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## DOCUMENTS BRANCH

# TRANSLATION

Number 77

6 Jun 1947

## ICE CONDITIONS IN THE WATERS BORDERING THE USSR



Prepared By

Documents Branch

CENTRAL INTELLIGENCE GROUP

New War Department Building
21st and Virginia Avenue, N. W.
Washington, D. C.



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Approved For Release 1999/08/25 : CIA-RDP78-03109A000500010009-5

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SUMMARY OF CONTENTS

Ice Conditions in the Waters Bordering the USSR

This publication is comprised of 49 extracts from 25 different Russian and Japanese documents. These translated extracts provide information on ice conditions in the seas bordering the USSR. The information is presented by geographical area, beginning with Sakhalin, proceeding roughly counterclockwise through the Arctic, and then down through the White and Black Seas.

Topics discussed include the formation of the various types of ice, influences affecting such formation, ice movements, the dates of the first and last appearances of ice, and harbor data.

The greater part of this information, which has been drawn from Russian documents or from Japanese translations of the Russian sources, concerns the ice conditions in the North Pacific and in the Arctic Seas. The information obtained from Russian sources falls into two categories: that obtained from ships investigating ice conditions in the Arctic Seas, and that obtained from ice observation stations in the Arctic Seas at important points along the Northern Sea Route.

It should be noted that temperature readings appearing in the text are in Centigrade.

The sources from which this material has been extracted are inserted for convenient reference following the section headings.

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EXTRACT TRANSLATION

# ICE CONDITIONS IN THE WATERS BORDERING USSR

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(Editor's Note: Names appearing in capital letters followed by an asterisk are transliterations from the original.)

# I. ICE CONDITIONS IN THE NORTH PACIFIC

/DB 294954, Oceanography of the Pacific, Pacific Association, 1943/

Grease Ice. Grease ice, by definition, is the term applied to the thin covering of minute ice crystals which cover the surface of the sea when freezing begins. It is seen first in the Bering Sea and the Sea of Okhotsk and then moves south. It may be said that the grease ice west of the Kamchatka peninsula moves south more rapidly than that on the east. In the Vladivostok area, grease ice appears much more rapidly than would be expected for its latitude, and the clustering of the isopectic lines may be a phenomenon worthy of note. Still, this clustering is noticeable only when the lines are drawn very roughly, and actually the formation of grease ice is a somewhat irregular phenomenon. Grease ice has an important connection with the subsequent formation of drift ice and land ice, and therefore with navigation.

Drift Ice. Generally its formation takes place in much the same way as grease ice. Investigations in 1929 and 1930 showed that drift ice appeared within 5 days after grease ice formed in about half of the places where observations were made. This was thought to indicate that a long period of time need not elapse between grease ice and drift ice, and indeed, some experts argue that in the Arctic, one day is sufficient for grease ice to change into drift ice about a foot thick. The author has observed that in the Straits of Tartary grease ice may change into lily-leaf-shaped ice in anywhere from a few minutes to several hours.

The course followed by drifting ice would seem to be controlled by surface currents and winds, but such observations are extremely difficult, and the true answer is not easy to obtain. It has been noted that drift ice off the Maritime Province, south of 45°N and east of 135°E, moves extremely slowly. One explanation offered for this is that it is due to the comparatively high sea temperatures brought about by the Tsushima Current.

Freezing Time. The freeze begins the latter part of September in the vicinity of Anadyr Gulf on the Bering Sea and ends in January near Vladivostok. Komandorskiye Island, Dutch Harbor, and Kiska display only a thin ice even in the most severe winters and mark the southern extremity of ice in the Bering Sea. The mouth of the Kamchatka River freezes the first ten days in November; hence, we can see how a narrow cold current flows near the Kamchatka Peninsula, and in the east, a warm one near the Komandorskiye Islands.

In the sea off the mouth of the PVMTA* river in western Kamchatka there are several places that are slow to freeze and often remain open until the end of December. Near the southern extremity of the peninsula, the west coast freezes about a month earlier than the east, i.e., in November.

As a whole, the sea of Okhotsk freezes earlier than the Bering Sea.

Navigation. Navigation becomes impossible along the north coast of the Bering Sea between the beginning and the end of October and along Kamchatka between the middle of September and the end of October. However, Petropavlovsk can be used, until the first of January. The north coast of the Sea of Okhotsk is closed to ships by the middle of October and the region around the mouth of the Amur River between November and December. It should be borne in mind that although these ice conditions control the dates when navigation is possible, the importance of individual voyages also controls the dates to some degree.

Complete Congelation. Complete congelation refers to ice frozen completely enough to allow communications to be carried out over its surface. Complete congelation occurs in the region of 45°N, and incomplete congelation around Kamchatka. The former is in the area affected by the extremities of the Tsushima Current. The latter is probably due to the Japan Current, or perhaps to the fact that the Kamchatka peninsula projects out to sea and has generally maritime meteorological conditions. At any rate it is not yet clear why Kamchatka does not experience more severe cold and freezing.

Surface Communications. Communications on the surface of the ice begin, in the Bering Sea, about the middle of October.

Thaw. The first sign that the land ice is beginning to thaw is the opening of fissures in the surface of the ice. The thaw, in general, proceeds opposite to the freeze, from south to north. The thaw occurs near Vladivostok the last of February, near Amur Bay the middle of May, in the Sea of Okhotsk and the Bering Sea the middle of June, and in Anadyr Gulf, near the end of July.

Resumption of Navigation. As the thaw progresses, navigation is resumed, usually about 20 days after the ice begins to split up.

Thickness of Ice. Inside Anadyr Gulf is 2 meters thick, but only 1 meter thick at the mouth of the Gulf. The 1.5-meter line runs E/W across the Sea of Okhotsk, and the 1-meter line runs roughly across the center of this sea. It should also be noted that although ice freezes early in the Vladivostok area, it does not reach great thickness.

A. Sakhalin

1. General

[DB 288688: Climate of Japan, OKADA Takematsu, 1931]

According to NODA, former director of the Meteorological Observatory at Otomari, in Results of the Meteorological Observations in Sakhalin for the 20 Years, 1906-1925, 1927, the sea ice is usually formed every winter on all the coasts of Sakhalin except at Maoka and its neighborhood. Even there, there are visitations of floating ice every winter. Generally, the sea is covered with floating ice more or less cemented together so as to form a large sheet of ice. This ice sheet usually has a thickness of 50 to 100 centimeters.

Often it surpasses 5 to 10 meters, and presents great inconvenience to navigation. The harbor at Otomari is closed by the formation of ice generally in the last ten days of December and that at Shikuka in the first ten days of the same month.

2. Ice off North Sakhalin

/DB 288706: Weather of North Sakhalin, Central Meteorological Observatory, 1925/

Alexandrovsk, the only important port in North Sakhalin, is shut for about half the year because of ice, and often even ice breakers prove to be of no value in restoring communications. It requires ten days from the mainland to north Sakhalin by sled and since it is a very difficult journey, attempts are often made to use Pilevo, near the border. However, even Pilevo cannot be said to be a completely ice-free port.

When the freeze begins the temperature is -10° or lower for several days, and the temperature of the water when it freezes is usually -2°. By the last ten days of October the northern coasts begin to freeze, and the ice gradually fills the Straits of Tartary, except for the mouth of the Amur River. In the area of Nikolayevsk the freeze begins the first ten days of November, and near Aleksandrovsk and along the east coast, the last ten days of November. The Amur channel and Straits of Tartary freeze and can be crossed on the ice after the middle ten days of December. This ice is difficult to classify according to type, but when relatively quiet weather prevails, it resembles ice cream, with a light film on top as if cryptomeria leaves were floating on the surface. As it becomes thicker, it becomes smooth, but in the north the gales cause the ice surface to become irregular. Also, once an ice field has been frozen, additional ice and snow may fall causing it to assume irregular shapes. At Alekandrovsk this is called "ice mountains."

The ice fields are not of uniform thickness, but the maximum thickness is 1 meter. At the peak of the season they cover the entire visible area, extending 3,000 meters or more from the shore, and are strong enough to allow men, horses, and even automobiles to cross.

The thickness of the ice, in addition to being influenced by the continuing cold, is added to by the Great Manchurian Tides which break through and cover the ice surface where they mix with the snow and freeze adding to the thickness. Transport over the surface of the ice is easy when the ice is smooth, but it requires great labor to clear a way through the mountainous irregularities which do appear.

Although the surface of the ice field appears firm, the tidal variations may cause it to fracture. Even in extremely cold weather, this, together with the wind, may be enough to break the ice from the shore and start it drifting. This situation has forced people to distinguish between this drifting ice and the "stationary" ice which remains attached to the shore, but actually they do not differ in nature. It is important, however, to recognize the drift ice, because of the danger of using it for transport. The current under the ice is extremely rapid, and since this keeps small channels open long after the rest of the area is frozen, the ice is liable to develop fissures. If one falls into such a fissure, he is almost sure to be carried away by the current.

The ice in the Straits of Tartary does not extend into the open sea and is therefore extremely strong. The straits can be crossed by sled from December of each year until April of the following year. People living in temperate lands cannot even imagine how extremely busy communications between the continent and North Sakhalin become at such a time!

The ice usually breaks up in May and drifts gradually southward. The increasing temperature, of course, contributes to the break up of the ice, the tides and gales are also important.

Information of this sort, concerning the nature of the ice fields, has aided in forecasting the periods of freezing.

Even though, in general, it may be said that by May all regions are free of ice, occasionally ice floes, a constant danger to navigation, are seen east of Sakhalin in June. The Straits of Tartary can hardly be said to be completely safe for navigation, even in June. Ice flowing out of the Amur River goes both north and south. Since the channel is wide and short, it is usually cleared early.

A short table of freezing and thawing dates recorded at Zhonkierskiy Light /Alexandrovsk/ follows:

| Year | Freeze | Thaw |
|---|---|---|
| 1915 | 18 Nov | 29 Mar |
| 1916 | 5 Dec | 17 Apr |
| 1917 | ? | 26 Apr |
| 1918 | 6 Dec | 20 Apr |
| 1919 | 1 Dec | ? |
| 1920 | 2 Dec | 8 Apr |
| 1921 | 22 Nov | 23 Apr |
| 1922 | 29 Nov | 7 Apr |
| 1923 | 29 Nov | 3 May |
| 1924 | 19 Nov | 22 Apr |
| 1925 | ? | 26 Apr |

3. Ice off South Sakhalin

/DB 396061: Sailing Directions for Sakhalin and Kuriles, Hydrographic Office, 1937/

Ice south of Sakhalin consists of ice frozen on the coast line and drift ice which has piled up on the coast. It is usually smooth, but when surface irregularities do occur, the result of snow accumulating and freezing on the drift ice, they are often several meters high.

Drift ice is generally controlled by the direction of the wind.

Drift ice at Maoka is carried in by the northwest and out by the southeast wind.

While at Funatomari it is carried in by the north or northeast and out by the west or northwest wind.

The island has extremely low winter temperatures. Since the water temperature often falls below the freezing point, the entire coast line freezes, and drift ice is always experienced in spring. A 40-or 50-mile region south of Maoka is rarely free of ice, but the region around Cape Soni and Cape Nishinotoru is often almost completely blocked.

The ice, caused by gales and extremes of temperature, forms over the sea where the depth is 3 to 5 meters; at such times ice from the rivers and snow mixes with this ice, causing it to look like whipped cream. Sometimes it assumes a dark grey color. Smooth, transparent ice is rarely seen.

This soft ice develops as the temperature drops, and when the daily mean atmospheric temperature drops 7 or 8° below freezing, the water temperature drops to -1° or lower which causes the ice to become fairly solid. Wind and tide force it into a compact sheet, keeping vessels away from the coast. This generally occurs in Otomari in the last ten days of December, about 20 days earlier in Shikuka, 15 days earlier in Ambetsu, and 20 days later in Maoka.

In Otomari about the last ten days of December, the mean daily atmospheric temperature falls to about -10° and the water temperature reaches -1.5°. The coastal ice thickens to between 0.5 and 1 meter.

Since it is stationary, its surface can be used to transport cargo, but in Maoka, the temperature, even in January, the most severe month, does not reach -10°. In Honto, since it does not reach -9°, there is little ice.

During the middle ten days of March, the warm spring weather begins, and as the daily mean atmospheric temperature reaches -5°, the temperature of the water under the ice rises, and the ice breaks off from the shore and begins to drift. Wind and tide carry it south. Sometimes it reaches the coast near Kitami but usually it melts in the area of 45° or 46° N.

According to Commodore Makaroff's observations, the Sakhalin cold current flows south from Cape Kitashiretoko into Taraika Bay where it is joined by ice from the Poronai and Naibuchi rivers. Proceeding north along the west coast, it affects Shiretoko Peninsula, Aniwa Bay, and Cape Nishinotoro.

4. Sea Ice on the East and West Coasts of Sakhalin

/DB 368798: Study of Sea Ice and the Freezing of Harbors, HAYASHI Takeshio and KURATSUKA Yoshio, 1941/

a. Sea Ice on the East Coast of Sakhalin

There is a marked difference in sea ice conditions on the east and west coasts of Sakhalin. The east coast of Sakhalin comes under the influence of a cold current with the result that its freezing period is about one month longer than the west coasts, and navigation is impossible for over six months in the year. Ice conditions on the east coast are determined by the east Sakhalin cold current which drives the drift ice south and gives rise to the drift ice off northeast Hokkaido. The details of the drift ice period are as follows:

| Location | | Freeze | Thaw | End of Drift Ice |
|---|---|---|---|---|
| Okhta Anchorage, Sakhalin (Urkt Road) | Urkt Bay | Late Oct | Early May | |
| | At sea | Late Dec | Late May | Late Jun |
| Lake Taraika | | Early Dec | Late Mar | Early Jun |
| Naka Shiretoko Peninsula | | Mid Dec | Mid Apr | Late May |

Sea ice is caused by the ice floes on the Horonai and Naibuchi Rivers which flow down to the sea in winter and form a belt of sludge ice along the coast until December. Gradually it changes into hard ice but it is naturally broken up when it comes under the influence of these wind tidal currents. Then it becomes drift ice and begins to move. During this period, the sea ice freezes into solid blocks and the ice floes come into contact with each other, forming large masses. To these is added accumulated snow and the area of ice is gradually increased. The southward flow of the east Sakhalin cold current, the flow of the rivers, the north wind, and Taraika Bay and other topographical features compel the drift ice to flow to the south, only to be obstructed by Tonnai Bay and Cape Airo. It naturally has a tendency to accumulate along the east coast to the north of these two points. If the ice encounters the strong northeast wind, it becomes increasingly compact and forms large ice fields.

With the advent of the spring thaw, the ice is carried away from the coast as sheet ice by the rise in temperature and the wind tidal currents. Although the ice breaks up under the heavy seas, it continues to drift southwards on the east Sakhalin current. The south wind, however, which blows in this region for four to six months, frequently interferes with the flow. The drift ice is carried on the cold current of the Sea of Okhotsk and stretches mainly from Kaihyo Island to Tonnai Bay, Sakaehama, and Cape Airo, and drifts about generally inside the bay, forming a large continuous ice barrier reaching to Cape Naka Shiretoko. The strong west wind, the rise in temperature, and the swell assist in the dispersal of the ice until it clears completely.

From the above and from shipping reports, it appears that there are two main strips of drift ice. One strip appears to stretch along the east coast from Shirutoru to Cape Naka Shiretoko and another from Kaihyo Island southwestward to Cape Airo. As in the southern section of Taraika Bay, the density of the ice in the northern section is low and the ice is forced to the south by the cold current as well as by the river ice from the Horonai River. Skirting Kaihyo Island, the drift ice enters the bay and is said to reach the Kashibo area on the east coast. There are no accumulations of ice as long as the rather strong southeast wind does not blow continuously along the coast in the Kashibo area.

If the westerly wind blows strongly, the ice, assisted by the southward current running along the east coast is forced southeastward. When a southeast wind blows continuously, the ice is always packed into the bay.

As long as there is no variation in the wind direction in the coastal belt stretching for 5 to 10 nautical miles below Shikuka, a southward current flows from the confluence of the river ice of this area and the sea water. This has a tendency to form a lane in the drift ice as far as Cape Naka Shiretoko. It is thought, however, that this lane will close as soon as the wind direction changes. Thus it is presumed that vessels navigating in the northern section of Taraika Bay during the thaw take advantage of the constant west wind. It is obviously the best policy when sailing northwards to make use of this ice-free lane.

