TIMING AND DURATION OF RIVER ICE BREAK-UP

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This note was prepared in response to a need for updated information concerning the timing of break-up on Canadian rivers. All data have been supplied by the Atmospheric Environment Service (AES) of Environment Canada and result primarily from a program instituted in 1956 at weather stations across the country, although long term records, some beginning in the nineteenth centruy, originate from a variety of sources (Allen 1978). Between 1957 and 1977, five reports were published updating freeze-up and break-up dates (Allen 1964, 1977; Allen and Cudbird 1971; Burbidge and Lauder 1957; Canada, Department of Transport 1959). Problems associated with changes in the definitions for different date classifications between these reports have been summarized by Catchpole and Moodie (1974). The last data summary (Allen 1977) contains records to 1974. The data used in this report are from 101 river ice stations with records varying from 10 to 104 years and reporting up to 1984.

Although AES records contain five different categories for describing break-up conditions only the dates for "First deterioration of Ice" (FDI) and "Water Clear of Ice" (WCI) are used herein. Dates for the first classification are "intended to be the earliest date during the final thawing period of the winter season (if more than one occurred), on which there were definite indications that the ice was beginning to melt. This date marks the beginning of the break-up process, which may be manifested by a definite movement of the ice, or the formation of cracks, leads or open water areas in the ice, all the result of weakening of the ice due to melting", and the date for WCI refers to the "earliest date on which the water was reported to be completely free of all floating ice, and remained so until the following freezing-up." (Allen 1977, p. xii). Fig. 1 and 2 show isochrones for these two dates which, even with the larger data base, show remarkable similarity to those presented in Allen (1977). The strong parallelism between break-up isochrones and spring 0°C isotherms has been discussed by Allen (1978).

To further examine the regional patterns associated with break-up, mean dates for each station have been plotted with latitude for five geographic areas: British Columbia; the Prairie Provinces including Alberta, Saskatchewan and Manitoba; Ontario and Quebec; the Yukon and Northwest Territories; and the Atlantic Provinces of Newfoundland, New Brunswick, Nova Scotia, and Prince Edward Island (Figs. 3-6). Table 1 contains the regression equations and coefficients of determination for each region. Although a detailed analysis of the relationships is beyond the intended scope of this note, some apparent trends in the data are noteworthy. Firstly, there are significant differences among the regions in regards to the northerly rate of advance of the two break-up dates. The slowest rates of advance (i.e. 5.4 - 6.1 days/degree) prevail within the coastal regions of British Columbia and the Atlantic Provinces while the most rapid northerly progressions occur in the Prairie Provinces and the Territories (3.5 - 4.1 days/degree).

