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SEA ICE CONDITIONS IN COOK INLET, ALASKA DURING THE 1974-75 WINTER

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ABSTRACT. The ice season in Cook Inlet during the winter 1974-75 was fairly normal. Ice formed close to the average and median dates. The southern extent of the sea ice reached as far as Chinitna and Anchor Point which is about normal for the average Cook Inlet winter. Satellite pictures showed ice to be present in Kamishak Bay which in previous years had gone undetected. Between mid-January and mid-February, a few ice floes up to 150 m long were being reported in the upper Cook Inlet and the ice was very hard at times. Ice thickness in the inlet was variable during the winter and generally ranged between 30 cm and 90 cm. A few chunks of beach ice up to 4 m thick were reported afloat in the northern inlet by the oil platforms Phillips and Dolly Varden. The ice was completely gone by the 15th of April.

DESCRIPTION OF ICE CONDITIONS

A map of Cook Inlet is shown in figure 1. Periodic ice reconnaissance was made over the inlet during the winter of 1974-75. The observations were made primarily by two U. S. Navy ice observers detailed to Elmendorf Air Force Base in Anchorage, Alaska. However, marine forecasters from the National Weather Service Forecast Office in Anchorage occasionally took part in the ice reconnaissance. This provided first-hand information for those responsible for ice forecasts. Transportation for all ice reconnaissance over Cook Inlet was supplied by the 5040th Helicopter Squadron at Elmendorf Air Force Base.