The types of drift ice in this area are as follows: Type A: the ice is spread out in a line floating upon the surface of the water. This becomes drift ice at the beginning of the thaw and gradually increases in size after travelling 1 or 2 kilometers. Type B: the ice is level and rather high, surmounted by white snow. Type C: the ise is flat and blue in color. Type D: the ice has accumulated like piled-up marble. Type E: the ice is a combination of the last three types. Type F: the ice is high above the surface of the sea and worn away near the surface of the water. Type G: the ice appears slightly above the water but is mainly submerged. Generally Types B and C are hard and Type D is the hardest. Because Type E is a combination of Types B, C, and D, gaps and cracks normally occur in the ice. During the thaw, Types F and H (deeply submerged ice) appear as individual units of drift ice. There are many gaps in the field where marine animals sport on the drift ice belt. When you come within 100 to 200 meters of the drift ice, the water temperature suddenly drops.

b. Sea Ice on the West Coast of Sakhalin

The climate of the west coast of Sakhalin is mild, compared to that of the east coast as it comes under the influence of Tsushima Current from the Sea of Japan. Even the effect of the drift ice is slight in comparison with the east coast. The west coast is distinctive in that it possesses the one ice-free harbor in Sakhalin, and at present, communications are maintained on every alternate day between Otomari and Wakkanai over the Railway Ministry communications route between these two points. The following is a summary of conditions during the drift ice season on the west coast of Sakhalin.

| Location | Freeze | Thaw | End of Drift Ice |
|---|---|---|---|
| Maoka | Late Dec | Late Mar | |
| Ushiro | Mid Dec | Early Apr | |
| Esutoru | Mid Dec | Early Apr | |
| Ambetsu | Early Dec | Mid Apr | |
| Aleksandrovsk | Early Nov | Late Apr | |

In Maoka Harbor, thin ice, about 20 to 30 centimeters thick, can be seen within the harbor itself and on the level beach area. Although the harbor is occasionally blocked by drift ice passing through from the north, large ships are not prevented from entering and leaving the harbor. The reasons for there being no ice between Maoka Harbor and Honto Harbor, almost 25 nautical miles away, are that the area is affected by certain sea currents to the south of Maoka Harbor and that the presence of waves within the harbor does not permit the water to remain calm. If we compart the east and west coasts, the following differences become apparent:-

| | Southern Section | | Northern Section | | Drift Ice |
|---|---|---|---|---|---|
| Coast | Freeze | Thaw | Freeze | Thaw | |
| East Coast | Early | Late | Late | Early | Plentiful |
| West Coast | Late | Early | Early | Late | Little |

c. Sea Ice in the Soya Straits (La Perouse Straits)

The most important role in maritime communications along the Sakhalin coast is played by the communications facilities of the Railway Ministry. These are mainly affected by the drift ice of Soya Straits and Aniwa Bay. The drift ice in these two areas varies greatly according to the locality and the year. At the end of December, floes of river ice float down to the mouths of the Susuya and Rutaka Rivers, and as the temperature decreases, the extent of the ice field gradually increases. Mounds of snow are thrown upon the surface of the sea and beaten about, turning into slush ice. The surface of the sea becomes sluggish and the waves die down until with a sudden drop in temperature, the surface freezes. These conditions extend all along the coast with an increase in the cold. The ice is broken up by the wind waves. However, the moment the wind drops, the ice reunites, forming large masses. With the fall of snow, it gradually develops into a thick ice field, extending over the entire area of the bay, and in motion at every point because of the wind and tidal currents. This sheet forms in early February, and by the middle of March, the ice is from 0.3 to 1.2 meters thick.

The waters of the Soya Straits seldom freeze because of the warm Tsushima Current flowing north from the Japan Sea. What little ice occurs is either of the slush or pancake type. Most of the drift ice, driven by the north wind and the east Sakhalin current along the coast of Sakhalin, flows south and drifts along the northern coast of Hokkaido. Some of the ice drifts into the Soya Straits and the presence of the numerous ice floes lowers the temperature in the strait for a period of two to four months. This ice rounds Cape Nishi-notoro and drifts as far west as Kaihyo Island and as far north as Cape Soni. To the south, it reaches the islands of Rishiri and Rebun off the west coast of Hokkaido. At the beginning of April, the drift ice, from 1 to 2 meters thick, clears.

As previously stated, the amount of ice in the Soya Straits depends to a great extent upon the year. About Feb 1931, freezing and drift ice conditions did occur. At this time, two icebreakers, a new type, the Aniwa Maru and a modified type, the Iki Maru, navigated the straits but the latter vessel frequently stuck fast in the ice field, which was 2 to 3 meters thick. Unable to move forward or back, it was compelled to remain in the ice until extricated, with difficulty, by the Aniwa Maru. The area was also affected by drift ice during the winter of 1939 when great volumes of ice driven by a very strong gale drifted into the straits on 6 Feb from the east coast of Sakhalin. On the 7th, the ice filled Wakkanai Harbor and as the Aniwa Maru stuck fast in the ice field while entering the harbor, all communication between Otomari and Wakkanai was temporarily suspended. From 10 to 24 Feb, communications were maintained along an emergency route between Otaru and Otomari. On the 28th, it was possible gradually to restore communications between Otomari and Wakkanai, and the damage resulting from sea ice diminished from that day on.

5. Harbors

a. General

/DB: 357487: Meteorological Report No 13, Hydrographic Office, "Confidential," Jan 1935/

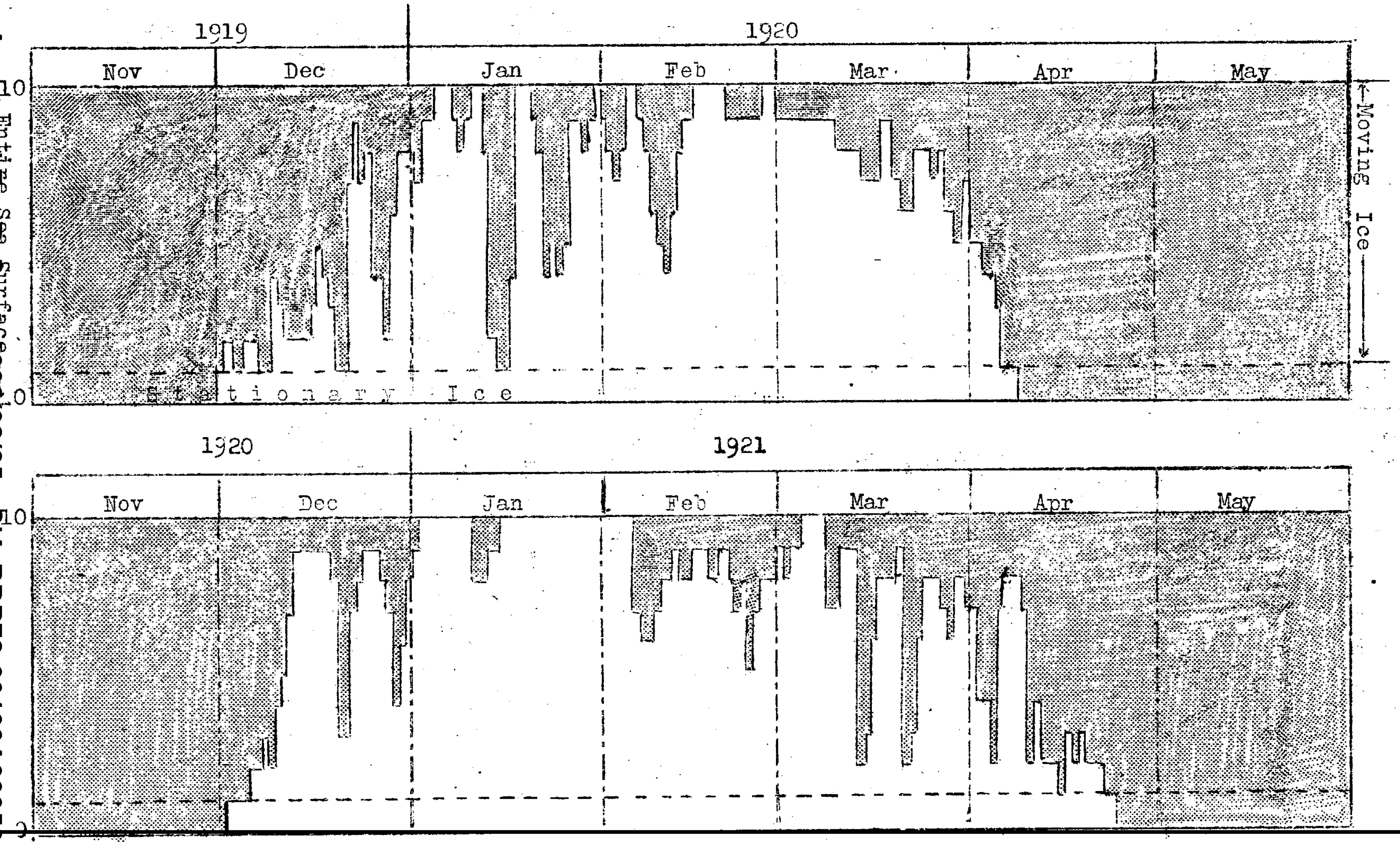
Ice is encountered everywhere on the coast of the island except for a region 4 or 5 miles south of Maoka. Maoka is subject to drift ice in February and March.

The north of Taraika Bay freezes solid in the middle of December.

Aniwa Bay often freezes in December and is always frozen solid in the middle of January. It thaws the last ten days of March, but as late as the middle of May, large ice floes are seen along its east coast.

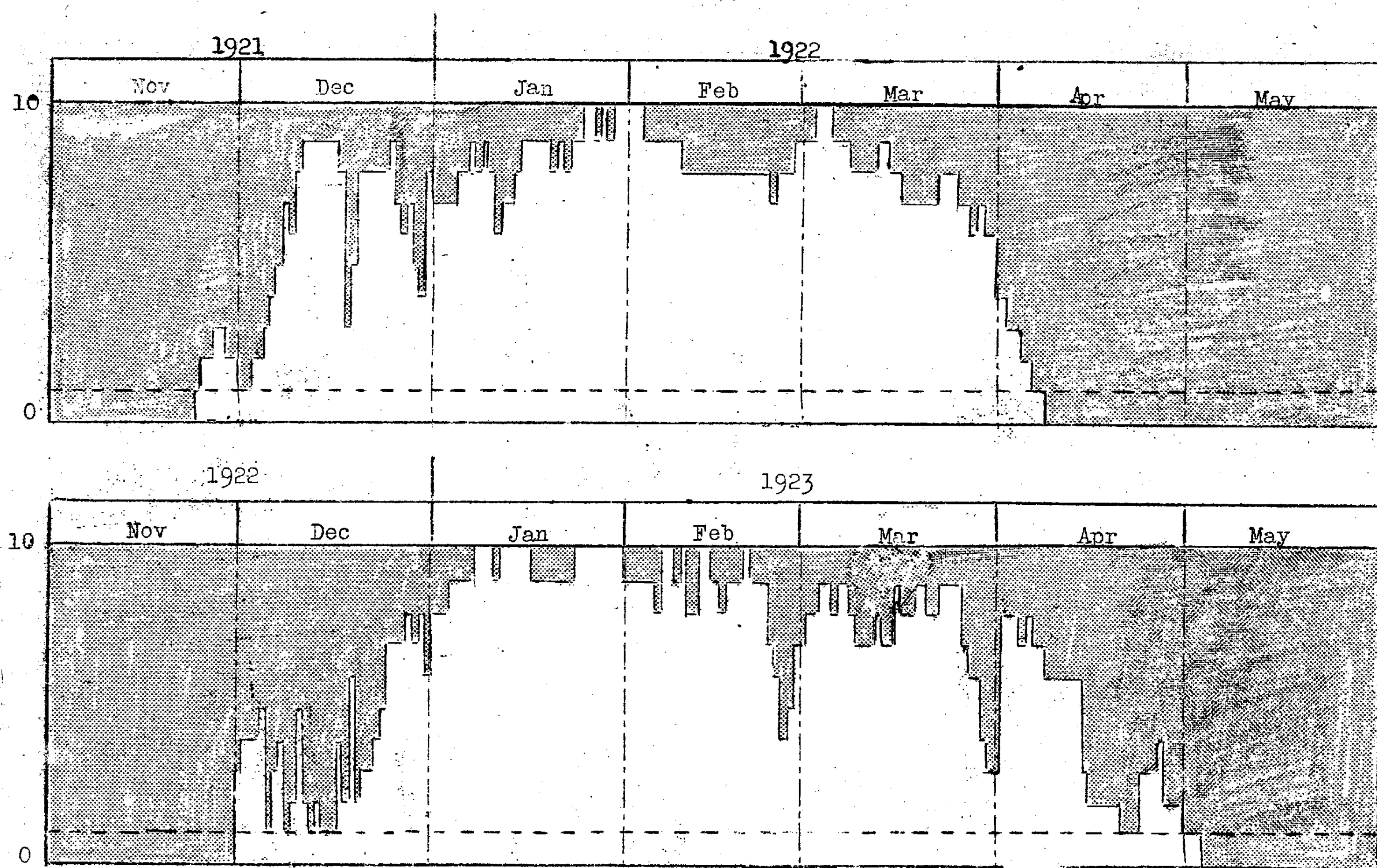
| Place | Years Recorded | Freeze Begins | Hard Ice Forms | Thaw Begins | End of Drift Ice |
|---|---|---|---|---|---|
| Otomari | 1906/1936 | 27 Nov | 19 Jan | 9 Mar | 2 Apr |
| Shikuka | 1906/1936 | 28 Nov | --- | --- | 12 Apr |
| Maoka | 1906/1936 | 21 Dec | --- | --- | 20 Apr |
| Ambetsu | 1929/1936 | 8 Dec | 28 Dec | 16 Mar | 13 Apr |

b. Ice at Aleksandrovsk (1919 - 25) [DB 288706: Weather of North Sakhalin, Central Meteorological Observatory, 1925]



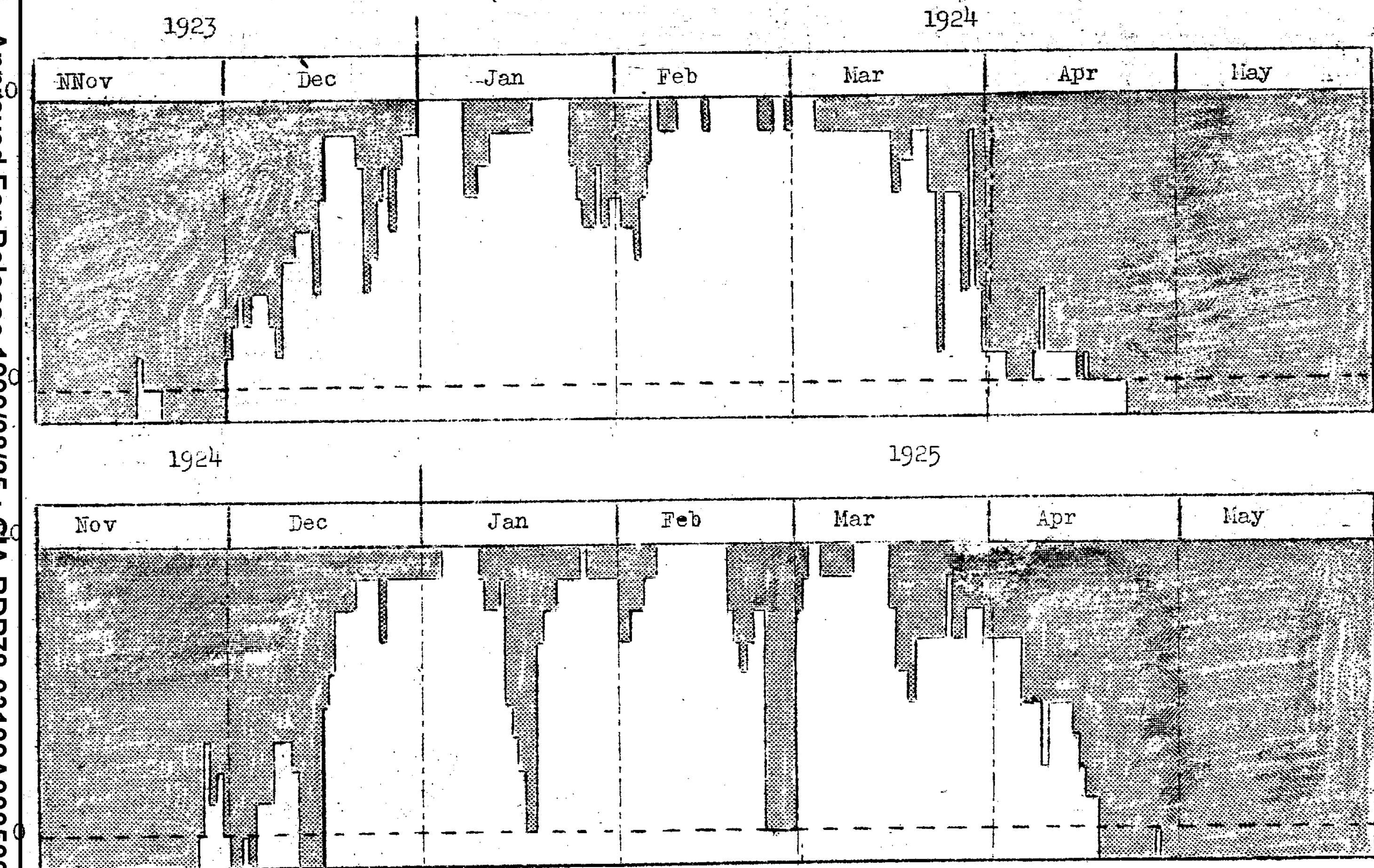

NOTE: In this diagram, the "entire sea surface," an area of about 15 miles radius, visible from Zhonkierskiy Light (elevation about 63 meters) is rated as "10," and the frozen portion represented in terms of this figure. "Stationary" and "moving ice" are defined as follows: "stationary ice" is that fixed to the shore, and is between 2 and 3 feet thick; "moving ice" consists of drifting floes, which, although they may occasionally attach themselves to stationary ice, are generally kept in motion by currents, tide and wind.

b. Ice at Aleksandrovsk (Contd)




See NOTE, previous page.

b. Ice at Aleksandrovsk (Contd)




See NOTE, page 12.



Approved For Release 1999/08/25 : CIA-RDP78-03109A000500010009-5

B. The Kuriles

1. Drift Ice off the Kuriles

/DB 368798: Study of Sea Ice and Freezing of Harbors, HAYASHI Takishio and KURATSUKA Yoshio 1941/

The drift ice off the Kuriles must be thought of in relationship to that off Hokkaido and Sakhalin. The drift ice which strikes the north coast of Hokkaido normally reaches Atoiya (Kunashiri Island in the southern Kuriles) about Feb, having been carried by the Sakhalin sea currents and the seasonal winter northwest wind. Then, it strikes the western coast of Etorofu and Shana about 19 Feb. From there, it drifts northeast and reaches the islands of Uruppu and Shimushiru in the central Kuriles.

