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SEA ICE CONDITIONS IN COOK INLET, ALASKA DURING THE 1973-74 WINTER

Ruben "SG" Schulz
National Weather Service Forecast Office
Anchorage, Alaska

National Weather Service, Regional Headquarters
Anchorage, Alaska
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ABSTRACT. The winter of 1973-74 was generally considered a mild sea ice season in Cook Inlet. The weather patterns for the season, which are briefly described, were such that three distinct abnormally cold periods were observed, interspersed with three above normal warm periods. This created a situation in the Cook Inlet where the ice did not have a chance to become very hard and pose problems to navigation. In addition, the southern extent of the sea ice was only as far as the southern tip of Kalgin Island, in contrast to the severe winter of 1970-71 when the ice in Cook Inlet extended as far south as Cape Douglas on the western side of the inlet, and to Anchor Point on the eastern side. Ice thickness during the winter ranged between 50 cm and 75 cm, with a few chunks to 3 m. During the winter, no large stamukhi were grounded on Middle Ground Shoals; in previous winters, buildups of up to 12 m have been reported.

1. WEATHER PATTERNS, WINTER 1973-74

During the first week of October 1973, a series of lows moved from Kamchatka Peninsula northeastward across the Bering Sea and over the northern third of the Alaska mainland. By mid-October, storm tracks shifted southward to across the Aleutians and into the northern Gulf of Alaska. During this same period, high pressure built over western Alaska, bringing the first below normal temperatures of the season to the Cook Inlet area (see Figure 1 for a map of Cook Inlet). This was followed by general low pressure and moderating temperatures over the Alaska mainland. By the end of the month, high pressure became firmly established over northwestern Alaska, with a high pressure ridge extending from Bristol Bay northeastward to the Mackenzie River Delta, while weak low pressure was found over the Gulf of Alaska. This weather pattern persisted into the first week of December.