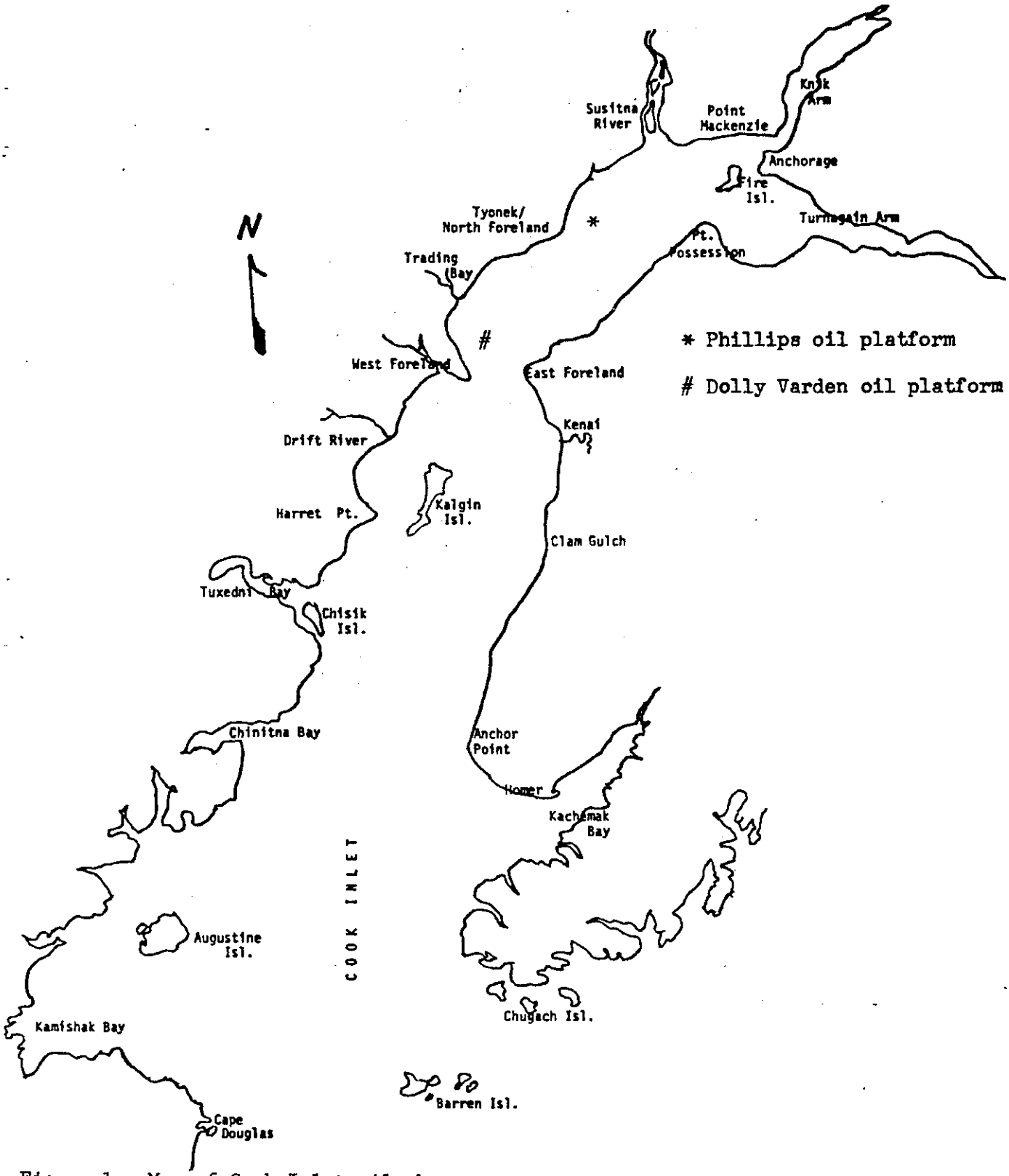

Figure 1. Map of Cook Inlet, Alaska

In addition, excellent pictures were obtained on a routine basis from the NOAA-4 satellite which had both visual and infrared capabilities. Sectional enlargements were very helpful in determining the extent of the Cook Inlet ice. This turned out to be such a useful tool that the need for visual reconnaissance was greatly reduced. As a matter of fact, visual reconnaissance frequently did not extend to the most southern portion of the inlet. With the satellite pictures, however, complete coverage of the inlet was frequently available. As a consequence, we discovered that shore-fast ice in western Kamishak Bay was more predominant than had been previously thought possible. At times with a strong northwesterly flow, this ice is flushed out of Kamishak Bay and into Shelikof Strait which creates some hazard to navigation.

Daily ice reports were also received from the Phillips and Dolly Varden oil platforms throughout the winter. The reports from these platforms are the primary source of ice information in the northern inlet. Sea water temperatures are also received from these platforms, as well as ice hardness conditions.

Mean monthly temperatures remained above or near normal at Anchorage through January 1975, and through December 1974 at Kenai and Homer, Alaska, as indicated in tables 1 to 3. For the remainder of the winter months through April 1975, mean monthly temperatures were below or near normal at all three locations. The first two weeks in January and the first half of February, 1975, were the only significant cold periods during the winter at Anchorage and Homer. Kenai experienced a similar pattern in January but recorded well-below normal temperatures for most of February. Mean daily temperatures are shown in figures 2 to 4 for the three stations.

Cumulative frost degree-days were computed for Anchorage, Kenai, and Homer. These data are presented in table 4. Frost degree-days are defined as the difference between the mean daily temperature and 0 deg. C, when the mean daily temperature is below freezing. For example, if the mean temperature is -10 deg. C, then 10 frost degree-days would be accumulated for the day. Negative frost degree-days are the difference between 0 deg. C and a mean daily temperature above freezing. Frost degree-days are cumulative, with the total for each day being added to the accumulated total for all previous days in the season. However, negative frost degree-days are multiplied by 3.33 and subtracted from the total. This 3.33 factor is used since the rate of decay of sea ice is approximately three and one-third times more rapid than the growth. It has been found from previous experience

Table 1.--Mean monthly temperatures (deg. C) at Anchorage, Alaska, 1974-75

Month	Observed	Normal	Departure from normal
Oct 1974	1.7	1.6	+0.1
Nov 1974	-5.0	-6.1	+1.1
Dec 1974	-6.7	-10.6	+3.9
Jan 1975	-11.1	-11.2	+0.1
Feb 1975	-10.3	-7.9	-2.4
Mar 1975	-5.2	-4.6	-0.6
Apr 1975	0.8	1.8	-1.0

