M = mixed rain and snow (mm)

STATION	temperature mean	anom	max	min	precip. ptot	st	wind max dir	vel
British Columbia								
Blue River A	19P	1P	30P	8P	18P	***		X
Cape St James	14P	1P	17P	10P	9P	***	300	70
Cranbrook A	18	-1	28	10	53	***	300	44
Fort Nelson A	17	1	28	8	12	***		X
Fort St John A	18	2	28	8	18	***	140	61
Kamloops A	23	1	34	13	1	***	100	70
Penticton A	22	1	30	15	30	***	170	52
Port Hardy A	14	0	19	9	0	***	320	37
Prince George A	18	3	28	5	2	***	320	48
Prince Rupert A	14	1	17	8	25	***	150	37
Smithers A	17	3	31	7	2	***		X
Vancouver Int'l A	19	1	25	13	9	***		X
Victoria Int'l A	17	0	24	10	17	***		X
Williams Lake A	18	2	28	8	23	***		X
Yukon Territory								
Komakuk Beach A	10	3	19	4	10	***		X
Teslin (aut)	14	*	24	6	19	***		X
Watson Lake A	16	1	25	5	16	***	270	54
Whitehorse A	13	0	23	4	15	***	170	32
Northwest Territories								
Alert	6	3	13	1	1	***		X
Baker Lake A	9	-3	16	3	0	3	340	43
Cambridge Bay A	10	2	19	4	0	***	130	46
Cape Dyer A	5	-1	13	-1	2	5	280	56
Clyde A	3P	-2P	12P	-1P	6P	***	330	78
Coppermine A	14	5	29	4	0	***	090	44
Coral Harbour A	7	-3	19	1	10	***	030	43
Eureka	8	3	15	2	0	***		X
Fort Smith A	16	0	28	6	4	***		X
Hall Beach A	7	1	17	1	2	***	330	48
Inuvik A	17	5	28	7	4	***		X
Iqaluit A	6	-2	18	1	35	***	330	57
Mould Bay A	6	3	12	3	3	3		X
Norman Wells A	19	3	28	10	15	***	310	41
Resolute A	5	0	11	0	0	***	130	50
Yellowknife A	16	0	24	10	0	***	080	44
Alberta								
Calgary Int'l A	16	-1	25	4	10	***	160	50
Cold Lake A	17	-1	27	7	30	***	100	52
Edmonton Namao A	18	1	26	9	7	***	290	65
Fort McMurray A	17	1	30	7	17	***	250	50
High Level A	15	-1	28	5	22	***	330	46
Jasper	*	*	26	*	*	***		X
Lethbridge A	17	-2	28	7	14	***	260	52
Medicine Hat A	18	-2	28	7	14	***	240	56
Peace River A	17	1	28	8	13	***	280	52
Saskatchewan								
Cree Lake	15	0	28	5	24	***	070	52
Estevan A	17	-4	30	5	4	***	160	54
La Ronge A	16	-1	27	5	20	***	270	37
Regina A	18	-2	30	6	4	***	320	72
Saskatoon A	18	-1	29	6	14	***	290	57
Swift Current A	17	-2	28	5	12	***	270	82
Yorkton A	16	-3	24	6	15	***	180	41
Manitoba								
Brandon A	17	-3	26	7	9	***		X
Churchill A	8	-4	22	-1	5	***	010	43
Lynn Lake A	15	-1	28	7	4	***	020	57
The Pas A	16	-2	28	6	16	***	230	56
Thompson A	15	0	30	4	3	***	230	50
Winnipeg Int'l A	16	-4	25	9	1	***	210	48
Ontario								
Gore Bay A	16	-4	24	8	2	***	320	63
Kapuskasing A	16	-1	28	5	34	***	340	46
Kenora A	16	-4	25	9	2	***	200	43
London A	17	-3	26	9	32	***	310	35
Moosonee	14	-2	29	5	65	***	340	54
North Bay A	15	-4	26	3	6	***	270	50
Ottawa Int'l A	18	-3	26	8	2	***	210	41
Petawawa A	17	-2	28	3	1	***	300	56
Pickle Lake	16P	-2P	27P	3P	9P	***	320	37
Red Lake A	15	-4	26	5	5	***	300	43
Sudbury A	16	-4	26	4	15	***	250	41
Thunder Bay A	15	-3	26	6	4	***	320	54
Timmins A	15	-3	29	2	27	***	320	50
Toronto(Pearson Int'l A)	17	-4	26	8	9	***	230	37
Trenton A	18	-3	25	8	5	***	220	43
Wiarton A	14	-6	24	6	9	***	230	39
Windsor A	19P	-3P	28P	11P	15P	***	050	33
Québec								
Bagotville A	16	-2	29	5	27	***	190	57
Blanc Sablon A	10	*	18	3	12	***	230	41
Inukjuak A	7	-3	16	2	7	***	360	39
Kuujjuaq A	8	-4	18	1	42	***	310	57
Kuujjuarapik A	7	-4	16	1	22	***	350	35
Maniwaki	17	-2	27	5	3	***	220	44
Mont Joli A	17	-1	27	9	14	***	270	61
Montréal Int'l A	19	-2	29	8	5	***	220	46
Natashquan A	13	-2	22	5	10	***	270	44
Québec A	17	-2	27	6	35	***	240	43
Schefferville A	9	-3	23	2	21	***	270	70
Sept-Îles A	14	-2	23	5	19	***	230	50
Sherbrooke A	16	-3	27	3	1	***	200	33
Val-d'Or A	16	-2	27	2	29	***	170	52
New Brunswick								
Fredericton A	19	-1	29	8	9	***	240	46
Miscou Island (aut)	17P	-1P	26P	8P	0P	***		
Moncton A	18	-1	28	8	31	***	240	44
Saint John A	16	-1	26	7	7	***	220	41
Nova Scotia								
Greenwood A	18	-1	29	8	1	***	240	37
Shearwater A	18	0	26	12	2	***		X
Sydney A	18	0	29	8	1	***	270	37
Yarmouth A	15P	-2P	22P	8P	1P	***		X
Prince Edward Island								
Charlottetown A	18	0	27	10	53	***	240	37
East Point (auto)	17	*	23	13	0	***		
Newfoundland								
Cartwright	12	-1	21	4	23	***	330	52
Churchill Falls A	10	-3	25	2	19	***	280	57
Gander Int'l A	16	0	27	7	15	***	220	52
Goose A	13	-2	24	5	21	***	270	48
St John's A	16	0	26	6	0	***	250	63
St Lawrence	14	1	22	8	0	***		X
Wabush Lake A	11	-3	24	3	17	***	300	56