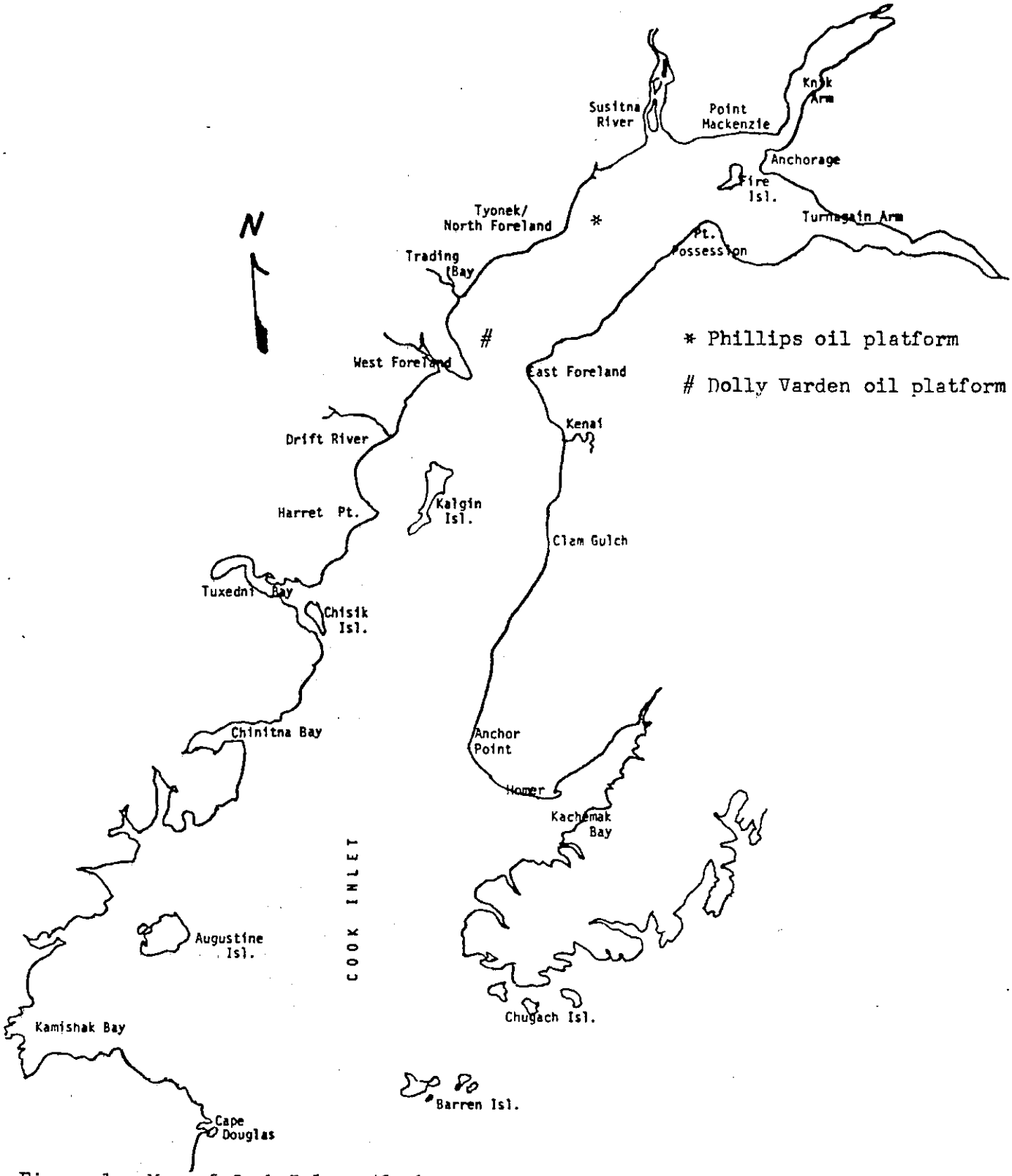

Figure 1. Map of Cook Inlet, Alaska

Low pressure became established over interior Alaska by the end of December with lows moving eastward along the Aleutians and into the Gulf of Alaska. During this time, two intense storms moved northeastward into the Chukchi Sea bringing a strong southerly flow of warm air to all of western Alaska.

After the first week in January 1974, high pressure began building over the Chukchi Sea with ridging southeastward into southern Yukon Territory. A weak low remained over the northern Gulf of Alaska.

During the first half of February 1974, high pressure over the interior sections weakened and storms tracked into the southeastern Bering Sea and the North Gulf Coast of Alaska. One very intense storm moved northeastward to the vicinity of St. Paul Island on the 5th of February, generating a strong southerly flow of warm air over southwestern Alaska. By mid-February, a strong high became established over eastern Siberia, with ridging southward to the eastern Aleutians, and eastward to the central Northwest Territories.

From mid-February to mid-March, the weather patterns changed little. High pressure continued over the interior of Alaska, while lows periodically intensified in the northern Gulf of Alaska.

By mid-March 1974, high pressure over interior Alaska began weakening as a series of lows south of the western Aleutians moved northeastward into the eastern Bering Sea. At the same time, high pressure became established over the eastern Gulf of Alaska and the Yukon Territory. This weather pattern generally ended the cold period for the season over Cook Inlet. Temperatures jumped to well above normal over Cook Inlet by mid-March and remained there as lows moved eastward along the Aleutians and into the eastern Bering Sea.

2. AIR TEMPERATURES OVER COOK INLET

Three significant and distinct cold periods occurred during the winter. Looking at the Anchorage mean daily temperatures (Fig. 2), the first significant cold spell began 01 November 1973. Temperatures were generally well below normal through the 5th of December, and again 12 January through 01 February 1974. The third cold period began 12 February and ended 15 March. In each case the cold spells were coincident with a high pressure buildup over the interior sections of Alaska, and general weak low pressure over the northern Gulf of Alaska.