There is little data for areas farther north, but according to the Report No 47 of the Kobe Oceanographical Observatory, in a normal year, the ice goes no farther north than Shimushiru, and even in years of heavy ice it is seldom seen as far north as Onnekotan Island in the northern Kuriles. In heavy years, it flows out of the Channel of Ricord, Vries Strait, and Boussole Channel, drifts from the east coast of Kamchatka to the Pacific side of the Kuriles by way of the Bering Sea, is carried down on the cold current which passes through the waters off the southeast coast of Hokkaido, and gradually disperses. This ice appears to originate in the Okhotsk Sea and does not appear to encounter that from the Bering Sea. The period of drift ice gets shorter as one goes north. Details as given in the following table:

Beginning and End of Drift Ice Off the Kuriles

| | | 1924 | | | 1931 | | |
|---|---|---|---|---|---|---|---|
| Island | Place Name | Begin | End | Duration | Begin | End | Duration |
| Uruppu | Mishima Bay | 23 Feb | 21 Apr | 58 days | 18 Feb | 20 May | 92 days |
| Shimushiru | Buroton Bay | 2 Mar | 26 Apr | 51 days | 19 Feb | 13 Mar | 23 days |
| | Ushishiru Bay | 7 Mar | 20 Apr | 45 days | 20 Feb | 10 Mar | 19 days |
| Matsuwa | Yamato Bay | 12 Mar | 23 Mar | 12 days | 4 Mar | 12 Mar | 9 days |

2. Ice in the Kuriles

/DB 396061: Sailing Directions for Sakhalin and the Kuriles, Japanese Hydrographic Office, 1937/

Floating ice on the Sea of Okhotsk side of the Kuriles is driven in by the north or west wind and out by the south or southwest wind. At Shiranuka and other places on the Pacific side this situation is completely reversed.

In Chinomiji on the southeast coast of Kunashiri, the ice is frozen from the first 10 days of January to the first ten days of May. On the northwest of Etorofu Island there is much floating ice, and although it freezes in winter, it does not become as firm as land. Ice, driven by wind and current from the north, enters the bays and piles up along the coast, gradually extending out to sea for several miles, and reaching a thickness of 3 meters or more. In Shana, a thin ice, due to the west or northwest wind, freezes on the coast in the middle of January. By the end of the month the bay is completely closed. In Shibetoro, the floating ice is blown inland the last ten days of January by the north or west wind, until in the first ten days of February all that can be seen is an ice field.

The region north of Etorofu Island, as far as Shimushu Island, has very little ice, compared with the seas to the south, but the northwest coast, even though it is north of Etorofu Island, is affected by the wind from the Okhotsk Sea and freezes. It may be said in general that with the exception of Shimushu and Paramushiro there is little evidence of ice here.

In general, there is much drift ice northwest and southwest of the Kuriles and surprisingly little near the islands between the east of Eruppu Island and Kamchatka, and on the southeast of the Kuriles. Thickness and size of ice also differs. On the northwest, ice forms each year, but on the southeast, often it does not form at all. On the southeast, even when ice does form, there are no vast ice fields as are seen in the northwest.

In the northwest of the south Kuriles, near Shana, ice begins to drift about 10 Feb. This ice is formed in the north and northwest part of the Sea of Okhotsk and is carried by wind and current. Occasionally, it blocks the straits and coasts for hundreds of miles. Etorofu Island, Kunashiro Island, the east coast of Hokkaido, and Shikotan are occasionally closed by ice 4 to 9 meters thick. This ice is melted by the Pacific, and the ports are open by the middle ten days of May.

The Chief of the Nemuro Observation Station at Rubetsu on Etorofu Island, determined, about 1921, that the April and May drift ice on the Kurile area freezes in the winter to the east of Sakhalin, breaks up in March, and is brought south by tides and wind. North of Hokkaido it meets the northeast current which washes the northwest coast of the Kuriles, is carried to Etorofu Island, Uruppu Island, and the coast of Shimushiru Island. One portion proceeds from Kunashiri Channel, the Etorofu Straits, and Eruppu Channel to the east of the Kuriles and is carried on south. The ice frozen west of Kamchatka and along the shores of the Sea of Okhotsk does not enter the Kuriles. Drift ice is generally encountered from April to the first ten days of May and after the middle of May is usually not encountered at all.

Drift ice found in June and July in the Sea of Okhotsk is always accompanied by fog, but fog does not occur in the Kuriles because the temperature conditions are not suitable. It is impossible to detect the presence of drift ice by measuring the temperature of the water because there is no difference between the temperature of the water near the drift ice and the usual temperature of the sea. The wind gives great force to the drift ice, and its surface is generally very irregular.

It is apparent from the experiences of ships entering these waters that the wind controls the position of the drift ice. The northwest coasts of Etorofu Island and Kunashiri Island are frozen solid, and it would seem to be extremely difficult to find suitable navigational conditions around these waters.

3. Sea Ice in the Central Kuriles

[DB 244833: Weather of the Central Kuriles, Report No 87, Kobe Oceanographic Observatory, Jun 1932]

Due to the severe winter wind and violent movement of the sea, the temperature of the water often drops below freezing without heavy ice forming. On clam days, or when there is a northwest wind, sludge ice forms about 50 or 60 meters out to sea. If, however, the sun shines or the wind changes to the southeast or becomes violent, the ice breaks up and begins to disappear. Observers have stated that sludge ice never occurs in Kobune Bay (Uruppu Island).

At Buroton Bay (Shimushiru) the entry of drift ice aids in the freezing of the sea, and heavy ice forms.

The period of freeze, as shown in the table below, generally lasts from the first ten days of February until the middle ten days of March.

Freezing Dates

| Place | Year | Freeze Began | Freeze Ended |
|---|---|---|---|
| Tokotan Bay (Uruppu ) | 1928 | 12 Feb | --- |
| | 1931 | 4 Jan | --- |
| Buroton Bay (Shimushiru) | 1920 | 24 Feb | 2 Mar |
| | 1921 | 18 Jan | 14 May |
| | 1924 | 17 Feb | --- |
| | 1925 | 10 Jan | 16 Mar |
| | 1928 | 28 Jan | 18 Feb |
| | 1931 | 16 Feb | --- |
| Nemo Bay (Onnekotan) | 1924 | 6 Mar | 11 Mar |
| | 1931 | 23 Feb | 12 Mar |

Drift ice floating along the coast comes from the Sea of Okhotsk, but none seems to come from the Bering Sea. Most of the drift ice encountered in this region seems to form along the east coast of Sakhalin, and along the coast of Kitami-Kuni, in Hokkaido. Broken up by changes in temperature, it is carried along on the Okhotsk current and the winter winds.

Assembling all observations on the movement of this ice we learn that it first approaches the southern Kuriles and proceeds north following along the archipelago.

Most years it stops in the vicinity of Shimushiru and rarely goes further north. Records show that in 1923, 1924, and 1931 the ice reached Matsuwa but was not observed at Onnekotan. These seem to have been unusually cold winters with correspondingly plentiful drift ice.

In contrast, the winters of 1926 and 1930 were comparatively warm with no drift ice. The drift ice also appears to have a relationship to the atmospheric temperature over the Sea of Okhotsk.

One part of the drift ice, while advancing north, goes into the Pacific, where the cold currents carry it south. This is the ice encountered on the Pacific side of the Kuriles. An observer at Mishima Bay observed pack ice drifting south through the south Uruppu channel.

The Hakuho Maru, attached to the Ministry of Agriculture and Forestry, encountered the following drift ice while patroling the Kuriles over a several year period:

a) 1150 15 May 1925: Encountered south-bound drift ice about 10 miles south of Uruppu.

b) Evening 17 May 1925: Encountered large amounts of drift ice entering Pacific south of Uruppu (Channel). Temperature of sea, $-2^{o}$.

c) 0900 17 Feb 1926: Encountered large amounts of drift ice coming from Kunashiri Channel, about 20 miles east of Shikotan. Temperature of sea, zero.

Drift ice in harbors and bays is governed principally by the wind. Sea winds drive it in, and the land winds drive it out. Thus, the position of a bay in the archipelago, i.e. whether it is on the Pacific or on Sea of Okhotsk, is most important.

Bays on the Okhotsk side are filled with drift ice by the northwest winds, and cleared by the south or east winds. When a great amount of ice comes in, the sea often freezes into large ice fields which are driven closer and closer together by the wind.

4. Harbors

[Source same as DB 244833]

Drift ice conditions at various harbors in the Kuriles are reported below:

a. Mishima Bay, Uruppu

This small harbor, near the northeast extremity of the island, east of Cape Shishiiwa, opens north. It is about ½ mile wide inside and about 1 mile wide at its mouth.

<u>8 Mar 1929</u>: Fresh northwest breeze. Drift ice observed off shore early in morning. About 1600 began to close in shore until about ½ mile away.

<u>9 Mar</u>: Drift ice increased. Covered entire visible area.

<u>10 Mar</u>: Large amounts of drift ice off northeast extremity of island, proceeding to Pacific.

15 Mar: Wind shifted to south. Harbor drift ice driven out to sea.

30 Mar: West wind produced a small amount of drift ice in the Sea of Okhotsk, which lasted until 3 Apr because of the calm weather. On 3 April the wind shifted to northwest, driving the ice shoreward.

10 Apr: East wind. Ice packs began to separate from the shore.

11 Apr: North wind. Ice returned.

14 Apr: Moderate south gale, driving ice out.

19 Apr: Southwest wind. Ice packs about 4 miles north west of island.

20 Apr: Ice approached shore, but wind changed to south, driving it northeast. Last day drift ice was noted.

b. Buroton Bay, Shimushiru

This harbor, in the northeast of the island, faces the Shimushiru Straits. It is half-moon shaped with a radius of about 3 miles. It varies in depth from 5.9 meters at the mouth to about 250 meters in the middle, and is surrounded by mountains which shelter it from the wind. The mouth is about 160 meters wide, 2 meters deep, and full of rocks and sea weed which show on the surface of the water. Flood tide at the mouth is about 2 knots and ebb tide about 3 knots.

17 Feb 1924: Noon atmospheric temperature -13°, water temperature -2°, a rapid fall from noon 16 Feb of 8° and 1°. West wind, accompanied by snow. Thin ice, about 50 meters out to sea, the first ice of the year.

21 Feb: South wind, causing ice to move. A blue fox on the ice was carried out of the bay. At about 1500, wind changed to west, driving the ice back towards the shore, rescuing the fox. (Such a fox, it should be noted, ordinarily weighs about 4 kilograms.)

7 Mar: Northwest wind; drift ice entered harbor for the first time.

8 Mar: Bay filled with ice floes, extending about 200 meters out to sea from the mouth of the port. Largest ice floes about 5 meters long, with about 1 meter of their height exposed above water line. Ice floes packed close together, permitting crossing on foot at will.

15 Mar: Nothing but ice visible from mouth. Shimushiru Straits, about 11 miles wide, frozen tight as far as Ketoi Is. Ice stops at Pacific.

18 Mar: East wind. Atmospheric temperature rose to -3° at noon. Ice floes began to move.

19 Mar: Ice completely gone outside of bay but remained in bay.

22 Mar: North wind. Drift ice.

23 Mar: From morning on, gentle south wind which gradually cleared mouth of bay.

24 Mar: East wind followed by severe southeast wind. Noon atmospheric temperature, 0°; water temperature, 1.5°. Ice floes, which up until yesterday could be crossed on foot, completely disappeared, and the sea was calm.

25 Mar: West wind. Ice appeared in bay.

26 Mar: Ice scattered over bay but did not leave bay.

6 Apr: West wind drift ice again entered bay. Continued until 8 April, covering bay.

13 Apr: Rapidly rising sea and atmospheric temperatures caused rapid thawing, and prevented pile-ups of ice floes. Most of ice disappeared.

14 Apr: Some ice, carried by morning tide, entered bay and remained until 24 Apr.

26 Apr: Large ice packs seen in Sea of Okhotsk. Last ice of season.

c. Ushishiri

This island consists, actually, of two islands, Kita and Minami, connected by a reef about 300 meters long. There is a bay on the east or Pacific side and one on the west or Sea of Okhotsk side.

7 Mar 1924: Fresh northwest breeze, accompanied by snow. Noon atmospheric temperature, -9°, water temperature, -0.5°. First drift ice of year seen in Sea of Okhotsk.

12 Mar: Moderate northwest breeze. Noon atmospheric temperature, -2.5°; water temperature, -0.5°. Drift ice in west bay about 5 miles to the north approaching island; reached west bay at 1815. Some drift ice apparently proceeding south in east bay.

13 Mar: Moderate northwest breeze. Noon atmospheric temperature, -4°; water temperature, 0°. Drift ice which entered west bay evening of 12 Mar now firmly packed around Kita and Minami Islands. Blue foxes seen crossing between the two islands.

14 Mar: Moderate west breeze in morning, changing to north in the afternoon. Noon atmospheric temperature, -3°; water temperature, -0.5°. Majority of drift ice off west of Minami Island disappeared. Drift ice on west of Kita Island proceeded into east bay through the reef.

15 Mar: Fresh west breeze. Noon atmospheric temperature -7°; water temperature, 0.5°. West bay solidly frozen from shore out, connecting Kita and Minami Islands. Some ice also in east bay.

16 Mar: Moderate northeast gale, bringing drift ice into east bay from 0700 on. Ice in west bay moved out to sea. Noon atmospheric temperature, 2.5°; water temperature, 0.5°.

17 Mar: Moderate northeast gale continued, completely removing ice from both east and west bays. Noon atmospheric temperature, -1.5°; water temperature, 0°.

19 Mar: Some ice entered west bay in morning, crossed the reef and entered east bay in afternoon. Ice noted occasionally out to sea, off the west bay, drifting from southwest to northeast.

20 Mar: Moderate south breeze. Noon atmospheric temperature, 5°; water temperature, 1°. No ice in east bay. Ice seen drifting off west bay from west to northeast.

9 Apr: Ice suddenly sighted off west bay.

10 Apr: Ice approached Island, then withdrew to the north.

19-20 Apr: Ice seen off west bay. Last ice of season.

Drift Ice Seasons

| Harbor | Year | First Day | Last Day | Notes |
|---|---|---|---|---|
| Tokotan Bay | 1921 | 2 Mar | --- | Drift ice until 9 Mar when observer left. |
| | 1922 | 1 Mar | 5 Apr | |
| | 1923 | 12 Feb | --- | No records after this date |
| | 1924 | 6 Mar | 14 May | |
| | 1927 | 1 Mar | --- | Ice until 11 Mar, when observer left. |
| | 1928 | 21 Feb | 9 Apr | |
| | 1929 | 12 Feb | 5 May | |
| | 1930 | 7 Feb | 21 Apr | |
| Kobune Bay | 1924 | 12 Mar | 17 Apr | |
| | 1925 | 23 Apr | 12 May | |
| | 1929 | 12 Apr | --- | Ice this day only. |
| | 1931 | 27 Feb | 1 Mar | |
| Mishima Bay | 1924 | 23 Feb | 26 Apr | |
| | 1925 | 8 Mar | 16 May | |
| | 1927 | --- | 16 Apr | Observations did not begin until 16 Mar when ice had already formed. |
| | 1929 | 8 Mar | 20 Apr | |
| | 1931 | 18 Feb | 20 May | Drift ice sighted far out to sea on 20 May; not seen between 29 Apr and 20 May. |

(cont'd) Drift Ice Seasons

| Harbor | Year | First Day | Last Day | Notes |
|---|---|---|---|---|
| Shimushiru Island | 1923 | 15 Mar | 13 Apr | |
| | 1925 | 11 Apr | --- | Ice this day only. |
| | 1927 | 29 Mar | 3 Apr | |
| | 1929 | 4 Mar | --- | Ice this day only. |
| | 1931 | 14 Feb | 25 Feb | |
| Nakatomari | 1927 | 28 Mar | 2 Apr | |
| | 1931 | 17 Feb | --- | Observer left before end of drift ice. |
| Buroton Bay | 1920 | 6 Mar | 25 Mar | |
| | 1921 | 27 Jan | 11 Mar | |
| | 1924 | 7 Mar | 26 Apr | |
| | 1925 | 1 Apr | --- | Ice this day only. |
| | 1927 | 2 Apr | --- | Ice this day only. |
| | 1931 | 19 Feb | 13 Mar | |
| Minami Bay | 1924 | 13 Mar | 27 Apr | |
| | 1931 | 19 Feb | 11 Mar | |
| Ushishiru Island | 1923 | 5 Feb | 27 Mar | |
| | 1924 | 7 Mar | 20 Apr | |
| | 1931 | 20 Feb | 10 Mar | |
| Rashowa Island | 1931 | 3 Mar | 12 Mar | |
| Yamato Bay | 1923 | 13 Feb | 15 Feb | |
| | 1924 | 12 Mar | 23 Mar | |
| | 1931 | 4 Mar | 12 Mar | |

Comparisons of Drift Ice Seasons

| Station | 1924 First Day | 1924 Last Day | No of Days | 1931 First Day | 1931 Last Day | No of Days |
|---|---|---|---|---|---|---|
| Mishima Bay | 23 Feb | 26 Apr | 63 | 18 Feb | 20 May | 92 |
| Buroton Bay | 7 Mar | 26 Apr | 51 | 19 Feb | 13 Mar | 23 |
| Ushishiru Island | 7 Mar | 20 Apr | 45 | 20 Feb | 10 Mar | 19 |
| Yamato Bay | 12 Mar | 23 Mar | 12 | 4 Mar | 12 Mar | 9 |

NOTE: The drift ice season is shorter in the northern islands.