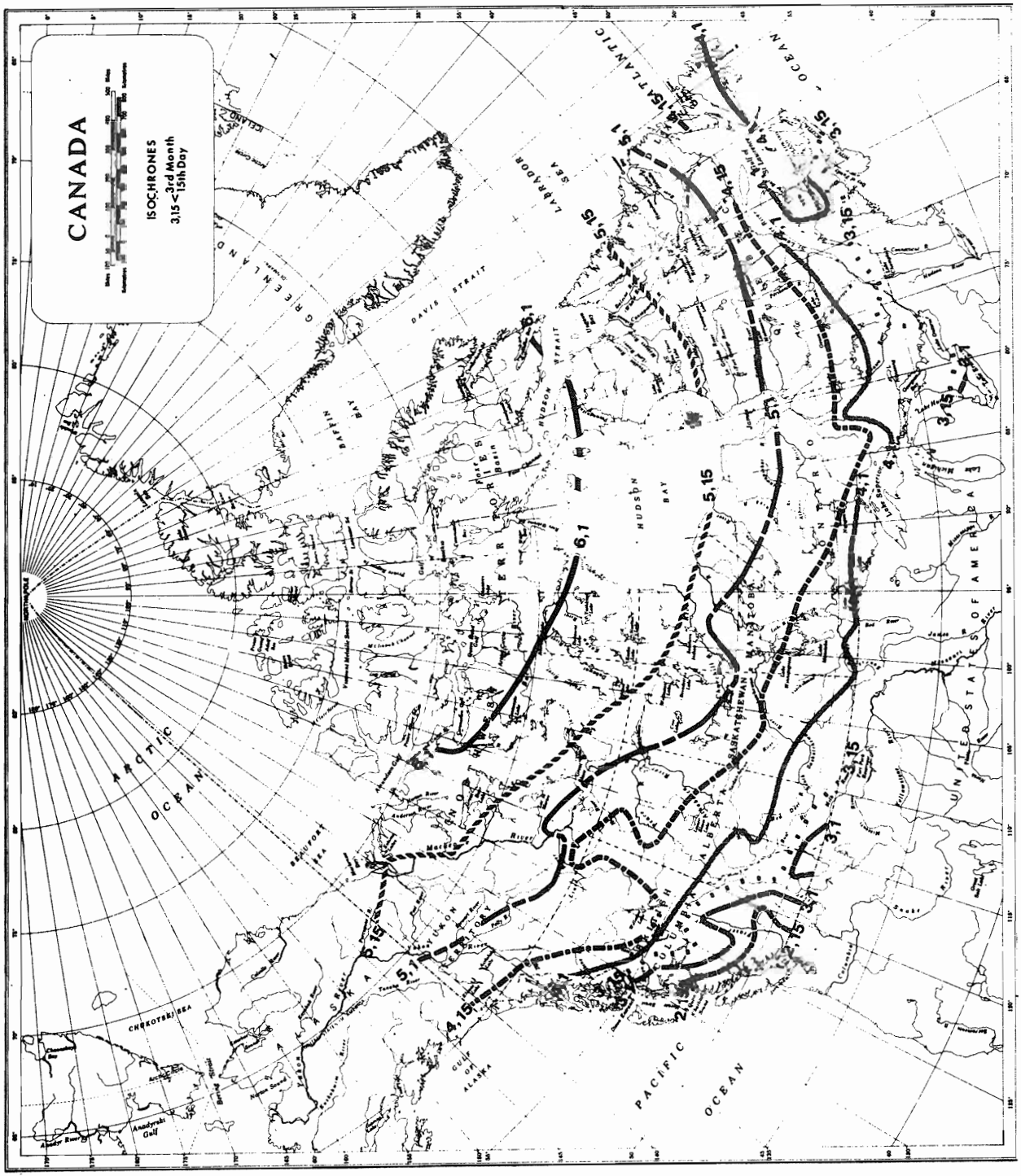

Figure 1: Isochrones of mean dates for the first deterioration of river ice.