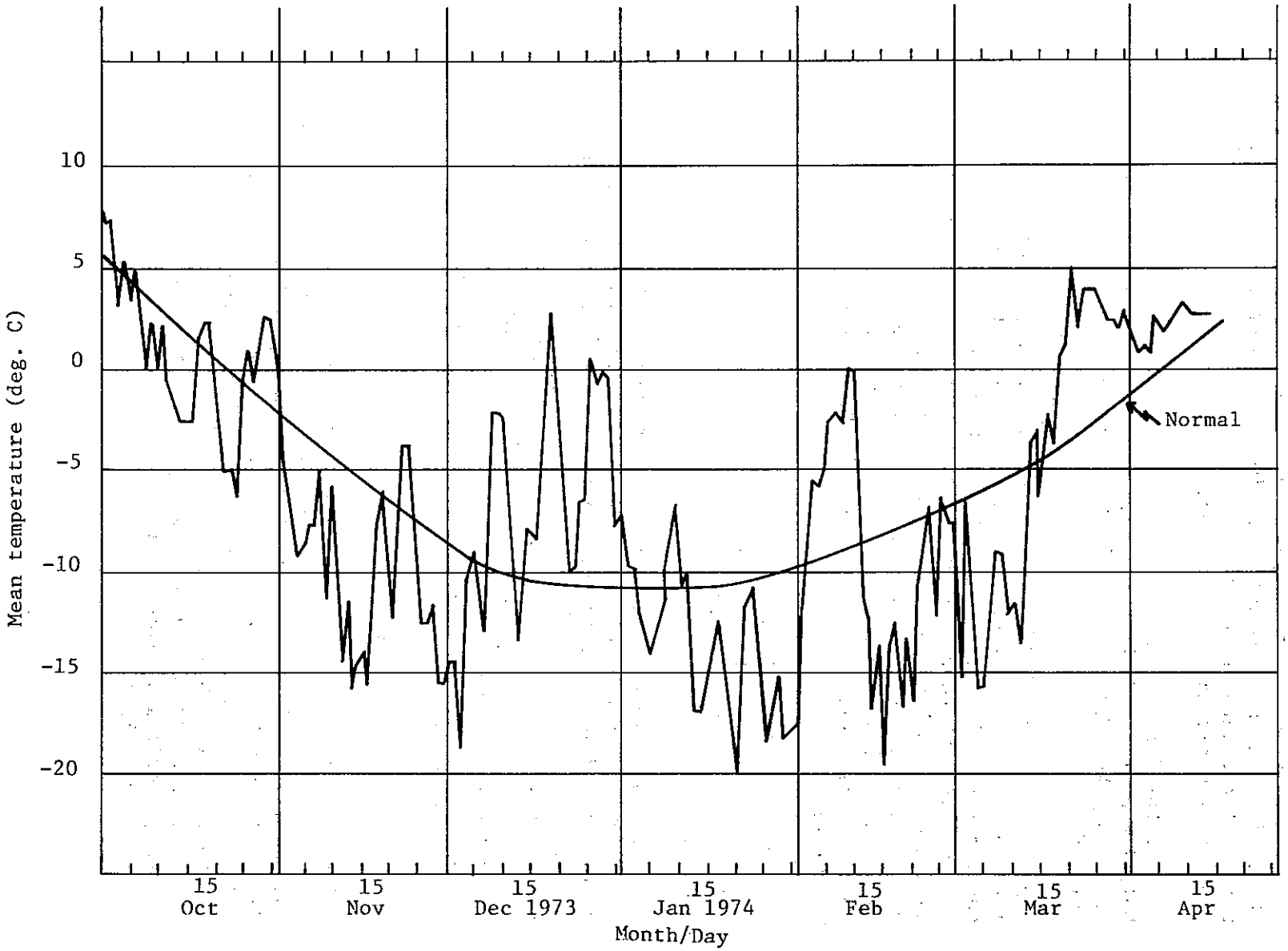

Figure 2. Mean daily temperatures at Anchorage, Alaska, winter 1973-74

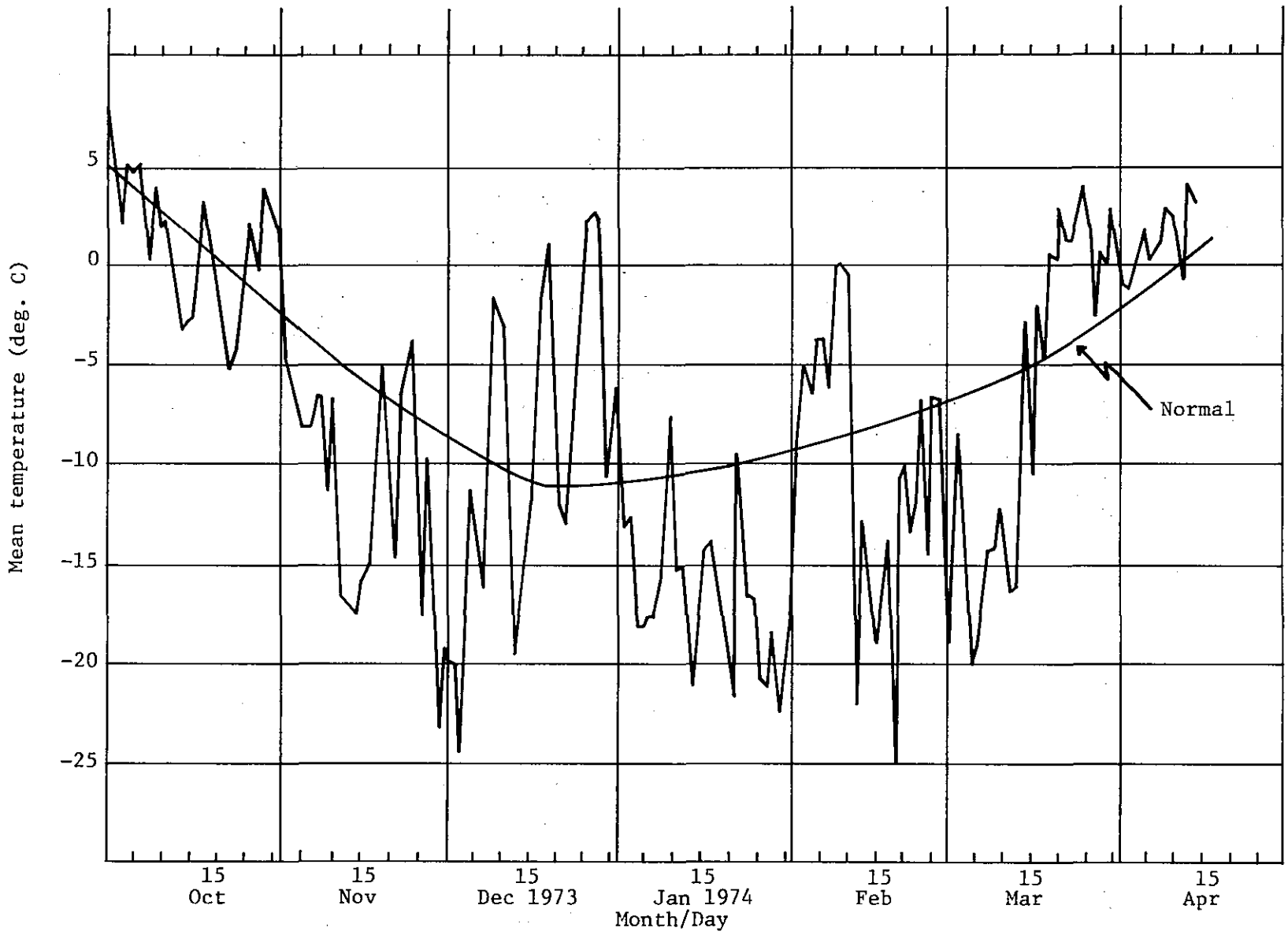

Figure 3. Mean daily temperatures at Kenai, Alaska, winter 1973-74

Conversely, there were three abnormally warm periods during the winter. Mean daily temperatures were much above normal from 07 December 1973 to 02 January 1974, and 02 February to 11 February. The third warm period began in mid-March 1974. Mean daily temperatures rose dramatically to above normal and remained above a mean of 0 C for the rest of the winter.

The mean daily temperatures at Kenai, Alaska (Figure 3) followed approximately the same pattern as at Anchorage, except that the second cold period was slightly longer.

Table 1 shows the departure from normal monthly temperatures was quite significant. Anchorage ranged from a -3.7 C departure in November to a +3.3 C departure in December followed by a -2.5 C departure in January 1974. This same pattern is reflected by the Kenai data as well, as shown in Table 2. For both Anchorage and Kenai, the departure from normal mean monthly temperatures for March is somewhat misleading. The first half of March had well below normal temperatures, while the second half had temperatures that were significantly above normal.

3. FROST DEGREE-DAYS

Accumulated frost degree-days are used in determining Cook Inlet ice thickness and rate of growth. Using mean daily temperatures, frost degree-days can be computed for any desired location. One frost degree-day is recorded for each degree that the mean daily temperature is below a base of 0 C. For example, if the mean daily temperature is -10 