C. Kamchatka

1. General

/DB 209732: Map of Sea and Weather Phenomenon, Northern Area, undated/

The east coast of Kamchatka is frozen from November through April. The ice breaks up the first part of May. When it is frozen it is possible to cross the channel (Litke Straits) from Kamchatka to Käraginski Island. A thin ice appears inside Petropavlovsk Harbor in the winter, but it is kept clear by power craft and ships may enter and leave. The lowest temperature at Petropavlovsk occurs in January, when it reaches 33° below zero.

The west coast of Kamchatka is frozen from November to April. The ice melts the first ten days of June, but there is much drift ice. Ice begins to melt on the south coast of Kamchatka in the middle of March.

The northern part of the Sea of Okhotsk is frozen from November to May. Drift ice is a danger to navigation on the east coast of Sakhalin until the middle of June.

2. Harbors

/DB 302646: Survey of Far Eastern USSR, Economic Research Section, South Manchurian Railroad, 1939/

The Bering Sea is acted upon in the south by the warm current, making Petropavlovsk practically an "ice-free port." However, the navigable season is usually only from April to November. Other so-called "ice-free ports" such as Vladivostok can be used only from February to December; at other times, navigation is almost impossible without the use of ice-breakers.

Navigation is generally difficult during the thaw because of the drift ice and gales. Accidents and collisions are especially frequent in the area from Nagayevo to the Straits of Tartary and on the east coast of Kamchatka.

In the East Siberian Sea, drift ice most often endangers navigation near Vrangelya Islands.

D. Gulf of Tartary

1. General

/Russian Pilot of the Pacific Ocean, Hydrographic Institute, 1940/

To the west of Soya Straits drift ice is carried out of Tartary by north and northwest winds. In the region of Cape Nishinotoro this ice may be observed from the end of December until the last ten days of March. Ice floes, weathering Cape Nishinotoro, reach up to Cape Soya. The ice diminishes in the presence of southeast winds.

Drift ice appears in the Soya Straits, usually about 20 Jan. This ice comes from the Sea of Okhotsk to the northeast. With the advance of spring, as soon as the southern and western winds begin to blow, the ice is usually carried off immediately. This occurs on the average around 16 Mar, although it is not rare to find drift ice even in April if there are no northeast winds.

In the region to the east of the Soya Straits, ice floes appear with north and east winds at the end of December or at the beginning of January, and disappear at the end of April or the beginning of May. But sometimes in the event of large accumulations of ice in the southwest part of the Sea of Okhotsk and the prevalence of northeast winds, ice floes up to 300 odd meters may be seen in succession across the Soya Straits in the area between 45°-47°N and 144°-145° E, even during the last ten days of May.

Along the southeast coast of Hokkaido on all the points from Cape Erimo to Cape Nosappu, drift ice may be seen from the middle of December to the end of March. There is an especially large amount of ice on the eastern extremities of Hokkaido where it often obstructs passage through Goyomai Straits.

Ice is widely dispersed in the sea and often obstructs traffic. Ice fields attain dimensions up to two square miles, and pile-up to a height of 7 meters above the water. They appear from the east and, as a result of the currents, gradually approach the shore where they freeze in with the thin shore ice.

In the winter the northwest coast of Hokkaido freezes out to 6 to 8 miles from shore, but the Soya Straits remain open as a result of the high temperature of the water brought by the current coming from the Japan Sea. Drift ice fills the straits from the end of December to the end of March, making navigation nearly impossible.

2. Harbors

/DB 209732: Map of Sea and Weather Phenomenon, Northern Area, undated/

North of Sovetskaya Gavan, pack and drift ice that can be dangerous to navigation is common. De Kastri is generally frozen until the latter part of June. Its minimum temperature in January is -29.1°.

Aleksandrovsk has a minimum temperature in January of -33.5°, and Nikolayevsk of -45.0°. The Straits of Tartary are frozen from the middle of December until the middle of March. The ice here breaks up in April, except in sheltered places along the coast.

Harbors in the vicinity of Okha freeze over in November, and the coast in December. Ice here melts the first part of May.

/DB 307665: Gazetteer of the Soviet Far East, South Manchurian Railroad, 1927/

The sea does not freeze in the vicinity of Fal'shivaya Bay, but a mile of ice does form along the coast. The main part of the bay, the mouth of Khadya River, does freeze, in spite of its great depth and area, since the temperature in winter sometimes reaches 40°C /sic/, but only for short periods of time. The weather at Fal'shivaya Bay is, in general, damp and cold.

De Kastri Bay is frozen usually from the beginning of December on, but it has been known to freeze the first part of November. Beginning in the east, it thaws in April, aided by the action of waves and tide. The thaw has occurred as early as the latter part of March. The ice, even after it is broken up, continues to float for some time in the offing, and in 1897, continued to float here until the middle of May.

That part of the Straits of Tartary facing De Kastri Bay freezes solid in winter as far as the eye can see, but the ice is not one continuous sheet, and drift ice is often seen off Cape Sushcheva. Only the inner reaches of De Kastri Bay can be navigated safely at such times, and so the gulf itself can be said to be navigable only for 6½ months---from the first of May until the middle of November.

In the area between Nikolayevsk and De Kastri Bay the first place to freeze is the region around Cape Jaore, which is usually closed by the end of October. Next, the channel between Popova Island and Cape Yekateriny freezes. About two weeks later, the Amur River facing Nikolayevsk freezes. Since the Straits of Tartary, when frozen, is used for traffic, it is supposed that it freezes completely, but there are portions south of Cape Lazareva which do not freeze.

E. Okhotsk Sea

1. General

/DB 292727: The Pacific Ocean, Academy of Science of the USSR, 1926/

In spite of low temperatures, the Sea of Okhotsk freezes only along the shores in a belt 75-90 kilometers wide, but bays and gulfs are entirely covered with ice. Freezing begins during the first half of November; the accumulation of ice continues until February, and in the north until March. Toward the middle of March, when the temperature everywhere has risen to $0^{\circ}$, the accumulation ceases, and in May the thaw begins along with concurrent breaking up of ice in the rivers along the coast. As a result of winds and currents the ice begins to move. At the end of May and the first half of June, the ice begins to go out to sea across the Kurile ridge. Usually towards the second half of June the Sea of Okhotsk is almost clear of ice. At this time the presence of ice is possible only in the western part of the Gulf of Sakhalin and the southwest corner of the sea. After that the ice moves mor persistently and disappears only towards the second half of July, and sometimes not until August, as was the case in 1915.

/DB 307665: Gazatteer of the Soviet Far East, South Manchurian Railroad, 1927/

Ice is, of course, encountered in the Sea of Okhotsk during May, and has been seen in July and August. During the cold season west and north winds prevail. In winter west winds are most frequent, with occassional north and east winds. In March the winds are changeable and often severe northeast gales which tend to break up the ice and spread it over the west and northwest of the sea arise.

The central part of the Sea of Okhotsk does not freeze, but its coast line is closed from November to April. In the first part of May, the various rivers emptying into the Sea of Okhotsk begin to thaw, and the sea ice begins to move from the north towards the Shantarskiye Islands, and the east coast of Sakhalin. Some enters the Soya Straits.

but most of it moves towards the mouth of the Kuriles, where it is melted by the Pacific waters in July. Ice remains near the Shantarskiye Islands until August, and has been recorded in Amur Bay as late as July.

2. Harbors

/Source same as DB 307665/

The Gulf of Sakhalin freezes in winter, but even though it freezes before Amur Bay, drift ice still occurs at the end of July.

Nikolaya Bay (53°40' Academii Bay) has a very mild climate; severe winters are rare. The rivers freeze the latter half of April as spring begins, and the ice completely disappears in May. However, the ice inside the gulf does not break up in winter.

F. <u>Bering and Adjacent Seas</u>

1. Drift Ice Conditions in Bering Straits, Bering Sea, and Chukotsk Sea.

/DB 302476: "Hydrological Survey and Drift Ice Conditions from the East Siberian Sea to Bering Sea," <u>Far Eastern USSR and Outer Mongolia Research Data No 54</u>, Research Section, South Manchurian Railroad, Dec 1939, from the Russian I.A. Kireev, 1936/

a. Chronological Observations During the Navigable Season 1932 (Survey made by the ship, Dal'nevostochnik, sponsored by the National Hydrologic Research Society and Pacific Marine Research Society and Pacific Marine Research Society)

<u>14 Aug 1932:</u> While cruising through the Bering and Chukotsk Seas from 14 to 17 Aug 1932, the ship encountered drift ice in the vicinity of the Bering Straits and the southwest part of Chukotsk Sea. On the morning of 14 Aug, an ice pack boundary lying along a north-south axis was seen 3 or 4 miles southeast of Cape Dezhneva (East Cape). The survey ship made anchor 2 miles east of the ice pack boundary (66° 00'N, 169° 27.5'W). A few small icebergs were seen only in the north-northwest direction. Ice spears were extended 4 to 5 miles south of Cape Dezhneva. Due to a north wind, these ice spears became broader and started to spread in the southwest direction. Drift ice from the north began to flow past the ship, and by nightfall its density was 4 to 5 balls.

<u>15 Aug 1932:</u> By early morning the drift ice completely surrounded the vessel. Several small icebergs were seen among the drift ice. The flow of drift ice throughout the day was to the south and southwest. In the afternoon the ship sailed into the bay near Cape Dezhneva to unload supplies at the Uelen weather station.

16 Aug 1932: While leaving the bay, it was necessary to cut across the ice spears at the mouth. After leaving the harbor, a westward course was followed, and drift ice was soon encountered having a density of 4 to 5 balls. The east portion of drift ice moved towards Ratmanova Island (Big Diomede Island), and now the ice barrier was extended from northeast to southwest. At 0630 the ship's position was 65° 53.8'N, 169° 27'W, and it was finally able to get out of the drift ice area. It sailed northward keeping parallel to the ice barrier on the left. At 0800 the ice barrier was no longer visible. A few hours later the course was changed to the west, and the ship sailed through open sea until nightfall. At a point 10 or 12 miles northeast of Cape Uiguen, an ice barrier whose boundary ran from southwest to northeast was encountered. The ship changed its course with the change in the ice barrier boundary, and later the course was changed toward Cape Thompson on the Alaskan mainland. After the ship cruised east for two days, on the night of 17 August, another ice barrier was sighted at 67° 06' N, 168° 39' W.

b. Chronological Observations During the Navigable Season, 1933 (Survey made by a ship sponsored by the National Hydrologic Research Society and the Pacific Marine Research Society)

11 Aug 1933: While the ship sailed along the coast line from Cape Dezhneva to Cape Serdtse Kamen, no drift ice was observed. Moreover, no ice was seen around the vicinity of Cape Serdtse Kamen. Even after sailing 60 miles north from Cape Serdtse Kamen, no ice was observed. The ship's course was changed to the west and then the northwest. On the morning of the 13th, an ice barrier was sighted at 68° 31' N, 175° 20' W. The ice barrier boundary lay along a north-northwest-to-south-axis. The ice barrier was disintegrating and was mostly composed of small ice floes having a density of 1 ball. The course was again altered to the north and several ice spears which were elongated by a north-northwest wind were crossed. After proceeding farther north, the ship encountered drift ice with a density of 8 balls. At 69° 45' N, 175° 45' W, the ice barrier boundary changed its direction to north-northeast. Numerous ice spears were elongated several miles in a southeasterly direction. The type of drift ice was the same as before; large and small ice floes having a density of 1 or 2 balls were seen.

13 Aug 1933: A north-northeasterly course was followed the 13th and the 14th, and at times the ice barrier boundary dropped out of sight.

14 Aug 1933: During the morning Herald Island, surrounded by drift ice, was sighted north-northwest of their position (70° 49' N, 173° 57' W). They sailed northward following an ice barrier which was mostly composed of small icebergs, and detoured around ice spears which were elongated towards the east. Towards evening they passed Herald Island, and at 2100 they reached the northernmost point in their course (71° 20' N, 173° 45' W). The density of the drift ice was 5 balls. At this point observations were made from the crow's nest (visibility, approximately 10 miles). An open sea passage, about 8 miles wide, extended to the northwest. Extended ice barriers were seen to the east, northeast, and east-southeast. Next, the course was changed to the southeasterly direction, and a new ice barrier was followed.

The nature of the ice was similar to the previous observations.

15 Aug 1933: The southeastern course was maintained until 1300. At 70° 41' N, 170° 23' W, ice barriers were seen to the east, southeast, and southwest. Solid ice about 4 or 5 miles wide was stretched between the old and new ice barriers, and it extended in the northeastern direction. In the west-southwesterly direction, extended ice spears from the west and northwest crossed each other, and the drift ice was very dense. The drift ice in the vicinity of Herald Island had the characteristics of melting snow. Even the trawling boats had difficulty in proceeding through this area. At 2100 heavy fog settled and at times drift ice completely surrounded the ship.

16 Aug 1933: During the morning ice floes of various sizes were sighted to the port seen around the vicinity of Cape Serdtse Kamen, Cape Dezhneva, and Provideniya Bay.

c. Chronological Observations During the Navigable Season, 1932 (Survey made by the ship, Litke, and others, sponsored by the Arctic Research Peoples' Maritime Commission)

23 Jul 1932: The ship, Anadyr, entered Chukotsk Sea and observed a narrow strip of drift ice along the coast of Uelen, facing towards the northwest. A drift ice pack was encountered near the coast of Inkigur. The ship, Suchan, also entered Chukotsk Sea, and sailed northwest to Cape Serdtse Kamen. At a position 9 miles northwest of the above cape, they encountered an impenetrable mass of drift ice. The natives along the coast explained that previous to this period no drift ice had appeared in this area. This phenomenon was caused by a strong north wind.

26 Jul 1932: A reconnaissance plane was dispatched from the ship, Suchan. Along the west coast of Cape Serdtse Kamen, an ice field, approximately 12 miles wide, and a drift ice pack, composed mainly of large ice floes, were observed. Farther off the shore, the ice conditions changed and ice floes of various sizes were seen in the open sea. This covered an area about 5 to 10 miles wide. About 6 miles east of Ididlya Island, a drift ice pack 18 to 20 miles wide was observed. North of this area there was no drift ice. The mouth of Kolyuchinskaya Bay and the area 20 miles to the north were covered with drift ice. An open sea lane one-half to 1 mile wide, was seen along the coast from Cape Dzhenretlen to the mouth of Kolyuchinskaya Bay.

2 Aug 1932: From a plane flying from Cape Helen to Cape Serdtse Kamen, a narrow drift ice belt, composed mostly of small ice floes, was seen along the coast from Cape Uelen to Cape Inchouk (Intsova) . The drift ice (ice floes of various sizes) northwest of Cape Inchouk gradually increased towards the north and at places it was 12 miles wide. This kind of drift ice extended from Cape Inchouk to Cape Serdtse Kamen.

3 Aug 1932: The ship Anadyr drifted with the drift ice to a position 8 miles northeast of Cape Inkigur, and came to a halt. Various observations were made at this position. An ice field composed mostly of ice floes of various sizes (density of 10 balls), was visible to the west and northeast. A narrow sea lane was seen among the scanty drift ice to the northeast and the southeast, but the ship was not able to free itself from the ice. The ship Suchan was stranded off Cape Serdtse Kamen on 28 Jul, and drifted for several days. Drifting came to a halt on 3 Aug, 50 miles southeast of Cape Serdtse Kamen. The ship was finally able to reach an open sea lane to the northeast when the south wind began to scatter the ice. The drift ice along the coast had a density of 7 balls, and its width was approximately 10 miles. The drift ice was composed of ice fields and variously sized ice floes.

4 Aug 1932: An ice barrier boundary extended in a direction approximately 330° from the above position to 22 miles northeast of Cape Inkigur.

5 Aug 1932: The two ships met off Cape Serdtse Kamen. Travelling westward to Cape Serdtse Kamen, the Suchan sailed through drift ice having a density of 5 to 7 balls.

6 Aug 1932: An aerial observation was made from Cape Uelen to Cape Serdtse Kamen. The drift ice from Cape Uelen to Cape Inchouk was mainly composed of small ice floes. The ice belt was approximately 3 miles wide, and it gradually increased in width to 18 miles near Cape Uiguen. The drift ice was composed of ice floes of various sizes which developed into iceberg fields, and the density increased gradually towards the shore. The drift ice conditions from Cape Uiguen to Inkigur were almost the same as before, but the density was greater, making passage impossible. However, the ice in the vicinity of Cape Inkigur was comparatively low in density, and there were numerous ice-free areas. The drift ice belt from Cape Inkigur to Cape Serdtse Kamen was about 25 miles wide. On various occasions, large floes from broken ice fields were seen. For a distance of 10 miles along the shore west of Cape Serdtse Kamen, the drift ice was rather dense and it appeared as though passage was impossible. The drift ice was composed of ice fields and large ice floes. The density of drift ice increased again from Cape Serdtse Kamen to Cape Dzhenretlen. The area between Cape Dzhenretlen and Kolyuchin Island was covered with pancake ice. To the north and east of the island the ice was similar, but its density was greater. Moreover, in the vicinity of Cape Onman the density of the drift ice reached a maximum, and passage was impossible.

7 Aug 1932: Along the coast line from Cape Schmidt to the mouth of the Amguema River, the drift ice was very compact; the density was greater near the shore line. It was impossible to penetrate the drift ice southeast of Cape Yakan, and new ice was seen forming continuously. In this manner the drift ice along the coastline from Cape Serdtse Kamen to Cape Yakan blocked the passage of ships during the early part of August.

18 Aug 1932: An aerial observation was made using Cape Uelen as a base. Around the vicinity of Cape Zhenretlek, west of Cape Serdtse Kamen, the drift ice was composed of ice floes of various sizes

and the density increased farther out to sea. However, there were some portions near the coast where the density was also high. From 174° 10' W, to the west of Kolyuchin Island, an open sea lane spotted with small ice floes was seen. Five miles north of the Kolyuchin Strait the drift ice was composed of small ice floes, but its density was relatively high. From Kolyuchin Island to Cape Vankarem, very little drift ice was observed. Some grounded sections of ice floes and ice fields were seen along the shallow waters near the coast. Drift ice consisting of small ice floes was seen in the western strait of Kolyuchin Island. Its density was rather high and numerous broken pieces from ice fields were observed. While progressing to Cape Onman, the drift ice became rather sparse.