92/07/20-92/07/26

mean = mean weekly temperature, ˚C
max = maximum weekly temperature, ˚C
min = minimum weekly temperature, ˚C
anom = mean temperature anomaly, ˚C

ptot = weekly precipitation total in mm
st = snow thickness on the ground in cm
dir = direction of max wind, deg. from north.
vel = wind speed in km/h

— Annotations —

X = no observation
P = less than 7 days of data
* = missing data when going to printing.

The Soil Moisture Index

Each week during the summer months we include on page 3 a map of soil moisture conditions across the country. The element shown is a moisture index of the soil which is computed by expressing the fraction of the water available to plants in the top metre of the soil compared to the maximum water holding capacity or saturation amount. What follows is an explanation of how this map is prepared, and how readers should interpret the values and patterns shown.

Climatic Water Balance

The amount of water in the soil is not often measured directly. Usually, it is a calculated value from a climatic water balance model. The climatic water balance is a replication of the hydrological cycle, where the fate of precipitation reaching the ground is followed as it percolates through the soil, flows across the land surface, accumulates in ponds, lakes and rivers, or goes into storage in a frozen state, or evaporates/transpires back to the atmosphere (evapotranspiration). Operating a climatic water balance model is a bookkeeping procedure, where the soil serves as a bank or storage facility, and moisture is added/deposited according to rainfall and snowmelt, and withdrawn as evapotranspiration occurs. Just as it is important to know how much money you have in the bank, knowing the soil moisture with some precision can help in estimating plant growth, the risk of forest fires, and the chances of stream or reservoir flooding after a storm or rapid snowmelt. This rather valuable tool was developed by the American climatologist, C. W. Thornthwaite, fifty years ago, and we are making use of a refined version of that work here.