C, then 10 frost degree-days would have been accumulated for that particular day. Negative frost degree-days decrease the total accumulated. Negative values are multiplied by 3.33 and subtracted from the total. This factor is used since the rate of sea ice decay is approximately three and one-third times more rapid than the growth.

Several cumulative frost degree-day curves for Anchorage are presented in Figure 4. Curve (a) shows the accumulation during the winter 1973-74, curve (b) represents the average for the past ten years, and curve (c) is a 42-year average. The winter of 1973-74 was considerably colder than the 42-year average, but was somewhat similar to the average for the last ten years. It is interesting to note that the average for the last ten years shows a distinct cooling trend has been taking place.

Table 1.--Mean temperatures (deg. C) at Anchorage, Alaska, by month, 1973-74

Month	Observed	Normal	Departure from normal
Oct 1973	0.2	1.6	-1.4
Nov 1973	-9.8	-6.1	-3.7
Dec 1973	-7.3	-10.6	+3.3
Jan 1974	-13.7	-11.2	-2.5
Feb 1974	-9.5	-7.9	-1.6
Mar 1974	-4.6	-4.6	0.0
Apr 1974*	2.2	1.8	+0.4

*first 15 days

Table 2.--Mean temperatures (deg. C) at Kenai, Alaska, by month, 1973-74

Month	Observed	Normal	Departure from normal
Oct 1973	0.7	1.5	-0.8
Nov 1973	-12.1	-5.6	-6.5
Dec 1973	-9.2	-10.0	0.8
Jan 1974	-16.7	-10.2	-6.5
Feb 1974	-10.9	-8.3	-2.6
Mar 1974	-6.9	-5.2	-1.7
Apr 1974*	1.1	-1.1	2.2

*first 15 days

Table 3.--Cumulative frost degree-days (base 0 deg. C) at Anchorage, Alaska, for the winter 1973-74

Period ending	Nov 30	Dec 31	Jan 31	Feb 28	Mar 18	Mar 31
Monthly total	300	212	419	298	176	-108
Cumulative total	300	512	931	1229	1405	1297