22 Aug 1932: An open sea lane approximately 1.5 to 2.5 miles wide appeared along the northwest shore of Cape Onman. The research party finally arrived at Cape Vankarem on the 24th. The drift ice off the shores of Cape Vankarem appeared to be very compact.

25 Aug 1932: The ships sailed through a narrow open sea from Cape Vankarem to Cape Schmidt, which was spotted with small drift ice. At times they encountered pack ice which covered the sea and extended to the shore. The drift ice was composed of ice floes of various sizes, and the greater part of many of the floes were submerged. The drift ice farther out to sea was exceedingly compact, and it contained large broken sections from ice fields.

26 Aug 1932: The ships proceeded northwest along the coast line. At times it was necessary for them to sail very close to the shore in order to prevent making contact with the drift ice.

27 Aug 1932: While passing Cape Schmidt, the ships encountered numerous drift ice barriers. At times explosives were used to make headway.

29 Aug 1932: At 69° 16' N, 179° 25' W the ships were unable to make further progress, so an aerial reconnaissance was made. A narrow sea lane, free of drift ice, was seen close to the shore line up to Cape Billings. Farther out to sea, the drift ice was much thicker and more compact. The large drift ice barrier near Cape Billings was pointing towards the north. An open sea, dotted with small drift ice, was sighted near Shalaurova Island.

d. Drift Ice Conditions Around the Cape Shelagski Area from Late Sep to Early Oct

26 Sep 1932: The survey ship left Cape Billings, and followed the coast line towards Cape Schmidt. The sea lane near the coast was almost free of drift ice, but farther out to sea the drift ice was always present.

e. Chronological Observations During the Navigable Season, 1932 (Survey made by the ship, Soviet, sponsored by the Kamchatka Company)

10 Aug 1932: At Lavrentta Bay arctic drift ice composed of small ice floes was encountered. The ice was drifting towards the south. The Soviet remained at anchor in this bay until 14 Aug.

15 Aug 1932: The Soviet sailed along the coast line to Dezhnav Village. In this vicinity ice floes which extended 9 to 11 meters below the surface of the water were seen. Due to the appearance of arctic drift ice, the Soviet was forced to leave Dezhnav Village before completing the loading of provisions.

16 Aug 1932: After leaving Cape Dezhneva, the Soviet passed through the Bering Straits, entered Chukotsk Sea, and headed towards Herald Island.

18 Aug 1932: At 0130 the Soviet encountered drift ice at a position 40 miles southeast of Herald Island. The drift ice was composed of small ice floes, and it was not necessary for them to change their course. At 70° 06' N, 174° 30' W, the drift ice became more compact. The ship drifted with the ice from 0300 to 1200. The drift ice in this area had a peculiar characteristic---the sun and the water left the ice with a layer of mud on its surface. Two ice floes containing wooden rubbish were seen.

19 Aug 1932: At 1500 the Soviet began to drift with the ice once again. The following table shows the drift ice conditions from 1800, 19 Aug 1932.

| Date and Hour | | Drift Direction | Notes |
|---|---|---|---|
| 19 Aug | 1845 | NNW | Position at 1147, 20 Aug was 70° 58.5' N |
| | 2000 | NNE | |
| | 2200 | SE | |
| | 2300 | S | |
| | 2400 | SE | |
| 20 Aug | 0100–0400 | SSW | |
| | 0900 | E | |
| | 1200–1500 | SW | |

20 Aug 1932: The Soviet proceeded towards Vrangelya Island, but a little later the course was changed towards an open sea lane to the east and south-east. The ship remained in this area for several days in order to wait for better ice conditions near Vrangelya Island.

3 Sep 1932: At 1100 the Soviet set its course towards Herald Island from its position at 70° 14' N, 177° 38.5' W.

4 Sep 1932: At 2000 the Soviet finally arrived at the drift ice barrier which completely surrounded Vrangelya Island. The drift of the ice was south-southwest.

5 Sep 1932: When the drift of the ice changed to west-southwest, the Soviet tried to get closer to Vrangelya Island by utilizing an open lane caused by the broken ice. However, the ship could not make progress, and it was necessary to withdraw to the open sea.

7 Sep 1932: The ship drifted with the ice pack from the 7th to the 11th. The drift ice conditions were as follows:

| Date and Hour | | Drift Direction |
|---|---|---|
| 7 Sep | | SSW |
| 9 Sep | 0000 to 0400 | S |
| 9 Sep | 1800 | S and SW |
| 10 Sep | | SSE |

12 Sep 1932: At 1715 the Soviet started for Cape Sevornyy. It finally came out to an ice-free sea 150 miles southwest of Vrangelya Isalnd.

13 Sep 1932: At a point 25 /miles/ north of Cape Vankarem, the Soviet encountered a wide drift ice area which extended all the way to the shore. On the way to Cape Dezhneva the ship had to sail through drift ice composed of small ice floes. Just before it entered the Bering Straits at 1800, 16 Sep, the ice became so compact that it was necessary to drop anchor. The ice was drifting south.

17 Sep 1932: At 1700 the Soviet encountered pancake ice drifting in a east-southeasterly direction.

18 Sep 1932: A southwest wind swept the drift ice from Uelen Harbor. The following day the wind direction changed to northwest, and the compact ice was pushed towards the shore.

19 Sep 1932: The following table shows the drift ice condition in the vicinity of Cape Dezhneva, from the 19th to 23 Sep.

| Date and Hour | Drift Direction | Drift Velocity (knots) | Wind Direction |
|---|---|---|---|
| 19 Sep 1300 | S | 2.0 | NW |
| 19 Sep 1800 | NNE | 0.1 | N |
| 20 Sep 0300 | ENE | 0.2 | NNW |
| 21 Sep 0500 | NE | 0.2 | |
| 21 Sep 1300 | NE | 0.3 | SSE |
| 22 Sep 0700 | ESE | 0.2 | W |
| 22 Sep 1300 | SW | 0.1 | NNE |
| 23 Sep 0900 | SW | 0.2 | N |
| 23 Sep 1300 | SSW | 0.2 | NE |
| 23 Sep 2400 | ESE | 0.2 | NNW |

24 Sep 1932: The Soviet left Cape Dezhneva and sailed towards Provideniya Bay. The last drift ice was seen at 65° 25' N, 170° 37' W.

2. Anadyr Gulf

/DB 270130: Report on Trip to Russian Kamchatka, Tamate M, 1922/

The ice on the upper reaches of the Anadyr River begins to move between the first and middle part of June. In summer the area around the mouth of the river is colder than the upper reaches, and so does not thaw until the middle of June. The thawing usually produces a flood stage in the river, with the water 15 feet or more. The floods subside towards the end of June, and the river returns to normal around the first part of July. Thin ice forms between the middle and last of September, and by the middle of October the ice has stopped the flow of water.

## II. ICE CONDITIONS IN THE ARCTIC SEAS

/DB 303091: Nature, Economics and Transportation of the Soviet Arctic, Research Section, South Manchurian Railway, 1939/

According to Prof Zupoff, the polar ice field covers 5,000,000 square kilometers, and the portion moving south each year contains about 1,000,000 square kilometers. The wind effects changes on the portion moving south, but, in general, the following may be said:

One portion of the ice moves from east to west, passing along Severnaya Zemlya (North Land), Franz Josef Land and Spitzbergen. The other portion goes along the north portion of Greenland, proceeding from west to east. Both pass through the straits between Spitzbergen Island, Greenland, and proceed into the Atlantic.

The coast line of the continent begins to freeze from the last ten days of September to the first ten days of October, and is completely frozen by the middle or end of October. The thaw begins near the end of May, and navigation can commence the middle or end of July. The ice is generally from 85 centimeters to 1.5 meters thick, and a maximum of 2 meters has been recorded off Taimyr Peninsular.

Navigation was previously thought to be extremely dangerous from the time the freezing began until after the thaw when the ice had completely disappeared. Recent research has proven this a false supposition since the coastal ice, as we have seen, never exceeds a thickness of 2 meters, so it can hardly be considered very dangerous. The problem, rather, is the portion of the polar ice field that moves south. This ice, driven by wind and current, is partially submerged, and sometimes becomes 45 meters thick. It prevents navigation, and on occasion has been known to pack around vessels and crush their hulls.

In 1932 the Sibiryakov encountered icebergs from 10 to 12 meters high on the Chukotsk and Bering Seas. The Sibiryakov was an ice-breaker which left Murmansk for Vladivostok at the beginning of the navigation season. The northern winter had already set in, however, when it reached the Chukotsk and Bering Areas, and the north and northwest winds, which blow from autumn into winter, had begun to effect the coast.

The east and west portions of the polar ice are considerably different in form. The west portion is considerably influenced by the Mexico warm current and the many large rivers near by, but the east portion has almost no outside elements affecting it, except for the Lena River. Atmospheric temperature, wind direction and shape of ice are all important to navigation, but the most vital is wind direction, at least as far as ice is concerned.

In summer, Arctic winds blow from the sea to the land, and therefore the ice has a tendency to be blown toward the coast.

In winter, the situation is reversed, and the direction of the ice is exactly opposite. In general, the Arctic may be said to have a prevailing easterly wind.

Ice found east and west of the Novo Sibirskiye Islands is quite different. In the east the high pressure of the Pacific affects the region during the first part of the navigation season, and southeast winds are common. The thaw is slower than in the west, and navigation conditions are good. In autumn the situation is reversed. The Pacific low pressure is in evidence, and the north and west winds blow ice floes along the coast. Navigation in the Borisa Vilkitskogo Straits and Bering Straits is, at such times, extremely difficult.

The west wind commonly blows inland during the first half of the navigable season, packing the drift ice against the shore, and making coastal navigation dangerous. During the latter part of the navigable season, the wind blows out to sea, driving the ice away from the coast and at the same time fascilitating navigation by combating the bad effects of the atmospheric temperature.

It should be noted that near Cape Chelyuskin /TN: across from Severnaya Zemlya, on the Borisa Vilkitskogo Straits/, the situation is somewhat exceptional. Here, the winds are generally west or east, while in the nearby Kara Sea area, in September the strongest winds are generally north, adding to the difficulties of navigation.

This Cape Chelyuskin area is one of the most dangerous for navigation in the Arctic region. If it is avoided, navigation to the east is quite easy, at least in the first part of the navigable season.

In summer the polar ice starts south from the Barents sea. It moves along Spitzbergen Island and the east coast of Novaya Zemlya, to the north of Vaygach Island and along the entire coast of the Taimyr Peninsula into the Novo Sibirskiye Islands and the Chukotsk Sea area. The Kara Sea, the Laptav Sea, and the Berents sea escape coastal ice due to their rivers and sea currents, but the Chukotsk Sea and the Taimyr Peninsula are almost entirely frozen in by the southward progress of the polar ice.

/DB 234307: The USSR and the Arctic, MORIARI Y, 1941/

| Station | Years | Ice Break-up | Ice Melts | Freeze | Frozen Shut | No of Days of Ice | Max Thickness (cm) |
|---|---|---|---|---|---|---|---|
| Yugorskiy Shar Straits (Kara Sea; Barents Sea) | 1910-1934 | 28 Jun | 24 Aug | 20 Oct | 20 Nov | 204 | 107 |

(Contd)

| Station | Years | Ice Break-up | Ice Melts | Freeze | Frozen Shut | No. of Days of Ice | Max Thick-ness (cm) |
|---|---|---|---|---|---|---|---|
| Matochkin Shar (Novaya Zemlya) | 1924-1934 | 9 Jul | 23 Aug | 10 Oct | 28 Oct | 310 | 137 |
| Malye-Karmakuly (Kara Sea) | 1924-1930 | 26 Jun | 10 Jul | 17 Oct | - | 247 | 109 |
| Kolguyev Island (Barents Sea) | 1925-1930 | 14 Jun | 4 Jul | 4 Nov | - | 233 | 79 |
| Vaygach Island (Kara Sea) | 1913-1934 | 17 Jun | 22 Jul | 22 Oct | 25 Nov | 346 | 112 |
| Cape Marc-Sale (Kara Sea) | 1913-1934 | 17 Jun | 17 Jul | 14 Oct | 26 Nov | 348 | 145 |
| Novyy Port (Kara Sea | 1924-1933 | 18 Jun | 6 Jul | 9 Oct | 5 Nov | 266 | 147 |
| Dickson Island (Kara Sea) | 1916-1934 | 23 Jun | 27 Jul | 18 Oct | 25 Nov | - | 158 |
| Indigirka River (East Siberian Sea) | 1939-1940 | - | 16 Jun | - | 4 Oct | - | 235 |
| Yeniseyskiy Gulf (Kara Sea) | 1924-1933 | 7 Jun | 17 Jun | 22 Oct | 25 Oct | 241 | 144 |
| Nizhne Kolymsk (East Siberian Sea) | 1923-1941 | - | 6 Jun | - | 5 Oct | - | 20 |
| Cape Schmidt (North Cape) (Chukotsk Sea) | 1911-1913 | - | 20 Jul | - | 5 Oct | - | - |
| Uelen (on Chukotskiy Peninsula) (Chukotsk Sea) | 1938-1941 | 20 Jun | 28 Jul | - | 15 Nov | - | - |
| Wrangel Island (Chukotsk Sea) | 1927-1935 | 16 Jul | - | - | - | - | - |
| Provideniya Bay (Bering Sea) | 1936-1941 | - | 24 Jun | 9 Oct | 24 Dec | - | - |
| Mouth of Lena River | - | 25 Jun | - | - | 2 Oct | - | - |
| Yeniseyskiy Gulf | | | | | | | |
| River | | 15 Jun | | | 15 Oct | | |
| Bay | | 15 Jul | | | 5 Oct | | |
| North Part of Bay (Kara Sea) | | 28 Jul | | | 28 Oct | | |

A Comparative Table Showing Portion of Sea Frozen During Latter Part of August

| Year | 1930 | 1931 | 1932 | 1933 | 1934 | 1935 | 1936 | 1937 |
|---|---|---|---|---|---|---|---|---|
| Kara Sea | 36% | 35% | 10% | 70% | 62% | 15% | 45% | 25% |
| Laptev Sea | -- | -- | 22% | 70% | 30% | 10% | 40% | 30% |
| East Siberian Sea | 75% | 84% | 65% | 58% | 20% | 50% | 60% | 40% |
| Chukotsk Sea | 25% | 24% | 32% | 18% | 20% | 08% | 12% | 06% |

A. Chukotsk and Adjacent Seas

1. Chukotsk Sea

["Data on Ice Conditions on the Soviet Arctic Coasts in the Winter of 1933-34," Transactions of the Arctic Institute, Vol 45, 1935]

a. Cape Schmidt (North Cape)

On 1 Sep 1933, within the limits of visibility, the surface of the water was covered with smooth pack-ice fields, hummocky on the west. In the bay there also floated combined large and small ice pieces, among which were separate fields. On 2 Sep the fields on the sea changed into large ice pieces as a result of the tide and a weak east wind in the deep part of the bay by the station, and filled the bay lying to the west. The drift ice on the open sea was separated in the morning from the ice in the bay by a gap extending across the bay at its entrance. During the day this gap widened, and with the improved visibility a second gap was observed about 0.5 miles wide 2 miles from shore. It extended along the seashore from west to east within the limits of visibility.

On 3 Sep this gap was covered with large ice pieces and was clear again for one day. From 11 Sep on, the gap at the entrance to the bay was sometimes cleared and sometimes covered again by large and small ice pieces which remained on the sea throughout September. On 16 Sep in the deep part of the western bay and in the bay by the station, young ice which extended east along the shore of the open sea was observed. On the evening of 16 Sep in the deep part of the bay at the station, the young ice froze and formed smooth fast ice which, spreading to the exit of the bay and beyond to the east along the shore, covered the whole surface of the bay by 21 Sep. A small gap remained only in the land floe at the outer part of the bay, but even it was covered by an ice sheet on 22 Sep. The western bay was not covered with a hummocky ice sheet until 1 Oct.

From 2 Sep on, the steamer Mikoyan was stuck fast in the large and small ice pieces in the western bay, and it was taken out by the icebreaker Litke on 11 Sep. Until the formation of the ice patch on 16 Sep, there was a conglomerate of large and small ice pieces in the western bay all the time. This formed a hummocky ice cover when the bay froze. On 17 Sep at Cape VEBER* the icebreaker Chelyuskin dropped anchor, and departed the same day. No more steamers appeared until the next navigation season.

During October the seaward part of the ice floe disintegrated frequently, and water appeared at the horizon reaching the shore to the west of the western bay. During November the visible surface was covered with a sheet of hummocky ice with ice fragments piled edgewise, and in December the seaward part of the land floe frequently underwent considerable disintegration.

After a southwest wind of over 28 m/s and a considerable lowering of the surface of the water, on 1 Dec, the ice in the bay at the station cracked considerably. Water came through the cracks and froze on 4 Dec.

Until 18 Dec the hummocky ice sheet covered the whole visible surface, and on 19 Dec a wide crack was formed along the shore at the place where the gap had been in September. It was covered up by 21 Dec.

On 1 Jan 1934 the seaward part of the land floe disintegrated due to the brisk southeast wind and the lowering of the surface. At the horizon, large ice pieces appeared, and, in the bay, cracks formed which were later covered by 4 Jan. On 8 and 9 Jan small gaps appeared in the land floe 2 - 3 miles from shore. They were 30 - 40 square meters in area, and decreased considerably on 10 Jan and vanished by 11 Jan. From this point to the end of the month, the ice cover remained unchanged. In February, March, April, and up to 5 May the whole visible surface was covered with a hummocky ice sheet.