Before the water balance model can be put in operation, it is necessary to estimate the water holding capacity or field capacity of the soil for a location, or meteorological station, where the the input data are obtained. This is dependent on the soil composition, its mineral texture, structure and depth to bedrock. Fortunately, the Department of Agriculture has computed this for Canada's main soil associations. However, it must be appreciated that we have to generalize conditions in order to have a country-wide perspective. As a rule of thumb, within a metre-deep soil profile, sandy textures hold about 100 mm of water, while denser clays can hold up to 280 mm.

The water balance model is initiated at a time when the soil is at field capacity. A suitable time often is during early autumn following a major rainfall. From then on, rainfalls and snowmelts add water to the soil, while evapotranspiration draws it away. When the moisture added exceeds what the soil can hold, the excess is directed down to the ground-water table or to overland flow. As air temperatures decline below the freezing point most precipitation is in a solid form, and is not added to the soil, but is held in storage until melt occurs. During the warm season there may be periods when the evaporative demand depletes the soil moisture to a point where the supply cannot meet the demand. A provision is made to progressively ration the remaining moisture as the tensional bonds within the soil increase. In our case, we assume two layers within the soil. The upper layer can hold 40 per cent of the water holding capacity. It supplies water on demand, while available. The lower layer (60 per cent) only supplies water when the upper layer is depleted, and the amount supplied is usually less than the demand according to a linear drying rate.

In summary, the climatic water balance model makes use of the following data:

— (a) daily precipitation: rainfall enters the soil or runs off; snowfall is held in storage. When temperatures rise above 0°C snowmelt is computed, and the liquid water enters the soil or runs off. As temperatures fall below the freezing point, all soil moisture is put in storage and evaporation ceases.

— (b) weekly average air temperature: together with daylength information and an empirical coefficient, potential evapotranspiration or the full evaporative demand when water is non- limiting, is computed.

The model outputs each week: actual evapotranspiration, run-off, storage, and soil moisture status.

Interpretation of the Soil Moisture Index

When the model is initiated under conditions of saturation, and there are no subsequent breaks in the temperature and precipitation data, the index should give reasonably representative values for the region. Because of local soil and climate variability, applications should not be too site-specific. Special situations may need closer interpretation. For example, an area may receive an extensive forest fire, while the soil moisture index remains high. Such a case occurred this spring in New Brunswick. The surface layer of the forest soil was very dry and fire-prone, while there was good moisture in the regional sub-soil.

Some of the seasonal values shown on the map for the Arctic region may be more speculative. High latitude soils for most of the year are frozen; because the model responds to air temperature, not soil temperature, which can be quite different, this may throw off the accuracy of the calculated values. As well, Arctic soils are less developed in terms of parent material breakdown and integration of organic material with the mineral particles. This affects water retention and transfer through horizons. Finally, it may be difficult to select an appropriate initiation date for the model. The thaw season is short; precipitation is meagre throughout the year, limiting the possible situations for recharge to field capacity. Caution in the use of Arctic values is suggested.

Water budgets have been used over the past few decades in many different sciences. Problems in hydrology and agriculture are the most obvious places where knowledge of the water budget can provide quantitative answers to specific questions such as the monthly or annual streamflow of ungauged streams, the available water supplies for reservoir storage or irrigation, or the probabilities of drought or flooding. But the water budget affects many other aspects of human activity. For example, information on the distribution of soils and vegetation, the effect of a suburban development on local ground-water recharge, and the understanding of seasonal changes in lake and reservoir levels can all be analysed using the water budget approach.

The water budget has been used and, at times misused, in an effort to modify nature to suit our needs. Examination of the water budget shows us the great mobility of water between the earth and atmosphere. Knowledge of this budget in different geographic locations and temporal time scales is necessary if we are to understand both micro-climatic processes and develop a sound physical basis for land use plans.

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