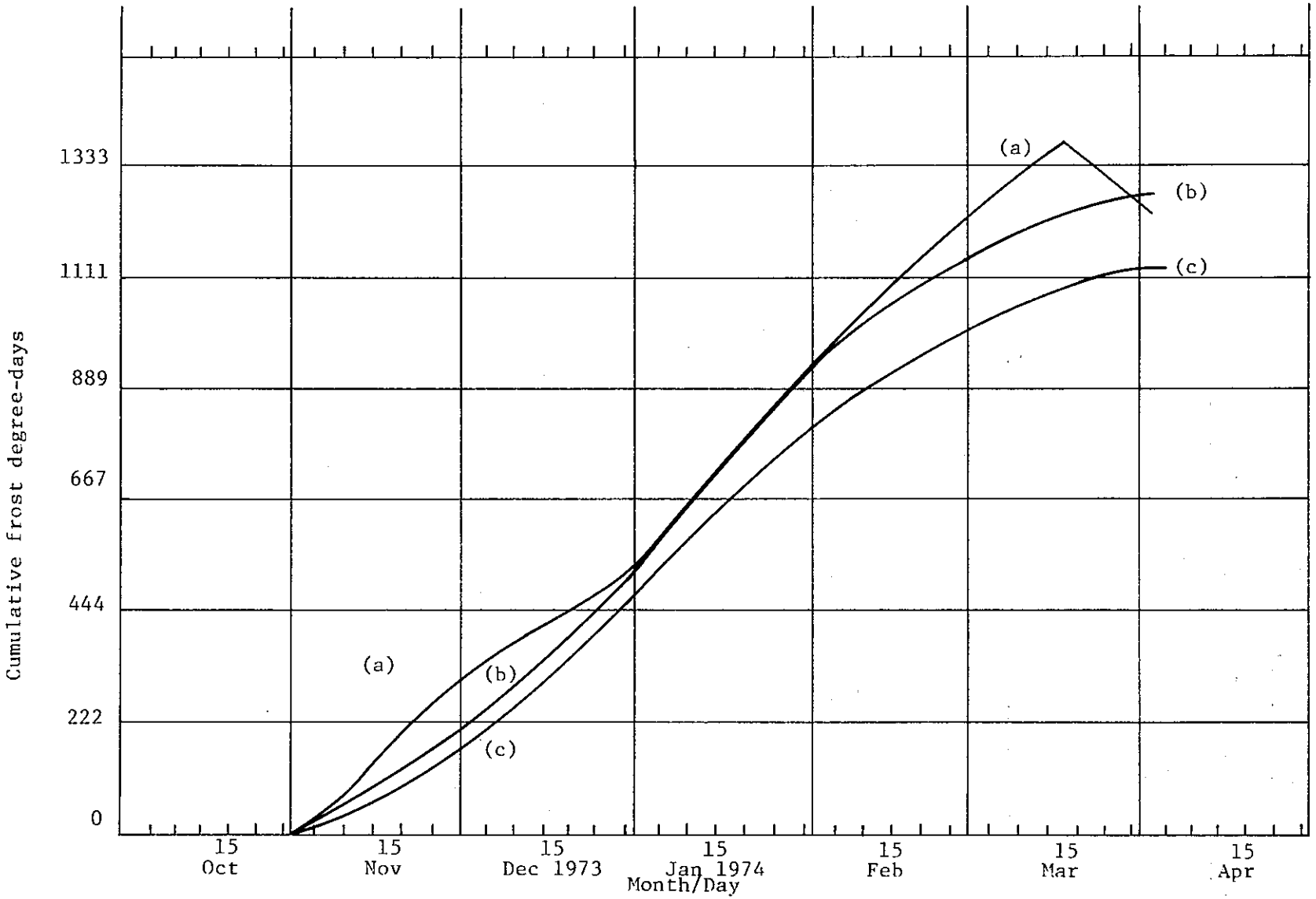

Figure 4. Cumulative frost degree-days (base 0 deg. C) for Anchorage, Alaska (a) 1973-74 (b) 10-yr. average, 1965-74 (c) 42-yr. average, 1923-68 (1925-27 and 1928-29 missing)

4. SEA WATER TEMPERATURES

Cook Inlet sea water temperatures are available only for the upper portion. The primary sources are the oil platforms Dolly Varden and Phillips, and the Port of Anchorage (see Figure 1). Sea water intake temperatures are measured at the platforms; bucket temperatures are taken at the Port of Anchorage.

The sea temperature in the inlet generally ranges from a minimum of -2.2 C to a maximum of 11.1 C. Figure 5 shows the general winter sea water temperature profiles as reported by the platforms during the winter 1973-74. Temperatures reported by Phillips platform, curve (b), are obviously too low because water would not remain in the liquid state at the temperature reported; however the relative trend is considered important.

5. ICE CONDITIONS

Sea ice in Cook Inlet during the winter 1973-74 created no significant problem to shipping. Throughout the winter, the ice was generally reported as being soft. This was probably due to the alternate warm and cold spells experienced, with no prolonged cold period.

The first ice reported in the inlet was by Phillips oil platform, on 18 November. This consisted of strips and patches of young ice and small floes (see ice glossary in Appendix) which probably formed in the extreme northern inlet. The Dolly Varden platform reported their first drifting ice sighted on 23 November 1973. At Port Nikiski, which is located just north of Kenai, Alaska, the first ice of the season appeared on 19 December 1973.