On 6 May, with light shifting winds, cracks appeared on the ice of the bay. On 7 May the ice in the bay was separated from the sea land floe by a crack about 10 centimeters wide on the line of Capes Kozhevnikov and VEBER*. On 9 May cracks up to 10 meters wide appeared in the land floe 2 miles from shore, and on 10 May they widened to 1 mile in the moderate south winds. On 12 May a gap was formed across from Cape Kozhevnikov, and on 16 May pools of melting snow appeared at the shore. On 21 May the gap across from Cape Kozhevnikov increased considerably, extending to the west beyond the limits of visibility. Large and small ice pieces moved about in the gap with the tidal currents; driven against the edges by the wind and chipping the ice, they brought about an increase in the size of the gap. When the wind shifted to the northwest, the gap changed into a narrow strip in the shape of a fissure.

The pools of melting snow, which were covered by new ice at the low temperatures up to 3 Jun did not freeze from 4 Jun on, but greatly increased in number, cutting the visible part of the ice cover in all directions. From 5 Jun to 9 Jun the cracking of ice was heard from time to time, regardless of the fact that the east winds did not exceed 17 m/s. On 10 Jun a crack 50 to 100 meters wide again appeared 3 miles from shore, extending west beyond visible limits. On 13 - 14 Jun the land floe disintegrated considerably, and on 17 Jun a water patch appeared. On 18 Jun the crack in the ice of the bay was about 70 centimeters wide. The land floe remained about 5 - 6 miles wide until 28 Jun. Beyond its edge large and small ice pieces were drifting, driven by winds from the northern half of the horizon against the edge of the land floe; sometimes they froze to it. On 29 Jun many pools and cracks appeared on the land floe, and on 30 Jun the steamers, Khabarovsk, Anadyr and Sever, passed from west to the east.

Until 6 Jul the cracks in the bay and the land floe continued to spread, and on 7 Jul the ice of the bay and the land floe broke up in the calm weather. The fast ice remained only at the southwest shore of the western bay and in the eastern bay. By 9 Jul there was no more ice in sight, and the eastern bay was quite clear. However, it still filled from time to time with small ice pieces.

Among the 9-ball drift ice, a large gap was distinguished which extended from east to west along the shore. On 10 Jul a second gap was formed opposite Cape VEBER*, parallel to it, and near the shore. There were many breaches in the large ice pieces until 14 Jul, but by 15 Jul they were covered over. On 24 Jul the ice thinned out, and another gap formed in the place of the former one. On 25 Jul once again the ice thinned out on the visible part of the surface of the water, but due to east winds, dense ice was formed at the west shores of the bays. As a result, a clear water approach to the station was opened for boats. On 28 Jul the eastern bay was cleared of ice a second time, and sparse large and small ice pieces with gaps and breaches were on the sea until the end of the month.

Thickness of Ice at Cape Schmidt

| Date | Thickness (cm) | Date | Thickness (cm) |
|---|---|---|---|
| 16 Sep | 1 | 10 Feb | 128 |
| 20 Sep | 2 | 20 Feb | 140 |
| 30 Sep | 8 | 2 Mar | 146 |
| 7 Oct | 27 | 10 Mar | 165 |
| 20 Oct | 40 | 19 Mar | 170 |
| 30 Oct | 42 | 31 Mar | 174 |
| 12 Nov | 46 | 30 Apr | 173 |
| 20 Nov | 49 | 10 May | 167 |
| 30 Nov | 62 | 18 May | 160 |
| 10 Dec | 69 | 30 May | 150 |
| 20 Dec | 79 | 11 Jun | 144 |
| 30 Dec | 89 | 20 Jun | 132 |
| 7 Jan | 98 | 30 Jun | 100 |
| 20 Jan | 100 | 11 Jul | 71 |
| 29 Jan | 117 | | |

b. Wrangel Island (DeLong Strait and Rogers Bay)

In 1933 slush appeared in the west part of the bay on 19 Sep, and remained in a dense border at the shore. The rest of the bay was covered with 6-ball ice pieces which combined at the shores. On 20 Sep 2-ball, separate, one-year and many-year hummocky ice blocs were observed, and on 24 Sep in calm weather the bay was covered with level sheet ice in which there were separate hummocks. The quantity of ice on the sea increased from 20 Sep on, and mixed young and many-year old ice was observed. On 25 Sep the ice on the bay would still support a man, and on 27 Sep one could cross the bay on sled. On 27 Sep, with the shift of the wind to the northwest, the ice on the sea began to diminish, and by 29 Sep there was only 1 ball left. On the following day when the wind abated, ice passed again to the east, covering the surface of the sea to a density of 6 balls. On 1 Oct in calm weather the whole visible surface of the sea was covered with frozen young ice from detached many-year old hummocks.

Fast ice remained on the sea until 28 Oct, when, due to the action of north-northwest winds of over 28 m/s, the ice broke up. Within the range of visibility from the station, the sea was cleared in less than 24 hours. According to Eskimos arriving from the island, ice from the Khishchnikov River was carried for 15 miles. Until 30 Oct when the wind was never less than 11 m/s, no ice was observed on the sea. On this date slush appeared and became dense; from this date on, the sea was covered with a winter ice sheet. (Observations could not be made from 1 Nov 1933 to 29 Jun 1934.)

On 29 Jun the sea was covered by a 9-ball hummocky ice sheet, and 1-ball one-year small ice pieces. On 2 Jul the land floe began to disintegrate under the action of southwest winds, and a gap appeared in it as well as in the bay. On 4 Jul the sheet ice on the bay also began to disintegrate, and only 7 balls remained. On 9 Jul the land floe not only in the bay but also on the open sea disintegrated considerably in the southwest winds, and by 11 Jul the amount of large and small ice pieces and fields on the sea increased to 2 balls. On 13 Jul the land floe vanished, and 6-ball ice, consisting of fast ice and large ice pieces, remained in the bay. On the sea 1 to 2 balls of ice remained with northwest winds, but when a calm arose on 20 Jul, the amount of hummocky fields and large and small ice pieces over a 24-hour period sharply increased to 6 balls and remained at 7 to 9 balls until the end of the month. There was not more than 1 ball of small ice pieces in the bay from 20 Jul on.

By 9 Aug the bay was completely clear of ice, but on 12 Aug 1-ball small ice pieces reappeared. Large and small ice pieces with hummocky fields of 6 to 8 balls remained on the sea from 12 to 13 Aug, with southeast winds. On 12 Aug ice observations ended.

c. <u>Cape Dezhnev</u> (Vellen Station)

Observations of the ice cover at Vellen Station began on 1 Nov 1933, when the visible surface was covered with 10-ball mixed hummocky ice. This cover remained unchanged until 5 Dec. On 6 Dec a strip of fixed ice with grounded floebergs 200 - 300 meters wide extended along the shore. Beyond the edge of this ice, small ice pieces were drifting; in the middle a gap about 2 miles wide, from which a channel of clear water 90 to 100 meters wide led westward along the shore was formed. On 7 Dec the gap began to widen, and 8 Dec the ice passed out to the horizon with a south wind, where it remained at 1 to 2 balls. A patch of ice, 200 - 300 meters wide remained at the shore with packed small ice pieces and grounded floebergs.

With the continuing south wind, on 12 Dec the seaward part of the patch developed several cracks, resulting in the detachment of ice floes that were quickly carried out to sea. The disintegration of the patch continued through 13 to 14 Dec, until the wind shifted to the north. Then, the rest of the patch combined with old ice from the sea which consisted of fields and large and small ice floes of 7 to 8 balls. Due to the ice which came up and froze to it, the patch widened to 500 meters, remaining so until 17 Dec. At that time during a calm, all the floating ice froze, forming a 10-ball land floe.

On 19 Dec the seaward part of the land floe was detached by the south wind, clear water appeared on the horizon, and another gap appeared opposite the station. On 21 Dec large and small ice pieces with floes again came up to the edge of the land floe in the north winds. Breaches and gaps were observed among the drift ice. From 22 Dec on, the main land floe was 400 - 500 meters wide; beyond the edge was a gap 500 - 1000 meters wide, and beyond that the moving part of the land floe. On 26 Dec, beyond the said gap, a second gap appeared 200 - 500 meters wide; beyond it pack ice, among which slush had formed, was observed. Young ice floated in the gaps.

From 27 Dec to 6 Jan 1934, no changes were observed in the condition of the ice, but on 7 Jan the cracks formed by the northwest wind and the young ice in them formed hummocks.

On 23 Jan cracks were formed in places on the land floe. On 6 Feb the whole visible surface was covered with a fast ice sheet which remained until 17 Feb, when the wind changed to the southern rhumbs and detached the seaward part of the land floe again. The remnant was 2 to 3 miles wide. When the wind shifted north on this same day, the whole visible surface was again covered with 10-ball ice.

Throughout March and April a fast sheet of hummocky ice was visible. On 3 May gaps 100 to 200 meters wide and about 2 to 3 miles long were formed in it along the shore. The snow on the ice became granular, and on 5 May water appeared under the snow.

On 14 May, when a gap was hollowed out from the direction of the Bering Strait, the ice had a granular texture. On 16 May the seaward part of the land floe disintegrated under a south wind, and only the foot of the land floe from 500 meters to 2 miles wide remained at the shore. Beyond it were drifting ice pieces and fields of 4 to 5 balls. On 17 May, east of the station, there was clear water beyond the land floe. Toward evening this became covered with drift ice. From 19 to 21 May pools of melting snow appeared both on the drift ice and on the land floe. A movement of ice to the northwest with a south wind was noted.

On 22 May air reconnaissance showed that the strait was clear. In places there were detached accumulations of drifting ice pieces, torn from the land floe which was visible as far as Cape Unikan. This land floe was 1 to 2 miles wide at this point, and 400 meters to 2 miles wide at Vellen. The floating ice moved north and northwest with the south winds. On 23 May a large amount of ice which had been carried out of the Bering Sea appeared on the horizon.

On 24 May the number of pools of melting snow increased and small lakes appeared; near the grounded floebergs the ice was considerably cracked. As a result the floebergs sunk deeper, and the water around them rose to the ice surface. The floebergs melted and darkened considerably, disclosing the sand and gravel in them.

From 25 May to 8 Jun the land floe underwent no change, and beyond its edge large and small ice pieces which changed their direction with the winds and currents were floating. With north winds the density of the floating ice reached 9 - 10 balls. On 9 Jun several small lakes formed on the fast ice, and ice particles were detached from the edge of the land floe. The width of the band of ice on 11 Jun was from 250 meters to 2 kilometers, and beyond its edge the strait was clear of ice. Air reconnaissance on 11 Jun disclosed that in the area of Dezhvev-Serdtse Kamen, the sea was clear and the land floe had been detached in places. On 13 Jun the width of the foot of the land floe was from 250 meters to 2 kilometers, and beyond its edge a slush formation was observed. A half day later, when the wind shifted to the northern rhumbs, large and small ice pieces drifted in from the sea and were driven against the foot of the land floe.

On 15 Jun the seaward part of the foot of the land floe was considerably disintegrated by the blows of the ice pieces, and its width along the shore of Uellen was reduced to 30 to 40 meters. From 15 - 21 Jun 1 to-2 ball ice pieces were moving on the sea, chiefly east to west or northwest. On 22 Jun, with a shift of the wind to the northern rhumbs, the amount of drift ice increased to 4 - 5 balls, and on 23 Jun the visible surface was cleared of drift ice by the south winds.

On 1 Jul the remains of the land floe were detached by the south-southwest wind, and only separate ice pieces were drifting on the visible surface of the sea. During the first 10 days of July the visible surface of the sea was covered from time to time with separate drift ice pieces which still remained at the shores from autumn. These were subsequently detached.

2. East Siberian Sea

[Source same as above]

a. Bolshoy Lyakhovskiy Island (eastern part of Dmitria Laptcva Strait)

The station of Lyakhovskiy Island was transferred in Apr 1934 to the main northern route and only from that time is there material on ice observations. Throughout April the strait was covered with a smooth, fast ice sheet, 176 centimeters thick at the end of the month. A shore band of ice, 2 to 4 kilometers wide, both on the continental side and the islands' side, had hummocky sections. On 30 Apr, in a strong west-southwest wind (up to 20 - 23 m/s), cracks appeared in the ice lasting through the first half of May. The quantity of ice did not diminish in May, but the snow began to melt on 14 May. Small lakes of fresh water appeared and froze over in a few days; this increased the general thickness of the ice to 210 centimeters. On 25 May, small lakes reappeared on the ice; and on 28 May new cracks through which the sea water came were formed.

On 8 Jun a water patch was formed near the shore by fresh water from the surface of the ice; it became transparent on 27 Jun. On the same day under a strong wind, the number of cracks at the shore increased and the ice rose in places. Bands of water were visible at the horizon (obviously fresh water on the surface of the ice). The amount of ice was the same. It was about 200 centimeters thick while in places the ice rested on the ground (there were considerable deep parts in the strait). On 8 Feb, the water patch widened to 2 kilometers and ice pieces floated in it. On 10 Jul, it all broke up and remained as pack ice (large and small ice pieces) until 21 Jul. On 22 Jul, the ice pieces were compressed toward the shore and then the ice went out and remained packed in the deep parts of the strait and thinned out at the shores. On 23 Jul, there was 9-ball-ice; 24 Jul, 5 balls; 26 Jul, 3 balls; 27 Jul, none; and 30 - 31 Jul, 1 - 2 balls of small ice pieces were brought to the shores by the wind.

b. Medvezh'i Islands (Chetyrekhstolbovoy)

Observations of the ice were made from Chetyrekhstolbovoy Island in the Medvesh'i Islands archipelago. The observation point was 2 kilometers from the station, 99 meters above sea level, overlooking the surrounding heights, so that the sea horizon was open all the way round. The visibility from this point was about 20 miles.

On 25 Sep, near the shores of the bay, ice crystals and slush appeared; a small amount of the latter remained until 30 Sep when it increased to 5 to 6 balls. On 29 Sep, sparse, small ice pieces which moved to the northwest appeared in the southeast sector of the sea. On 1 Oct, the slush on the bay changed to pancake ice and within the limits of visibility, on the sea, a slush formation was observed among the sparse large and small ice pieces.

From 2 Oct on, large and small ice pieces also appeared in the bay and remained along with the slush until 6 Oct, after which the whole surface was covered with brash ice about 2 centimeters thick. On 7 Oct, the bay was cleared by a moderate north wind. Until 4 Oct, there were no observations of the sea due to poor visibility. On 5 Oct the whole visible surface of the sea was again covered with forming ice (slush, brash ice) changing into pancake ice; 9-ball-young ice (slush, brash ice, ice rind ice), hummocky in places, remained until 12 Oct when young ice appeared. On 13 Oct, a hummocky land flow formed at the island, beyond the edge of which ice moved about in a wind to the northeast. From 14 Oct the area of the land floe at the island increased considerably and on 22 Oct the whole visible surface of the sea was covered with a fast ice floe in weak winds and with individual gaps in places.

After the clearing of the bay on 7 Oct, slush and ice rind appeared in it again, and patches formed along the shore. The ice became thicker every day and on 16 Oct the whole bay was covered with a fast ice sheet, hummocky in places, 3 centimeters thick. On 23 Oct, at the northern shore of the island, a gap formed in weak south winds covered with floating pan-cake ice. This gap widening from time to time, and covered the whole time with young floating ice, lasted until 2 Nov.

Similar gaps appeared from time to time also in the southern half of the sea horizon, but on 3 Nov all the gaps froze over. They began appearing again when the wind shifted from the north to the southeast and east on 22 Nov.

The formation of gaps in all directions from the island went on until 21 Dec, depending upon the direction of the winds. There were no changes in the ice cover from this date to 3 Jun 1934, except for the formation of hummocks at the edge of the shore and the floe which surrounded the island in a band about 2 to 5 miles wide.

On 4 Jun 1934 water, from thawing, appeared on the ice near the shore, and flowed through the cracks. From this water on 5 Jun a water band was formed on the ice around the island and grew wider each day. On 6 Jun pools of melting snow appeared on the whole visible surface of the ice; their number increased continually until on 11 Jun small lakes formed. On 7 Jun on the north part of the horizon for the first time after the freezing, a water sky which subsequently appeared several more times was noted. On 8 Jun, along the shores of the island, a transparent water patch formed 20 to 100 meters from the shore.

On 14 Jun, the number of small lakes on the ice decreased considerably since the water was flowing into the cracks and thawed gaps which had formed. The hummocking of the ice, regardless of the weak winds, evidently continued due to the vibration of the surface and the currents.

During the second half of June the ice disintegrated considerably and on 28 Jun the cracks in some places became 10 meters wide. There were many cracks to the west of Chetyrekh-stolboyov Island in the direction of Lysov Island.

On 8 Jul, there was a movement of ice in the north wind. The ice was up to 100 centimeters thick but it was melting considerably underneath. As a result of the movement along the southwest shore of the island, a gap, which extended west to Lysov Island was formed. The outer part of the bay was free of fast ice.

On 11 Jul, there was a marked slow movement of ice in the sea to the west-southwest in a brisk east wind. The ice moved in a body forming gaps and hummocks. The pressure of ice on the eastern shores was so strong that the shore disintegrated.

On 13 Jul, the fast ice broke up completely, several gaps formed and on the whole visible surface of the sea there was a 9-ball-mass of ice in the moderate east winds which formed hummocks and moved slowly westward. On 16 Jul, in the east and among the islands in the west, a large space with sparse ice was formed. On 17 Jul the island was encircled with large ice pieces and large 8-ball-floes beyond which a field of ice pieces was observed. Ice, gradually disintegrating with the shifting winds and waves, changed on 26 Jul from large fields to large and small ice pieces. Hummocky fields remained only in the eastern half of the horizon. On 28 Jul, the fields moved to the island and in the east wind passed further to the west. On 31 Jul, large and small ice pieces with sparse fields up to 2 balls were observed within the limits of visibility.