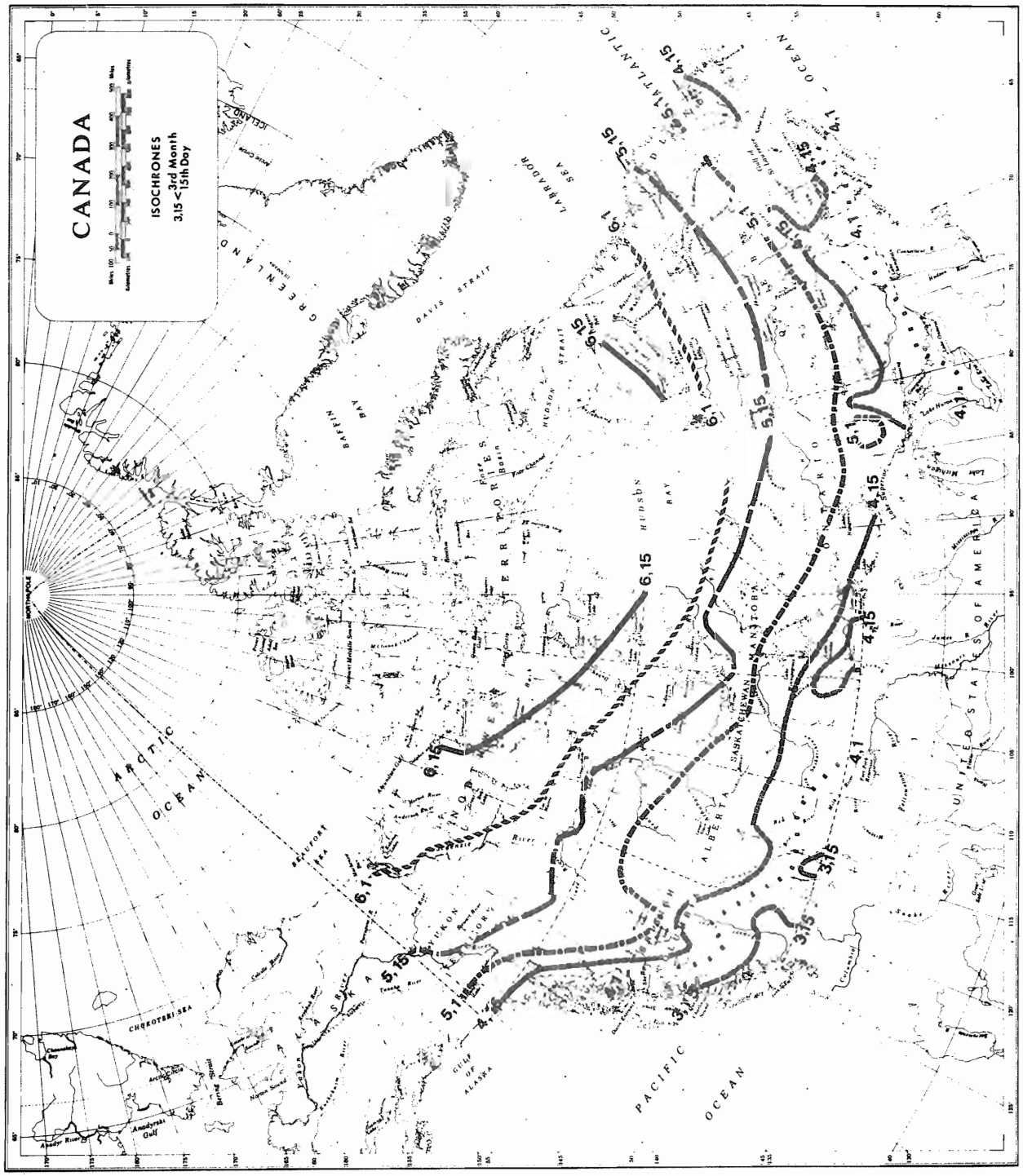

Figure 2: Isochrones of mean dates for water clear of ice in rivers.

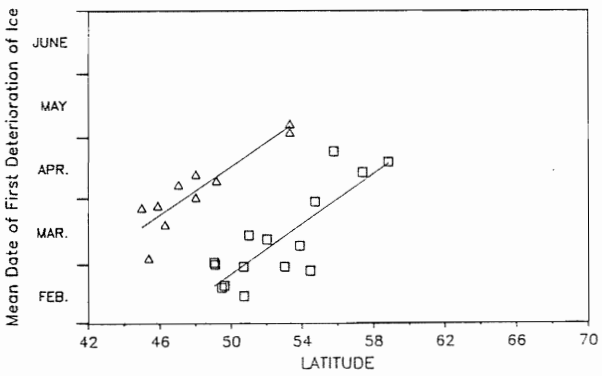

FIGURE 3: Mean dates of first deterioration of river ice versus latitude for stations in British Columbia (□) and the Atlantic Provinces (△).

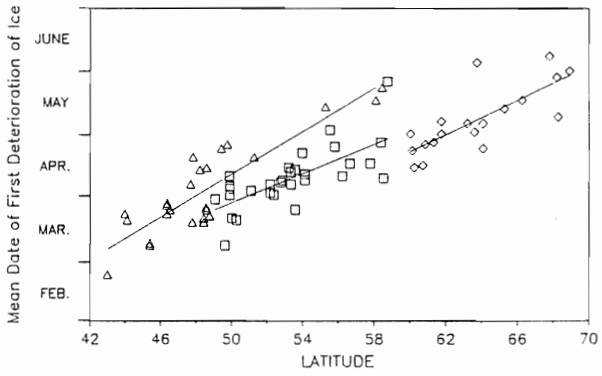

FIGURE 4: Mean dates of first deterioration of river ice versus latitude for stations in the Territories (◇), the Prairie Provinces (□), and Ontario and Quebec (△).

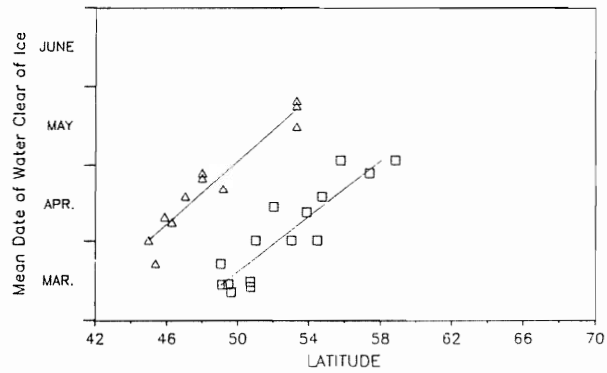

FIGURE 5: Mean dates of rivers clear of ice versus latitude for stations in British Columbia (□) and the Atlantic Provinces (△).