A 50 percent concentration of new ice was reported at Phillips platform on 29 November. Ice concentration increased rapidly to 80 percent in the northern inlet by 04 December and continued to range between 80-100 percent until early March 1974. At the Dolly Varden platform, 80-100 percent ice concentration persisted from 20 December 1973 through early March 1974. The southern extent of significant ice concentration in the inlet was near the southern tip of Kalgin Island. This was a dramatic change from the winter of 1970-71 when the ice in the inlet extended as far south as Cape Douglas on the western side of the inlet and to Anchor Point on the eastern side.

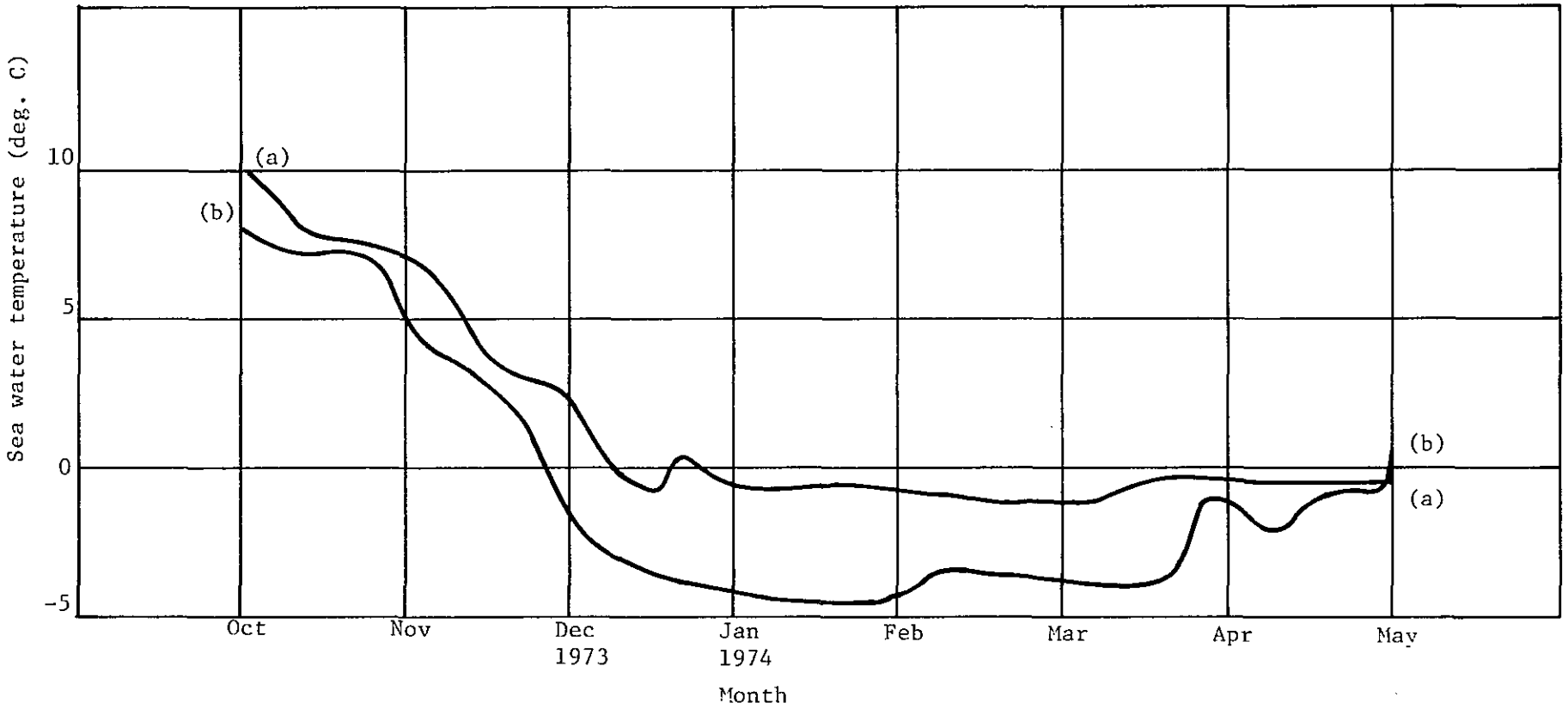

Figure 5. Sea water temperature, Cook Inlet, Alaska, 1973-74 (a) Dolly Varden oil platform (b) Phillips oil platform.

Maximum sea ice thickness in the inlet, as reported by the oil platforms, ranged between 50 cm and 75 cm, with a few chunks to 3 m. These larger chunks of ice probably came out of Turnagain Arm where, on 05 February 1974, strong southeasterly winds almost completely flushed the ice from the Arm temporarily. The ice thickness reported in the inlet compares favorably with the Cook Inlet ice growth chart (Figure 6), using the Anchorage accumulated frost degree-days and assuming a 5-8 cm snow cover on the ice.