Thickness of Ice at Chetyrekhsolbovoy Island

| Date | Thickness of Ice (cm) | Date | Thickness of Ice (cm) |
|---|---|---|---|
| 2 Oct | 2 | 8 Jan | 103 |
| 12 Oct | 5 | 19 Jan | 114 |
| 20 Oct | 20 | 29 Jan | 124 |
| 30 Oct | 28 | 4 Feb | 131 |
| 10 Nov | 43 | 24 Feb | 142 |
| 22 Nov | 57 | 9 Mar | 171 |
| 30 Nov | 66 | 2 Jul | 130 |
| 9 Dec | 82 | 9 Jul | 110 |
| 19 Dec | 91 | 19 Jul | 90 |
| 30 Dec | 94 | | |

Until 17 Jul, 1- to 2-ball-large and small ice pieces remained on the sea. On 18 Aug, the visible surface of the sea was completely cleared of ice; ice remained only in the bay.

3. Drift Ice Conditions in the East Siberian Sea

/DB 302476: "Hydrological Survey and Drift Ice Conditions from East Siberian Sea to Bering Sea," Far East-USSR and Outer Mongolia Research Data No 54, Research Section, South Manchurian Railroad, Dec 1939, from the Russian of I. A. Kireev, 1936/

a. Chronological Observations During the Navigable Season, 1932 (Survey report by Arctic Research Peoples' Maritime Commission).

31 Aug 1932: While the ship was passing Cape Yakan, a small area of 7 to 8-ball-drift ice was observed. As the ship sailed westward, the ice gradually became more sparse and off the shores of Cape Billings an open sea lane was formed. At nightfall,

drift ice having a density of 3 to 4 balls was seen several miles west of Cape Billings.

1 Sep 1932: The survey party sailed through 20 miles of drift ice (density of from 3 to 5 balls) after leaving Cape Billings. Large ice fields began to appear in the vicinity of NORIDE* Bay.

2 Sep 1932: The survey party's progress westward was retarded because of heavy fog, and it was necessary to sail among the ice fields and large ice floes to get maximum protection from the strong wind. The fog began to lift around the neighborhood of Cape KOZHMIN*. The ships followed a course close to the shore and about 10 miles east of Cape Shelagski, a sea lane with scanty drift ice was found. The ships proceeded to Aion Island.

3 Sep 1932: The density of drift ice north of Aion Island was 6 balls, and it was found that the density of drift ice decreased as they neared the island. During the westward progress to Cape Baranov, wide-open lanes, containing little or no drift ice, were found.

4 Sep 1932: Some of the ships in the survey party proceeded to the mouth of the Kolyma River, and no drift ice was seen in this area. These vessels remained at anchor in this region from 4 to 24 Sep.

24 Sep 1932: The survey party left the Gulf of Kolymski and sailed eastward to Aion Island. At 166° 10' E, they sighted a sea lane containing no drift ice, and at 69° 54' N they observed a flow of drift ice having a density of 3 to 4 balls. The amount of drift ice increased as they sailed eastward. Reaching the western side of Aion Island, they noticed an ice-free passage between the shore and drift ice boundary. To the north this open lane gradually became narrower.

25 Sep 1932: One of the ships sailed through the narrow strait southwest of Aion Island, and proceeded to Chaunskaya Bay. During the night a large drift ice pack was encountered at 70° 18' N, 168° 52' E. This ship was unable to free itself from the ice pack, so it was necessary to spend the winter in this area. Another ship circled Aion Island and attempted to enter Chaunskaya Bay from the north. However, the entrance to the bay was completely blocked by ice. Wide areas of drift ice were seen drifting towards Cape Shelagski. A field of ice also extended from Cape Shelagski, along the coast southward to Rautan Island.

26 Sep 1932: The open sea lane on the northwest side of Aion Island gradually moved away from the island, and the drift ice spread along the coast. The old ice closed in on the entrance to Chaunskaya Bay and formed an ice barrier along 70° N. Thin ice and new ice were seen within the bay.

28 Sep 1932: The thin ice in the northern part of Chaunskaya Bay was 5 to 10 centimeters thick.

2 Oct 1932: The icebreaker located at 70° 14' N, 169° 05' E tried to assist a ship stranded 5 or 6 miles south in Chaunskaya Bay, but failed after four days. The thickness of the new ice in the bay increased 15 to 18 centimeters, and the formation of icebergs began. On 7 Oct the icebreaker also retreated into the bay and joined the other stranded vessels to prepare for the winter.

b. Observations During the Winter Season, 1932-1933

All the ships in the survey party were stranded in Chaunskaya Bay until the spring thaw. One of the vessels was stranded in drift ice north of Chaunskaya Bay and between Aion Island and Cape Shelagski. At first the vessel drifted eastward, then towards the northwest. During the latter part of November it drifted as far north as 71° 06' N, 168° 37' E, approximately 70 miles north of Cape Shelagski. Then it drifted southward, and in May it was located several miles north-northwest of Cape Shelagski.

c. Chronological Observations During the Navigable Season, 1933

1 Jul 1933: The icebreaker was the first vessel to leave Chaunskaya Bay and was sent to aid the vessel which was located north-northwest of Cape Shelagski. The icebreaker finally reached the stranded vessel on 18 Jul, at 70° 45.5' N, 168° 23' E, north of Aion Island. The icebreaker was able to free the stranded ship, and they both arrived at the mouth of Kolyma River on 21 Jul 1933. Three of the five ships in Chaunskaya Bay set sail on 16 Jul, rounded Aion Island on 17 Jul, and arrived at Kolyma River on 19 Jul 1933. The other two vessels sailed eastward from Chaunskaya Bay, and after passing Cape Shelagski on 17 Jul, they encountered a large drift ice pack. The two ships made very slow progress and on 1 Aug they were only 20 miles east of Cape Shelagski. By utilizing the flow of drift ice, they were able to reach Cape Shalaurova on 4 Aug.

23 Aug 1933: A large drift ice pack was observed between Shalaurova Island and Cape Aachim. In some instances, explosives were used to free the stranded ships.

1 Sep 1933: The drift ice along the coast of Shalaurova Island receded out to sea and formed huge ice floes. This phenomena was caused by a south wind. The scattered drift ice were all joined together by the formation of new ice (about 3 centimeters thick).

3 Sep 1933: The open sea lane from 8 miles off the coast of Cape Billings to Cape Yakan abruptly closed up at 69° N, 176° 50' E, and it was necessary for the ships to return toward Cape Billings. The second attempt was made along the coastline, but the progress was very slow. The party finally arrived at Cape Vankarem on 13 Sep.

4. Observations of the Icebreaker Litke, 1934

/DB 303474: Ice Conditions in the Arctic Ocean During the 1934, According to Observations of the Icebreaker Litke, Central Meteorological Observatory, Aug 1943, translated from the Russian of V. Yu. Vize, Transactions of the Arctic Institute, Vol 29, All-Union Arctic Institute, 1935/

The Litke, which had left the Bering Sea for the Chukotsk Sea, encountered ice at: 67° 55' N, 174° 39' W, on 14 Jul. This ice was small tongues of ice lying some distance northeast of a large ice field which was in contact with the Chukotsk sea coast. Skirting the northeast ice floes, the Litke advanced northwest and entered the ice at 68° 42' N, 177° 01' W. The density of the ice, which was broken up considerably, soon reached 7 balls, but when we arrived at 68° 57' N, 178° 12' W, it was 10 balls. Because it became extremely difficult to advance through this hard compact ice, the Litke drifted along with the ice until 20 Jul, when it shifted its course toward the southeast and then reversing itself went through the ice floes. From here (68° 41' N, 176° 53' W) the ice floes continued all the way to 69° 21' N, 175° 12' W; at this point, the ship entered ice again. At 69° 33' N, 175° 34' W, where the Litke stopped 21 Jul the ice was considerably broken up and with a density of 8 balls. The ice of the Chukotsk Sea in Jul 1934 had characteristic channels running in a northwest direction because of the influence of the warm sea water from the Bering Sea.

Because of maneuvers of airplanes, the Litke halted near the ice floes until 23 Jul; on that day it started once more on its voyage toward the northwest. From 68° 50' N, 177° 38' W to 69° 09' N, 179° 51' W the ice density varied between 7 and 10 balls. Here, the outer surface of the ice was composed of broken ice of various sizes; the ice field of paleocrystic ice floes was composed of brash ice. The larger ice floes were very dirty in color and greatly eroded by melting.

From the 180° meridian, the Litke advanced along the sea coast through a thin ice-belt 3-5 miles in width, as far as 176° 30' E. This belt was bounded by ice floes heaped one upon another, which were extremely dirty and which had small fresh water lakes on the surface. Along the coast the Litke encountered, rather frequently, ice floes rising above sandbars (stamukhi). West of 176° 30' E, no consolidated ice fields were seen in the north. Before arriving at Shalaurova Island the Litke entered clear water composed of gaps of water in an ice-covered surface (Polyn'ya) along the seacoast about 4-10 miles in width. The gaps near Cape Yuzhmin were blocked by a field of large ice floes. The icebreaker went around the field on the coastal side.

In crossing Chaun Inlet, the Litke sailed a zigzag course through clear water which was some distance from the ice floes on the southern side. At 69° 58' N, 167° 13' E the

Litke again entered ice, which continued as far as Cape Medvezhi. It encountered flat ice 30 centimeters thick broken up into various sizes. West from 165° E, the ship ran into extremely dirty ice floes for the most part.

On the trip (31 Jul) from Cape Medvezhi to Medvezhi Island, the Litke encountered ice of 7-9 balls density (broken ice of various sizes, brash ice-fields, and flat ice-fields). The northern tip of this ice lay across 70° 27' N.

While sailing from Medvezhi Island to the Novo-Sibirskiye Islands, the Litke cut across two ice accumulations. These were in the form of tongues, separated from the ice floes which were conjectured to exist in the northeast. Perhaps the previously-mentioned accumulations of ice were not a continuation of the large ice floes in the Siberian Sea; they seemed to form individual pancake-shaped ice masses; however, these various conjectures are not very reliable.

The Litke encountered the first accumulation of ice between 71° 28' N, 159° 36' E and 71° 45' N, 157° 58' E. Here, it discovered large amounts of brash ice and fragments of ice fields whose density varied between 1 and 3 balls. The second accumulation of ice was between 72° 00' N, 156° 13' E and 72° 20' N, 153° 30' E. Here were ice fields, ice field fragments, and brash ice of all sizes whose density was 1 to 8 balls. The ice fields were not hard (20 cm thick) and were greatly eroded from melting; they gave an appearance of great decay. The greater part of the ice was very dirty.

Heading westward from this second accumulation of ice, the Litke continued to encounter isolated masses of ice (density for the most part less than 1 ball); after that it never encountered any ice at all in the seas, until it arrived at Great Lyakhov Island.

Although Dmitriya Lapteva Strait, passed 2 Aug, was clear, on the south coast of Great Lyakhov Island white patches of ice could be seen. While the Litke was sailing to Tiksi Bay, ice was encountered only at 72° 48' N, 137° 54' E (3 Aug). There a sheet of thin ice (density: 1 ball) about one-half mile wide was seen. This strip of ice did not extend very far to the south; in the north, the strip continued beyond the horizon. This belt of ice was very thin and consisted of ice fields which had completely broken up.

Travelling from Tiksi Bay to Samuila Island, the Litke encountered small detached ice floes, at 73° 04' N, 131° 18' E. At 73° 15' N, 131° 20' E, the density of the ice (broken up into various sizes) was as low as 1 ball. Some ice detached from these floes was seen at 73° 24' N, 131° 22' E.

In the northwestern part of the Laptev Sea, ice was first sighted on 11 Aug. The southern tip of the ice was sighted at 76° 12' N, 118° 40' E. Sailing alongside this ice margin at a safe distance of 2-10 miles, the Litke continued northwest with the ice margin to the starboard. At 76° 41' N, 115° 45' E, the

Litke entered the 4-5 ball-ice which was broken up in large and small floes. At 76° 49' N, 114° 52' E, it began to encounter a greatly eroded ice field with a thickness of 5-50 centimeters. Icebergs which had small freshwater lakes at rare intervals were also encountered. At 76° 54' N, 114° 14' E the density of the ice was 8-9 balls. About 70% of the ice here was less than 50 centimeters thick; ice one meter-thick was rarely encountered. On 12 Aug, at 77° 06' N, 111° 17' E, the Litke entered a sea of ice. All the ice encountered on the course northeast from PIYOTORU* Island was less than one year old.

It was not difficult for an icebreaker to sail through these ice belts whose width was 73 miles.

On 12 Aug the Litke approached Samuila Island. The straits between the various islands in the above group were covered with land floe ice that was still difficult to crack. According to N N ULVATEV* who passed the winter on these islands, Faddeya Bay at this time of the year freezes in the same manner as Samuila Island.

The steamer belonging to the Lena River Survey Unit was anchored in the land floe between the islands of the Samuila group; the Litke had to assist this ship. In order to sail the ten-odd kilometers between it and the Lena River Survey Unit ship, the Litke had to labor for 112 hours. During the first two days it advanced slowly by pulverizing the land floe which was ½ to 3/4 meter thick; on the third day the ice was 1.5 meters thick.

From 18 to 19 Aug, two airplanes carried out reconnaissances to explore the width and general nature of the hard ice which lay across the eastern part of the strait from the Litke. On the second reconnaissance the ship captain N M Nikolaev himself participated. The width of the above ice was 19 miles. The ice-margin extended northward from the Samuila Islands, then northeastward, and finally toward the area of Malyy Taimyr Island.

On 21 Aug, the Litke traversed the course opened as the result of icebreaking by the YERMATSK* and crossed the ice lying across Vil'kitskiy Straits. The ice, rarely exceeding ½-2/3 meters in thickness, was greatly melted. According to observations made by the Sibiryakov, this ice cracked finally on 27 Aug.

Between Cape Chelyuskin and Russkiy Island (24-25 Aug), the Litke entered upon clear water; it rarely encountered ice floes. Crossing a belt of thin ice north of Russkiy Island, at 76° 56' N, 94° 05' E, the Litke approached the margin of the ice (brash ice-fields and large floes of broken ice), but sailing along the margin of this ice, advanced toward the northwest. On 27 Aug the Litke took a course toward the southwest and advanced 55 miles to come out upon a smooth sea. However, on the way it encountered year-old ice, large and small ice fragments, ice almost completely melted, and ice 20 centimeters thick.

Cruising along the western part of the clear water, on 29 Aug the Litke encountered continuous fields of ice floes (8 balls in density) and blocks of ice rising up over sandbars

(76° 30' N, 89° 03' E). On 31 Aug, the Litke again took a southwest course and encountered chiefly small ice floes about one year old; occasionally, closer inspection showed fields of ice floes two years old. After 75° 16' N, 86° 57' E, ice fields were no longer encountered. At 74° 47' N, 84° 10' E the Litke came upon clear water (1 Sep) and then cut across the lower part of a sea of thin ice, about 10 miles wide. The southwestern edge of the ice in this sea was sighted at 74° 22' N, 82° 37' E. The sea from here was clear all the way to Dickson Island.

In navigating from Dickson Island to Yugorskiy Shar Straits (14-16 Sep), absolutely no ice was encountered.

The table below lists the number of miles the Litke passed through ice:

| Sea | No of Miles Through Ice | Distance Through Compact Ice |
|---|---|---|
| Chukotsk Sea | 135 | 60 |
| East Siberian Sea | 345 | 16 |
| Laptev Sea | 94 | 58 |
| Kara Sea | 179 | -- |
| Barents Sea | --- | -- |
| Total | 753 | 134 |

Since the distance from Cape Dezhnev to Cape Murman is 3505 miles, the number of miles of ice the Litke traversed was only 22% of its total voyage in the Arctic Ocean. The distance through compact ice (density of 8 or more balls) was only 4% of the total distance.

According to these figures, the summer of 1934 can be regarded as a year when there was little ice on the Arctic Ocean routes.

B. Kara and Adjacent Seas

1. Kara Sea

/Data on Ice Conditions on the Soviet Arctic Coasts in the Winter of 1933-34," Transactions of the Arctic Institute, Vol 45, 1935/

a. Cape Zhelaniya, Novaya Zemlya (76° 56' N, 68° 35' E)

On 19 Oct 1933, small icebergs, moving slowly northeast, were noted for the first time in the open sea, as observed from the cape by rhumbs from northwest to north-northeast. Ice in the form of floating icebergs and fields with a density of 5 to 7 balls was observed for the second time 28 to 30 Oct. On 31 Oct the water was clear.

On 1 Nov there was 8-balls-brash ice. On 2 Nov it was clear, but on the northern part of the horizon an ice sky was seen. From 3 to 5 Nov there were 1 to 5-ball-ice fields moving south-southeast. On 6 Nov it was blown back beyond the limits of visibility by the south-southeast wind. From 10 to 11 Nov a few large drifting icebergs appeared; from 13 to 18 Nov icebergs and ice fields of 2 to 10 balls' density appeared. On 19 Nov the sea was clear; on 21 Nov there was another 3-ball-field from northeast; on 21 Nov the sea was clear; on 22 Nov 8-ball-ice fields came from the north. On 23 Nov there were 10 ball ice fields, and on 24 Nov the ice stopped moving and turned into a 10'ball stationary icefield of land floes from 15 to 150 centimeters thick. On 26 Nov there were 7 balls of ice left, and on 30 Nov the sea was clear, due to a south-southeast wind of over 28 m/sec. Wherever slush was formed, it was 1 ball.