Table 2.--Mean monthly temperatures (deg. C) at Kenai, Alaska, 1974-75

Month	Observed	Normal	Departure from normal
Oct 1974	1.3	1.5	-0.2
Nov 1974	-5.3	-5.6	+0.3
Dec 1974	-8.9	-10.0	+1.1
Jan 1975	-15.6	-10.2	-5.4
Feb 1975	-14.6	-8.3	-6.3
Mar 1975	-9.5	-5.2	-4.3
Apr 1975	-2.4	-1.1	-1.3

Table 3.--Mean monthly temperatures (deg. C) at Homer, Alaska, 1974-75

Month	Observed	Normal	Departure from normal
Oct 1974	3.7	3.0	+0.7
Nov 1974	-1.2	-2.1	+0.9
Dec 1974	-4.0	-5.9	+1.9
Jan 1975	-7.7	-5.9	-1.8
Feb 1975	-7.4	-3.9	-3.5
Mar 1975	-3.1	-2.4	-0.7
Apr 1975	0.8	1.7	-0.9

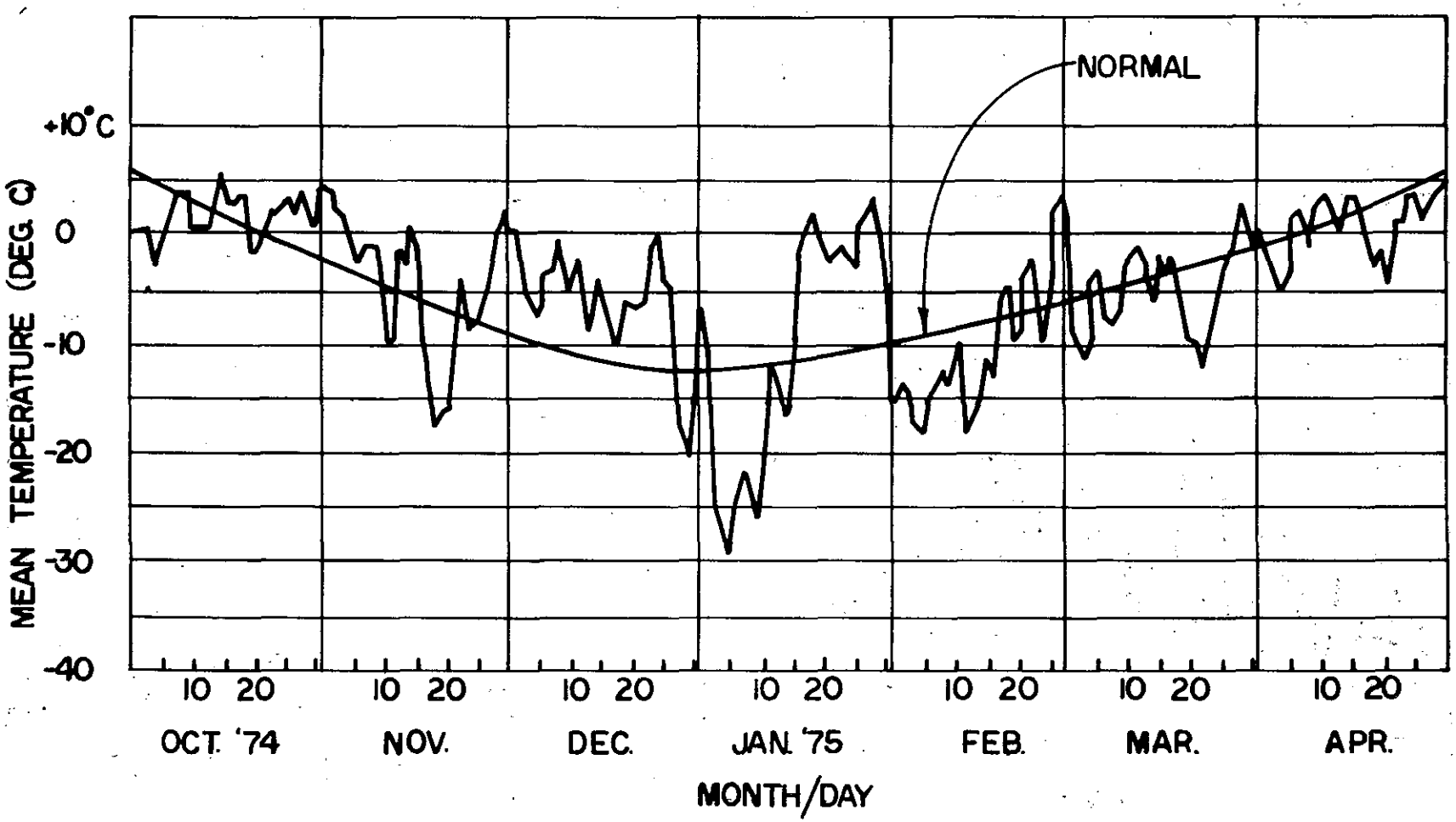

FIGURE 2. MEAN DAILY TEMPERATURES AT ANCHORAGE, ALASKA, WINTER 1974-75

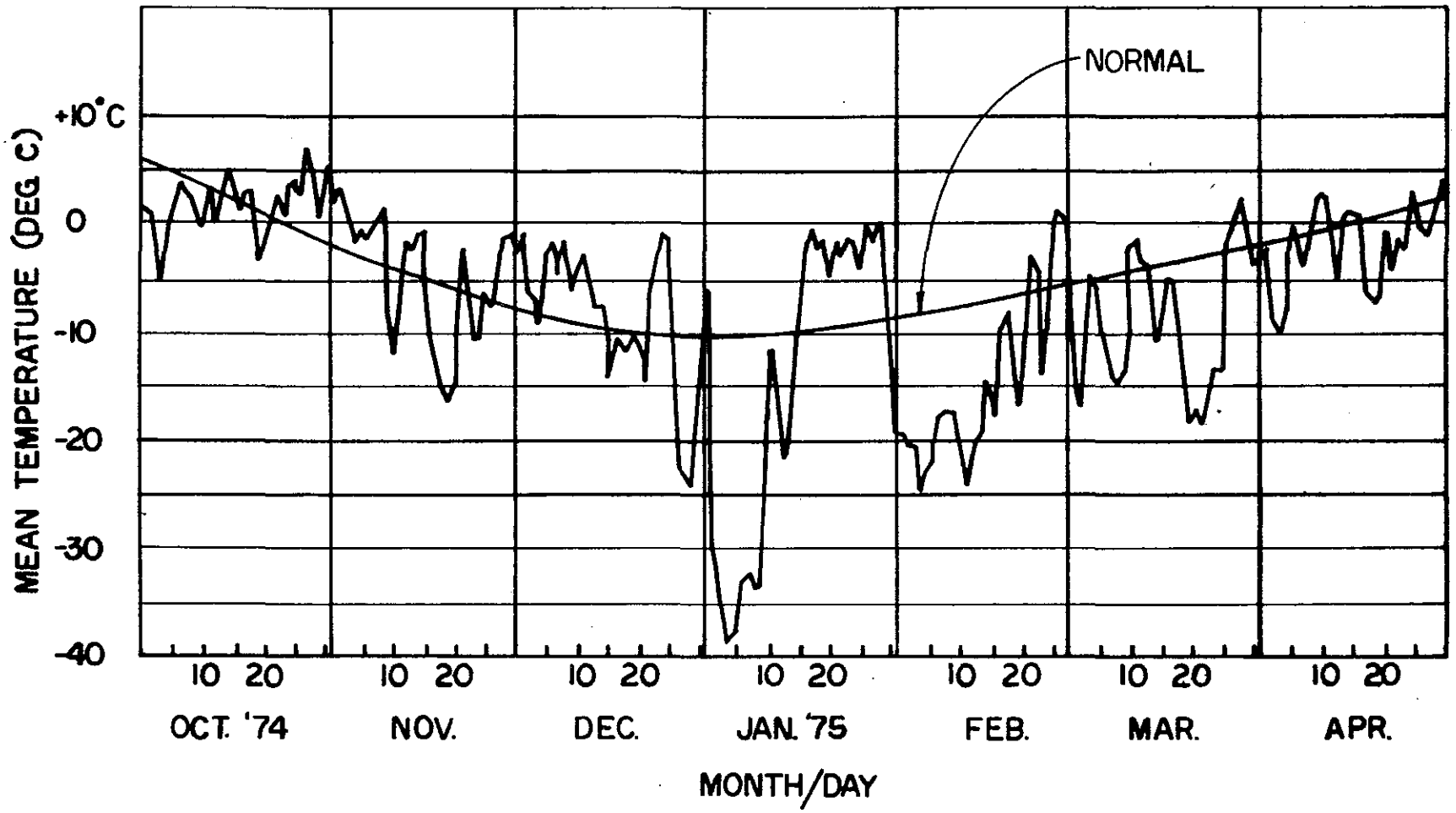

FIGURE 3. MEAN DAILY TEMPERATURES AT KENAI, ALASKA, WINTER 1974-75