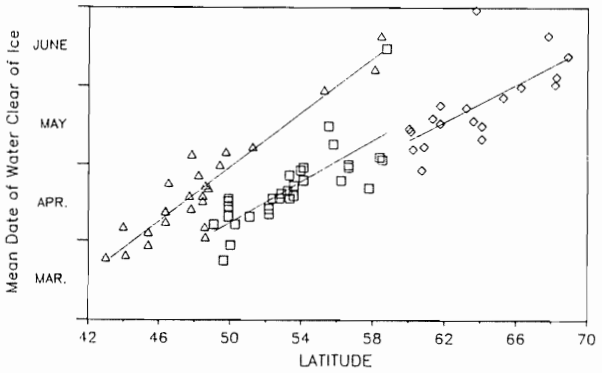

FIGURE 6: Mean dates of rivers clear of ice versus latitude for stations in the Territories (◇), the Prairie Provinces (□), and Ontario and Quebec (△).

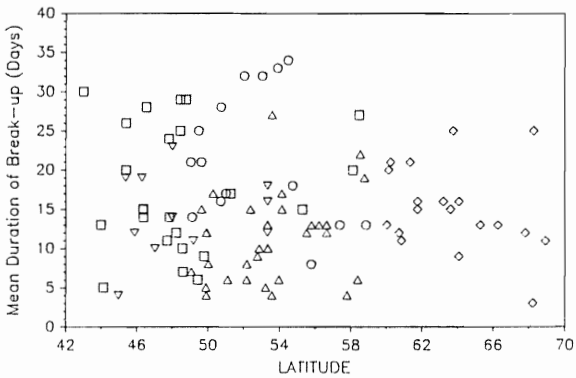

FIGURE 7: Mean duration of river ice break-up versus latitude for stations in British Columbia (○), the Territories (◇), the Prairie Provinces (△), Ontario and Quebec (□), and the Atlantic Provinces (▽).

Second, there are distinct differences among regions in the timing of break-up for comparable latitudes. This is best illustrated by the results from the two coastal regions, the relationships for which bracket those of the other regions. For example, the mean date for FDI at 50°N in British Columbia is February 25 while, at the same latitude in the Maritimes, it is 51 days later on April 17. Similarly, the respective dates for WCI are March 21 and May 2. Because of the controlling effect of climate in the break-up process, further investigation of these regional differences should be performed on a data base separated according to climatic region and not by the political boundaries used in this case.

In view of the physical definitions for FDI and WCI, the dates for each can be considered to bracket the beginning and end of the break-up period. Based on a study of approximately

60 Canadian rivers, Allen (1964) calculated the mean duration of break-up to be 10.0 days. The average time between the mean dates for the two break-up stages in this report is over 50% higher at 15.3 days. Notably, however, there does not appear to be any significant relationship in the duration of break-up with latitude on a regional or national basis (Fig. 7). This suggests that break-up duration, as defined in these terms, is controlled more by physical factors such as the size and steepness of the river, the number of upstream tributaries and length of river contributing ice, and even the frequency of ice jamming which can impede the process of ice clearance.

Latitude (L) versus

Region	Date of First Deterioration of Ice (T_d)			Date of Water Clear of Ice (T_c)		
	r^2	Equation		r^2	Equation	
British Columbia	0.69	T_d =	-243.5 + 6.0L	0.82	T_c =	-189.3 + 5.4L
Yukon and N.W.T.	0.60	=	-131.3 + 4.1L	0.48	=	-85.6 + 3.6L
Prairies	0.52	=	-86.0 + 3.5L	0.61	=	-101.2 + 4.0L
Ontario/Quebec	0.78	=	-152.9 + 5.1L	0.87	=	-142.9 + 5.2L
Atlantic Provinces	0.86	=	-182.3 + 5.8L	0.92	=	-182.5 + 6.1L

Table 1: Regression equations and coefficients of determination (r^2).

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