No large stamukhi were seen grounded on Middle Ground Shoals throughout the winter. This area is located about 15 mi southwest of Fire Island where in previous years stamukhi 7.7-12.2 m in height have been reported.

At Nikiski dock, ice presented no real problem to the vessels there except, on occasion, during the last two hours of flood tide. Also, the rig tender Alaska Husky had no difficulty navigating through the Cook Inlet ice.

Ice disintegration and melt occurred rapidly after mid-March 1974. This coincided with the dramatic rise of mean daily temperatures (see Figure 2) in the inlet and agrees well with the rule of thumb that ice in the inlet normally will be completely gone approximately 21 days after the Anchorage mean daily temperature rises to 0 deg. C or above and remains there.

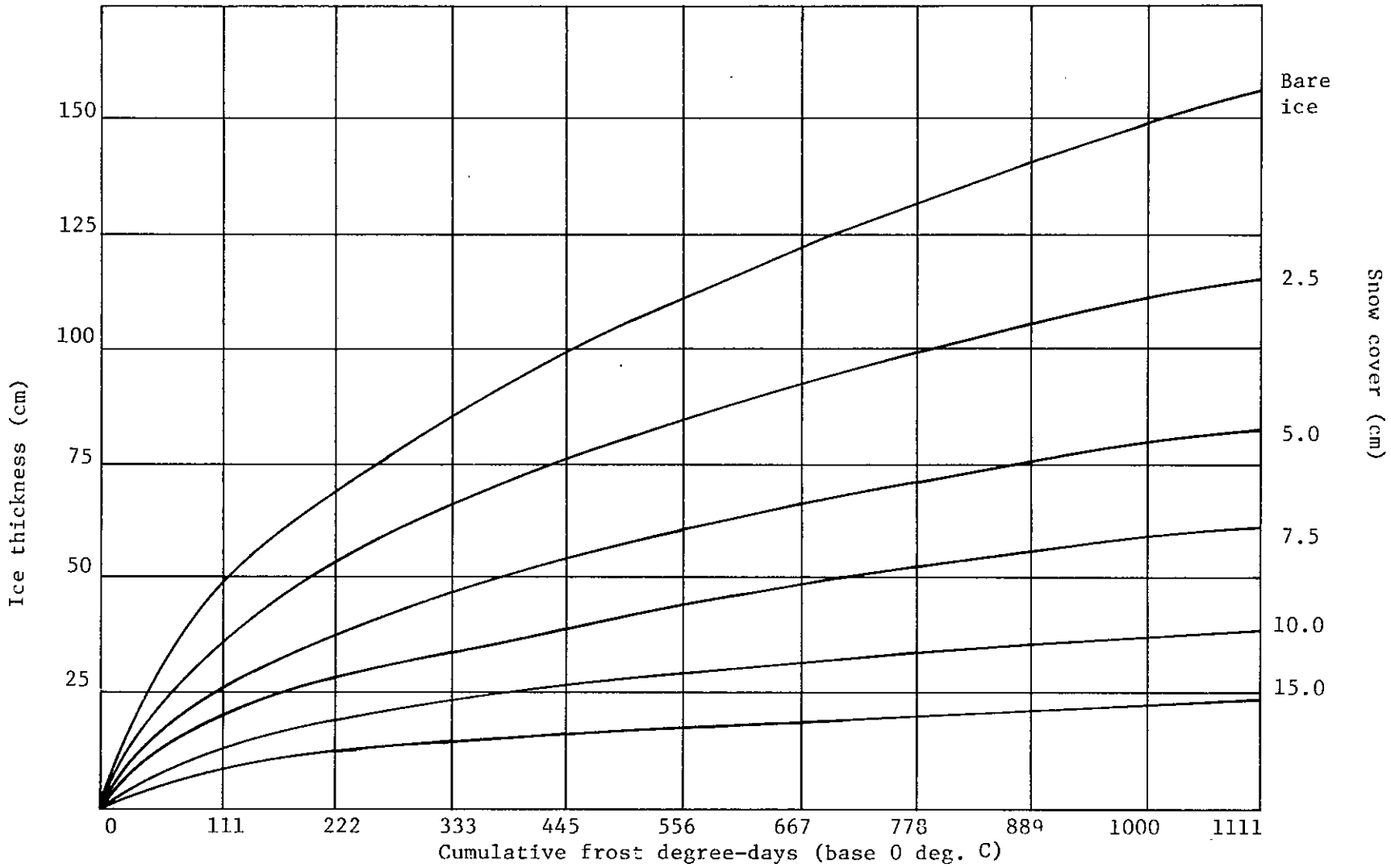

Figure 6a. Ice growth chart for Cook Inlet, Alaska

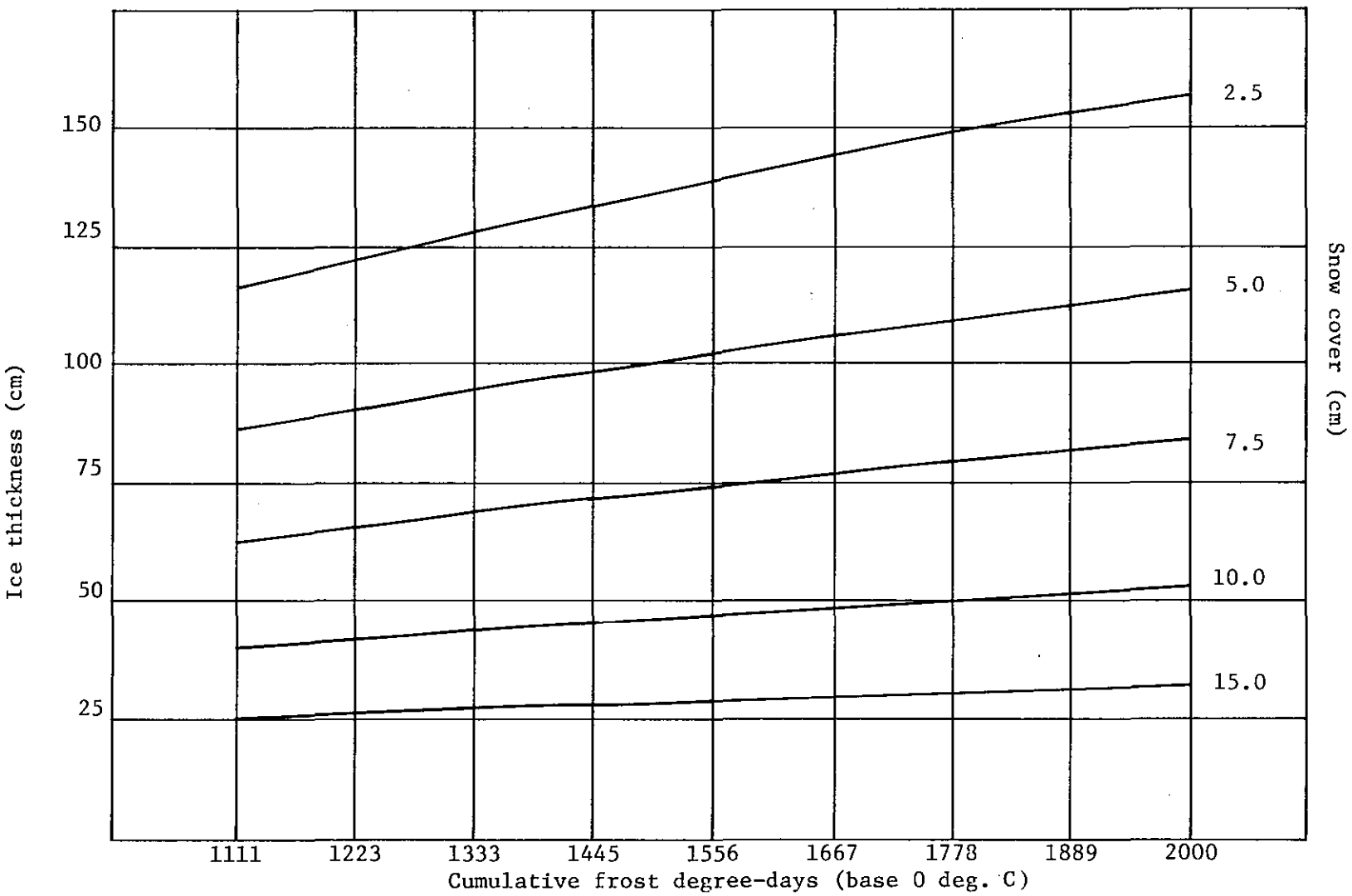

Figure 6b. Same as 6a, continued.

APPENDIX. ICE GLOSSARY

Term	Usual age	Usual thickness
New ice	Hours to days	Less than 10 cm
Young ice	Days to weeks	10-30 cm
Thin (first year) ice	Weeks to months	30-60 cm
Medium (first year) ice	Months	60-120 cm
Thick (first year) ice	Months	Greater than 120 cm
Multi-year ice	More than one year	3 m or more

Categorical term	Coverage (in tenths)
Ice free	0
Very open pack ice	1-3
Open pack ice	4-6
Close pack ice	7-9
Very close pack ice	10

Term	Size (diameter)
Brash (disintegration of other ice)	Less than 1.5 m
Cakes	1.5-20 m
Small floe	20-90 m
Medium floe	90-450 m
Big floe	450 m - 1.5 km
Vast floe	1.5-10 km
Giant floe	Greater than 10 km

Other terms used

Fast ice: attached to the shore, beached, stranded in shoal water, or attached to the bottom of shoal areas.

Slush: an accumulation of ice crystals which may or may not be slightly frozen together; sometimes found as a viscous, floating mass in water after heavy snowfall.

Stamukha: (plural: stamukhi) a single fragment of ice stranded on a shoal.