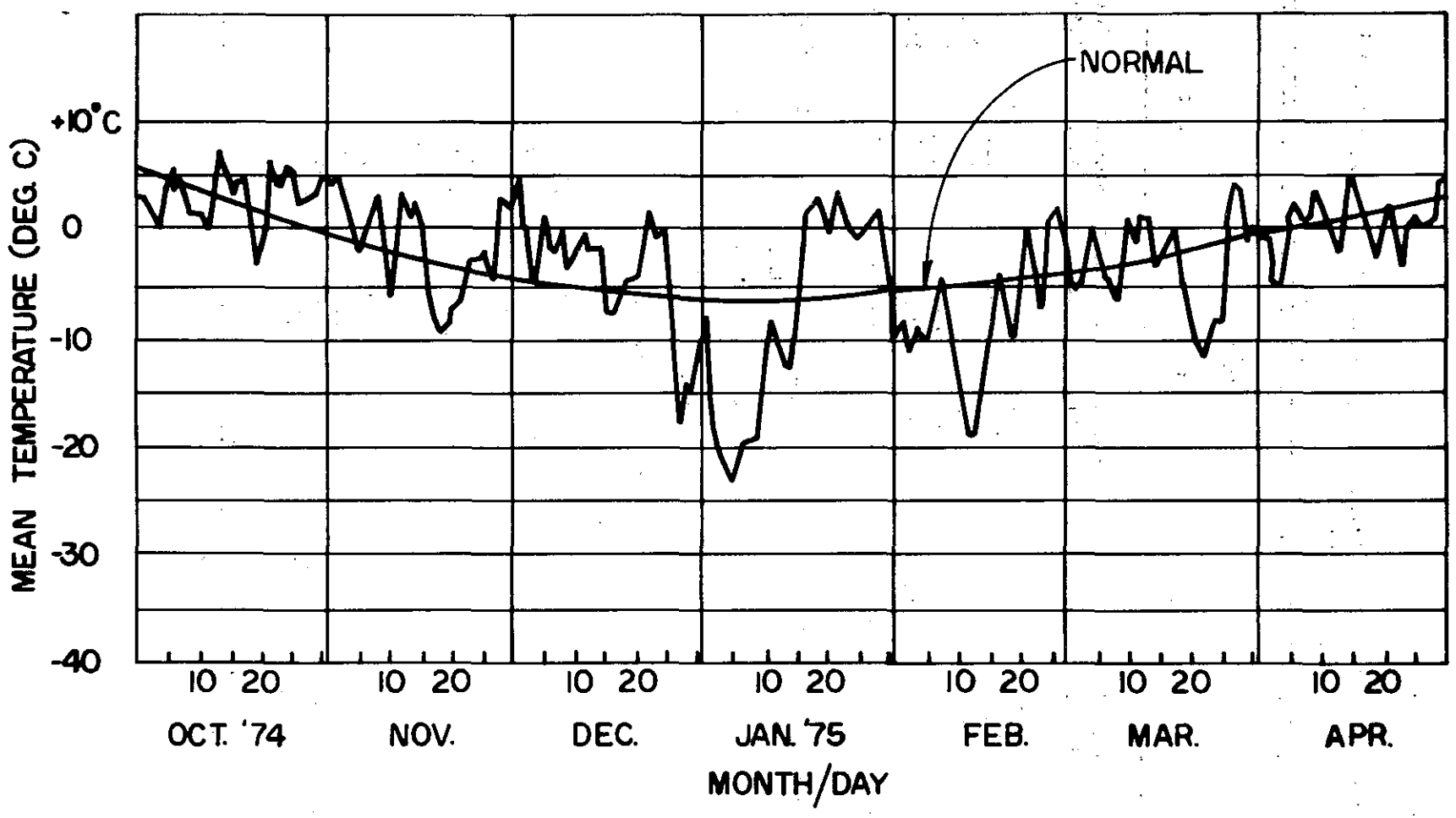

FIGURE 4. MEAN DAILY TEMPERATURES AT HOMER, ALASKA, WINTER 1974-75

Table 4.--Cumulative frost degree-days (base 0 deg. C), by month and city, 1974-75

Month Ending	City					
	Anchorage		Kenai		Homer	
	Monthly Total	Cumulative Total	Monthly Total	Cumulative Total	Monthly Total	Cumulative Total
Nov 30	151	151	156	156	0	0
Dec 31	207	358	276	432	117	117
Jan 31	324	682	485	917	194	311
Feb 28	275	957	405	1322	194	505
Mar 31	154	1111	289	1611	57	562
Apr 30	-143	968	44	1655	-132	430

Table 5.--Cumulative frost degree-days (base 0 deg. C), at Anchorage, Alaska, for each of 11 winters, by month

Winter of	Period Ending				
	Nov 30	Dec 31	Jan 31	Feb 28*	Mar 31
1964-65	174	706	1082	1419	1356
1965-66	188	510	893	1159	1472
1966-67	238	600	1027	1297	1511
1967-68	74	348	682	822	883
1968-69	161	602	1072	1287	1356
1969-70	147	205	599	643	581
1970-71	201	497	1008	1196	1500
1971-72	227	498	938	1236	1514
1972-73	181	528	1014	1306	1450
1973-74	300	512	931	1229	1297
1974-75	151	358	682	957	1111
Average	186	488	903	1141	1276

*February 29 for leap-years

that, normally, Anchorage must accumulate at least 250 frost degree-days before any significant ice forms in the northern inlet. Significant ice is considered to be coverage of 10 percent or more.

It has also been found that close knowledge of the cumulative frost degree-days is useful in determining both ice hardness and ice thickness. During a period of very rapid cooling, for example, brine pockets trapped in the ice are larger than those that occur with a slow, steady rate of cooling. The resulting ice, in the former case, is softer, at first, than in the latter case. Reports have been received from oil platforms, after a long continuous cold spell, of sea ice which has become very hard and literally jars the teeth of those on the platforms during tidal action. At times of extreme ice hardness, a definite hazard to navigation exists.

During the 1974-75 winter, the cumulative frost degree-days for Anchorage, as shown in figure 5, equaled a 42-year average accumulation until the end of November. The 1974-75 accumulation was less than the 42-year average for the remainder of the season. The relative mildness of the winter is also indicated by the tabulated frost degree-day data for the past eleven years, shown in table 5. By March 31, 1975, a total of 1111 frost degree-days were accumulated, 165 less than the eleven year average.

Sea water temperatures dropped to -1.7 deg. C at Phillips platform on 21 November 1974 and to -2.2 deg. C on 07 December 1974. From past experience, it has been found that very little ice forms in the northern inlet until the sea water temperature at Phillips platform drops to -1.1 deg. C; ice growth becomes very rapid after the sea water temperature there drops to -2.2 deg. C.

The first ice reconnaissance of the 1974-75 season was made by the U. S. Navy observers stationed at Elmendorf Air Force Base, on 29 November. They reported an open pack of slush and small cakes (see ice glossary in appendix) from Turnagain Arm to the mouth of the Susitna River and northward to Knik Arm. Considerable fast ice was observed along the coastlines from Kenai northward. The first significant ice in the northern inlet was reported by Phillips oil platform on 24 November 1974 where, on high tide, strips and patches of ice, two to three miles long and one-half mile wide, were observed. The date of this first ice sighting of the season was the latest recorded in the past seven years. The median first sighting date at Phillips is 18 November and the average is 12 November.

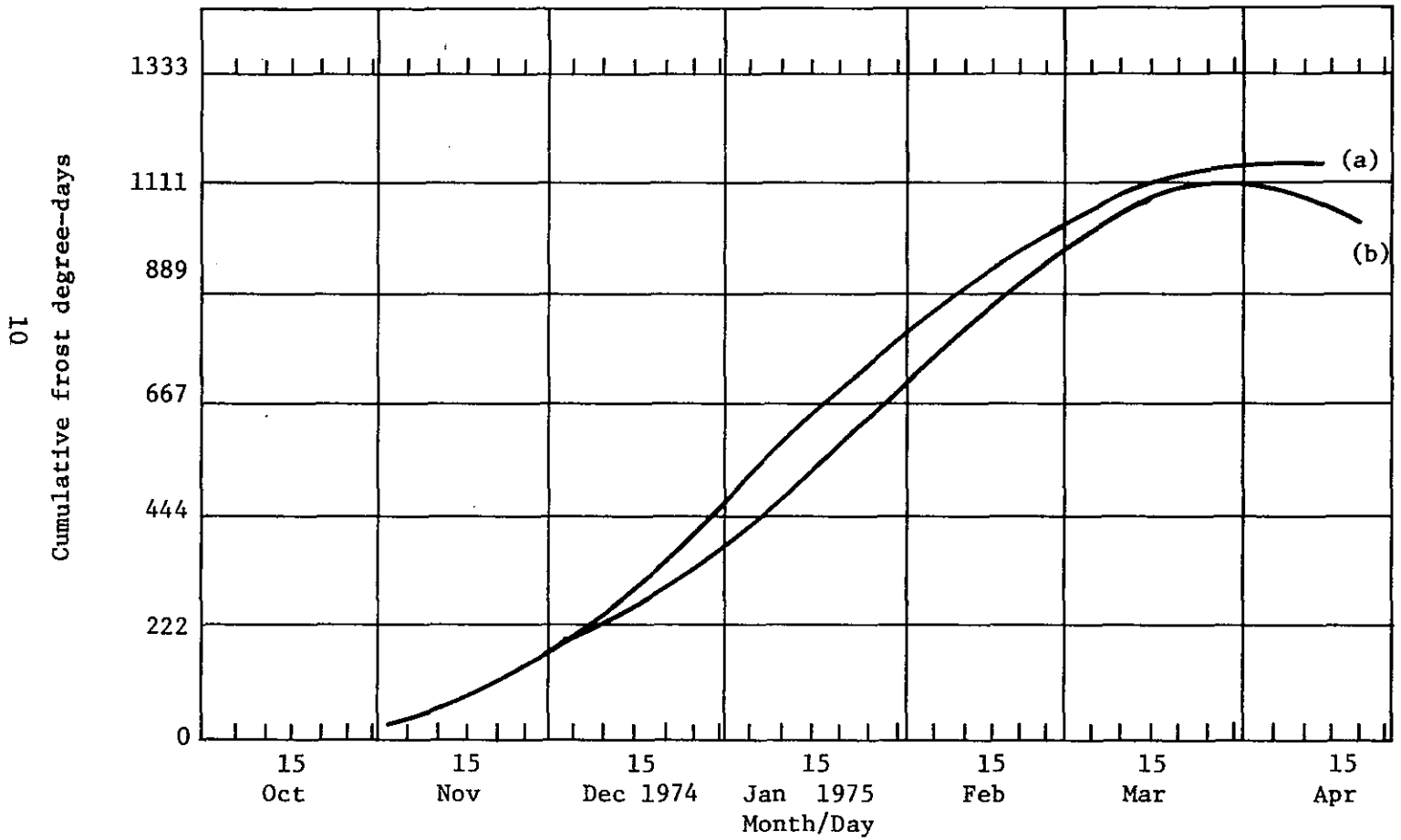

Figure 5. Cumulative frost degree-days (base 0 deg. C) for Anchorage, Alaska (a) 42-yr. average, 1924-68 (1926-27 and 1928-29 missing) (b) 1974-75

The ice concentration at Phillips platform increased from 10 percent on 05 December 1974 to 90 percent on 27 December 1974. During the period 07-18 December, Phillips at times reported no ice visible due to considerable shifting during tidal action.

The first ice of the season at the Dolly Varden platform, located near the West Forelands, was reported on 26 December 1974. This goes along well with the normal three to four week lag between the first sighting of ice at Phillips platform and the first sighting at Dolly Varden. The ice concentration at the Dolly Varden platform increased rapidly to 80 percent by 02 January 1975. The sea water temperature there had dropped to -2.2 deg. C on 21 November 1974.

An ice reconnaissance flight, taken on 03 January 1975, showed a very close pack of young and thin ice north of a line from Point Possession to Tyonek, and close pack southward to the East and West Forelands. Between the Forelands and Kalgin Island, open to close pack young ice had developed. At this time, the ice thickness at the platforms was estimated at 46 cm.

Ice concentration increased rapidly during January; by mid-February the southern extent of the ice was at Chinitna Point and Anchor Point. Chunks of beach ice 1.8 m to 3.6 m thick were occasionally found afloat. Also, by mid-February, some new and young ice was observed in western Kamishak Bay southeastward to Cape Douglas and northward to Chinitna Point. This ice was generally close to shore and the concentration was up to open pack. However, on occasion, brisk northwest winds drove some of this ice out into Shelikof Strait. This is about the only way that ice ever gets out of the inlet. Contrary to popular belief, the author believes the ice in the inlet does not have a flushing cycle. Flood tide currents at the surface are greater than ebb currents which creates a net overshoot to the north and results in retention of ice in the inlet. Satellite pictures show that the last remnants of ice in the inlet during late spring extend in strips and patches from northern Kalgin Island to north of East Forelands, and are located in the exact center of the inlet.

Between mid-January and mid-February, a few floes up to 150 m long were reported in the upper inlet and the ice was very hard at times. On 19 January 1975, a barge was damaged by ice two miles off Cape Kasilof (about 10 miles south of Kenai), which indicates the relative hardness of the ice.

The ice thickness in the inlet was variable throughout the winter; it generally ranged from 30 cm to 90 cm. As usual, chunks of beach ice were found afloat and were reported up to

4 m thick. Most of this beach ice came from the Susitna River mud flats and Turnagain Arm. Turnagain Arm is an especially good breeding place for large chunks of sea ice and strong southeasterly winds frequently force these chunks into the inlet. This, of course, creates a hazard to navigation since these chunks are usually very hard.

By mid-March, the ice in the inlet began to decrease, especially in the northern and southern extremities. Phillips platform reported only 20 percent ice cover by 26 March and was ice free by 09 April. During the past seven years, the median date that the northern inlet became ice free has been 10 April; the average has been 17 April.

At the Dolly Varden platform, 50 percent ice cover was still being reported by 08 April. However, the ice decrease was rapid and by 15 April the ice in the inlet was completely gone.

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.