On 4 Dec, 10-ball-large ice pieces appeared with a wind of over 28 m/sec blowing northwest. Part of it, 3 balls, remained by the shore. On 6 Dec the fast ice was already 10 balls. During the following days, the ice became firmer and from 21 to 144 centimeters thick. On 16 Dec part of the ice was blown away by a 17 m/sec wind. From 17 Dec to the end of the month there was 10-ball-ice, 48 to 116 centimeters thick, regardless of storm winds. On 30 Dec there was a water sky at the horizon from northwest to north.

On 8 Jan 1934 part of the ice was torn from the northwest side and carried out to sea, leaving the remainder at 8 balls. On 10 Jan almost all the ice was carried out except a narrow 1-ball-strip of shore land floe from 68 to 134 centimeters thick. On 13 Jan there were 6 balls of ice. On 14 Jan all the ice was carried out by a wind of over 28 m/sec. On 15 Jan there was a level land floe, 7-ball-young ice, and on 16 Jan, 10 ball. On 19 Jan half of the ice broke up, and on 20 Jan almost all the ice was carried out. A 1-ball-shore land floe remained. On 21 Jan 5-ball-large ice pieces were blown out by a south-southeast wind of over 28 m/sec; on 22 Jan the sea was clear; on 23 Jan there were 4-ball-ice fields; on 24 Jan the sea was clear, and ice fields were visible on the horizon to the northwest. From 25 Jan to the end of the month drifting large and small ice pieces were observed of from 7 to 9 balls density, except on 30 Jan, when there was no ice (with a west wind of over 28 m/sec; however, on the following day, this same wind blew in 7-ball-ice).

Throughout the first 10 days of February a conglomerate of ice pieces and ice floe masses, 63 to 80 centimeters thick, of 10 balls density, remained fast. On 12 Feb its seaward part was moving southeast. In the fast part (the shore part, of 5-ball-ice) individual gaps appeared.

The 10-ball-ice remained until the end of the month. In the seaward part, movement to the southeast was noted from 21 Mar on. On 27 Feb the ice was broken up, and on 28 Feb it changed into 7-ball-small ice pieces. There was clear water on the horizon. On 1 Mar there were thinning small ice pieces of 8 balls, and then on 20 Mar there was a 10-ball-fast sheet. On 21 Mar part of the ice was carried out, with a remainder of 7 balls, of which 2 balls were large ice pieces.

From 22 to 24 Mar there were from 3 to 8 balls of ice, almost all floating ice pieces. From 25 to 28 Mar 1-ball-small ice pieces and icebergs floated by at infrequent intervals.

On 29 Mar there were 8 balls and on 30 Mar there were 10 balls of fast ice.

About 10 balls of ice remained until 22 Jun. From 0.2 to 0.5 of its area was taken up with the movement and breakage of ice during the beginning of the first and second ten day periods of Apr. On 8 Apr part of the ice was carried out by a strong wind from the south-southeast, leaving a remainder of 7 balls; however, its quantity increased to 10 balls again in the course of the day.

On 23 Apr the northwest portion of the ice was blown away, with a 6-ball-remainder; on 24 Apr, it was 4 balls, and on 25 Apr large ice pieces were blown in by a north-northwest wind. With the remains of the fast ice, there were 6 balls in all. On 27 Apr there were 10 balls of fast ice floes.

On 2 May 3 balls of ice were left, under the influence of a west wind. Of the fast ice only the narrow shore band which generally does not disintegrate in winter remained. From 4 to 10 May the quantity of ice increased, and most of it became quite fast. On 16 May there were 10 balls of fast ice. On 17 May half the ice broke up. On 18 May there were 8 balls of ice, mainly ice pieces. On 20 May there were 10 balls. On 24 May there remained only a shore land floe of 1 ball, on which there were pools of melting snow. On 29 May 5 ball large ice pieces came in; on the following day there were 6 balls, and the land floe band increased to 2 balls.

Through the first 10 days of Jun the ice remained from 8 to 10 balls, while the land flow band grew to 4 balls, and then broke up. On 12 Jun there were 7 balls of ice; on 13 Jun 4 balls; on 14 Jun, 8 balls. The fast band of ice grew again in these and the following days, and on 18 Jun all the 10-ball-ice became fast and remained so; on 28 Jun it all broke up and was carried out. On 30 Jun there was a 1-ball-remainder of small ice pieces.

Southeast of the station in Pospelov Bay, the ice process went on rather uniformly.

On 19 Oct 1 ball of slush appeared for one day, then 5 to 6 balls from 27 to 30 Oct. From 1 to 2 Nov there were 3 to 7 balls of ice crystals. From 3 to 6 Nov there were 8 to 10 balls of young ice. On 7 Nov this was already a 5-ball-land floe, reaching 10 balls on 11 Nov. On 12 Nov 2 icebergs appeared in the bay. The ice was torn away on 18 Nov by the west wind, and half of it was blown out to sea. On the following day there were only two icebergs left in the bay, resting on the bottom. On 20 Nov 7-ball-ice was blown into the bay by a northeast wind. On 21 Nov the sea was clear, (except for the icebergs, which remained throughout the winter). On 22 Nov small ice pieces blew in from the sea, and they combined with the local young ice, 10 balls. On 2 Dec the ice was carried out to sea by a northwest wind; on 4 Dec 6-ball-sludge ice was formed. On 5 Dec an 8-ball-fast land floe 5 centimeters thick was formed. Then, until the end of the month there was 10-ball-fast ice, except on 16 Dec, when two-tenths of the ice from the sea side of the bay was carried out to sea.

In the first 10 days of January there were 10 balls of ice. From 11 to 13 Jan 1934 there were 4 to 5 balls of ice. The ice was torn from the sea side of the bay; on 14 Jan there were 10 balls, and on 15 Jan, 7 balls; on 16 Jan, 10 balls; on 19 Jan there were 8 balls, while in the seaward part there were ice pieces. On 20 Jan there were 2 balls, and on 21 Jan all the ice was carried out to sea to the north. On 22 Jan there was 1 ball of young ice, increasing on 28 Jan to 7 balls and forming a small land floe. On 29 Jan the amount of ice diminished to 4 balls. From 2 Feb it increased and on 4 Feb reached 10 balls. Half of the ice was floes. On 12 Feb there were 8 balls of ice, and on 13 Feb 10 balls, then for 3 days, 6 balls. From 17 Feb on there were 10 balls again. From 26 Feb to 4 Mar the ice remained at 5 to 6 balls, while in the seaward part there were ice pieces. From 5 to 20 Mar there were 10 balls. A third was fast ice, the remaining two-thirds being floes. On 21 Mar the seaward portion of the floe ice was carried out. There was a remainder of 8 balls. From then on the ice continued to break up and be carried out. On 29 Mar there was a remainder of 1 ball.

On 30 Mar small ice pieces appeared and solidified into 10 balls of young ice. Fast, largely floe ice of 10 balls remained throughout April and May. But in May at the time the wind strengthened there were days with less ice: from 7 to 8 May there were 5 balls; 18 to 19 May, 8 balls; 24 to 28 May, 8 and 6 balls. On 30 May the thickness of the ice measured 120 centimeters.

In Jun the ice was generally 10 balls, except for 1 Jun when it was 7 balls, 5 to 8 Jun, 7 to 9 balls; 15 Jun, 9 balls; and 29 Jun, 8 balls. At the end of the month, the ice deteriorated as follows: on 26 Jun there were individual gaps; and on 27 Jun there were pools of melting snow. On 30 Jun there were fresh water pools on the surface.

b. Matochkin Shar (73° 16' N, 56° 24'E)

On 5 Oct slush appeared on Nochuev Brook, and on 7 Oct ice crystals appeared on the northern shore of the strait. After a snowstorm on 12 Oct snow blown from the bank formed sludge ice at the mouth of Nochuev Creek. On 15 Oct the whole eastern part of the strait was covered sludge ice, especially thick on the northern shore. From Cape Drovyaniy to the outlet of the strait into the Kara Sea, a land floe was formed which extended to the middle of the strait.

With the formation of the land floe an intensive formation of brash ice, sludge and slush began in the whole strait, as a result of which passage for ships was impossible on 15 Oct. On 16 Oct the whole eastern part of the strait was thickly filled with brash ice and slush, which, on the morning of 17 Oct, was driven to the north shore of the strait by the south wind, and in the evening was carried into the Kara Sea by the west winds. On 18 Oct brash ice appeared for the second time in the strait. On 19 Oct ice appeared on the horizon of the Kara Sea.

From 22 to 24 Oct the strait was clear of ice, and on the 24th the strait and the visible part of the sea were covered with brash ice and slush to the extent of 9 balls. On 25 Oct the frozen brash ice and slush formed a land floe at the southern shore and sheet ice in the area of Capes Popevechinyy and Drovyanoi and at the outlet of the strait. The rest of the strait was covered with yound ice. On the morning of 26 Oct the eastern part of Matochkin Shar was covered with a fast ice sheet, in which a shore gap on the northern shore between Nochuev Brook and Cape Vykodnov and a gap across from the station remained until evening.

On 27 Oct young ice and a sludge ice were floating in the gaps. On 28 Oct only the shore gap at Nochuev Brook remained. On 29 Oct the number of gaps increased, and, regardless of the weak winds in the northern quarter, the land flow was separated from the southern shore of the strait by the current, evidently, and on 30 Oct in the morning the eastern edge of the land floe advanced from the station to Cape Byk. All the ice was carried by the current from the eastern part of the strait into the Kara Sea, but in the evening sludge and young ice were formed again, and on the horizon of the Kara Sea, fragments of an old ice field were visible. In the evening of 31 Oct the strait was partly cleaved by the current, and on 1 Nov ice rind formed. This froze on 5 Nov into a flat sheet of winter ice, the edge of which extended for several miles beyond the confines of the strait into the Kara Sea. The solid land floe remained in that form until 3 Feb 1934, when its seaward part thinned, and on the horizon hummocky fragments of ice fields appeared; these broke up into large ice pieces on 5 Feb.

In the evening of 10 Feb the seaward part of the land floe formed again, but it was hummocky, differing from the fast ice of the strait. From 13 Feb on, the land floe was not formed beyond the line of Cape Vykhodnoy and Cape Klokov, and the whole visible portion of the sea beyond the edge of the land floe in the strait was full of floating, chiefly heavy, hummocky ice of a variegated type, except for icebergs.

Ice was brought daily by the ebb and flow of the tides near the edge of the land floe, and at other times carried out again, forming a band of clear water along the edge. According to traders, long hummocks extended on the horizon from across the strait to the north beyond Cape Kankrin. There were no instances of the visible surface of the sea being clear of floating ice for more than one day until 1 Sep.

The thickness of the ice, measured at a distance of 100 to 200 meters from the shore, increased intensely at a rate of 9 centimeters every 5 days until 13 Nov, after which the increase dropped to 1 to 3 centimeters. From 22 Nov on, it increased again to 5 to 9 centimeters every 5 days. The greatest jump in the development of ice, as much as 12 centimeters, was observed between 15 and 20 Dec, after which the growth decreased again and did not exceed 3 to 4 centimeters every five days until 20 Apr. On 20 Apr the thickness of the ice reached its maximum of 121 centimeters, which remained with small fluctuations (up to 119 centimeters) until June. Then intensive thawing began, and between 25 to 30 Jun, the thickness diminished to 38 centimeters, after which the change in the thickness proceeded slowly until the winter ice sheet actually disappeared. The maximum measurement of ice thickness in November was 40 centimeters; in December, 77 centimeters; in January, 85 centimeters; in February, 94 centimeters; in March, 112 centimeters; in April, 121 centimeters; in June, 119 centimeters; and in July, 41 centimeters.

The thickness of the snow cover on the ice in November was about 2 to 3 centimeters, and in April about 16 centimeters.

The disintegration of winter ice in the strait began on 7 May with the formation of pools of melting snow at the northern shore. The melting pools were covered with snow except on 28 May when a drop in atmospheric temperature covered them with young ice. The amount and extent of the pools kept increasing constantly. On 21 Jun at the northern shore water, which expanded considerably at Nochuev Brook on 23 Jun appeared.

As a result of the expansion of the water and the increased pools on the ice, foot traffic across the strait was impossible on 25 Jun. On 26 Jun cracks appeared on the ice, and a gap extended from Nochuev Brook to the middle of the strait.

On 10 Jul the gap from Nochuev Brook extended far to the south, and also along the northern bank. The sheet ice of the eastern part of the strait was considerably vitiated by small lakes and gaps. On 11 Jul it was broken up by a south-southeast wind of 4 m/sec. The edge of the sheet ice remained between Cape Poperechnyy and Cape Drovyanov, and a large ice field floated at the mouth of the strait.

On 24 Jun a post was set up on Cape Kaukrin to observe the ice on the open sea. The results indicated that the shore land floe had combined with the Matochkin Shar land floe, that the sheet ice of Kaukrin Bay was covered with small lakes, and that beyond the land floe floated large pieces of 10-ball hummocky ice. On 30 Jun the land floe was torn loose north of Cape Kaukrin, and on 1 Jul it was torn away south of the bay. On 3 Jul a heavy pack of 7-ball-floating ice was driven toward the horizon by southwest winds; on 5 Jul the sheet ice in Kaukrin Bay was broken up and carried out to sea. After that, on 18 Jul the bay was piled up with small ice pieces by winds from the northeast coming in from the sea, and the bay was not clear until 22 Jul.

On 12 Jul the land floe disintegrated in the narrows between Cape Popevechnyy and Cape Drovyanoy, and in the eastern part of the strait, within the range of visibility, there remained only 4-ball-small ice pieces. On 14 Jul these were carried out of the strait by the current and by winds from the northwest. Until 16 Jul the strait was quite clear of ice, and 16 Jul 6-ball-large ice pieces were carried into the strait from the sea. These were gradually carried out to sea by northwest winds from 18 Jul on, and by 22 Jul the strait was cleared, although on the horizon of the Kara Sea there remained large pieces of hummocky ice. On 26 Jul small ice pieces were again carried into the strait from the sea by southeast winds. Sometimes they filled the whole strait, and sometimes they thinned out and were driven against the shore. This condition lasted until 1 Sep.

Thickness of Ice in Matochkin Shar Strait, 1933-34

| Date | Thickness (cm) | Date | Thickness (cm) |
|---|---|---|---|
| 7 Sep | 18 | 11 Jan | 80 |
| 13 Nov | 27 | 20 Jan | 85 |
| 15 Nov | 28 | 30 Jan | 85 |
| 17 Nov | 30 | 11 Feb | 88/16 |
| 21 Nov | 30/3 | 20 Feb | 94 |
| 22 Nov | 31 | 1 Mar | 98 |
| 23 Nov | 31 | 14 Mar | 108 |
| 24 Nov | 33 | 23 Mar | 112 |
| 25 Nov | 34 | 10 Apr | 116/16 |
| 26 Nov | 36 | 20 Apr | 121 |
| 28 Nov | 37 | 30 Apr | 121 |
| 29 Nov | 37 | 10 May | 120 |
| 30 Nov | 40 | 20 May | 120 |
| 1 Dec | 42 | 1 Jun | 119 |
| 2 Dec | 44 | 20 Jun | 101 |
| 3 Dec | 46 | 24 Jun | 79 |
| 6 Dec | 51 | 25 Jun | 75 |
| 9 Dec | 56 | 26 Jun | 70 |
| 10 Dec | 56 | 27 Jun | 55 |
| 13 Dec | 56 | 28 Jun | 49 |
| 14 Dec | 58 | 29 Jun | 44 |
| 15 Dec | 59 | 30 Jun | 37 |
| 17 Dec | 65 | 1 Jul | 41 |
| 18 Dec | 68 | 2 Jul | 36 |
| 19 Dec | 70 | 3 Jul | 28 |
| 20 Dec | 71 | 4 Jul | 28 |
| 23 Dec | 73 | 6 Jul | 26 |
| 25 Dec | 74 | 7 Jul | 24 |
| 26 Dec | 75 | | |
| 31 Dec | 77 | | |

NOTE: Denominator of fractions indicates depth of snow on ice.

c. Vaygach Island (70° 24' N, 58° 47' E)

On 2 Nov at the station on Vaygach Island ice crystals appeared; on 7 Nov, regardless of brisk winds from the east, slush formed, and after a snowstorm on 8 Nov, sludge ice was added to the slush, and the sludge remained, especially at the shores. On 11 Nov brash ice, and, the next day, having been driven against the shore, it formed an ice band which extended into the bay to a width of 1 mile. On the same day on the north-northwest horizon, large pieces of 1-ball-hummocky ice appeared. Navigation for boats, except icebreakers, was at an end. The last boat went through the strait on 19 Oct. On 13 Nov the whole visible surface was covered to the horizon with young ice moving south. On 14 Nov, due to the action of the wind and tide, small ice pieces, slush, brash ice and pancake ice came in from the Kara Sea and filled the whole strait. There were two small gaps in this ice southeast of Oleniy Island and one large one opposite Cape Bolvanskiy.

The ice remained without essential change until 16 Jan, but on 17 Nov the strait, except for the bay, was piled with large ice pieces due to north winds. Among these was observed intensive formation of young ice. On 17 Nov, in the bay between the shores of Vaygach Island and Oleniy and Voronov Islands young sheet ice and gaps which surrounded Oleniy Island from the south remained. On 18 Nov young ice was violently torn off in the direction of the station shore by a strong west wind, and on 19 Nov the strait was completely cleared. After this, due to a heavy snowstorm, there was no visibility until 22 Nov. On 22 Nov brash ice, brought in by moderate northeast winds, was observed within the limits of the 4-mile visibility in the strait and the bay. Slush and sparse small ice pieces moving north were also seen.

On 24 Nov a land floe, whose edge advanced from Cape Bolvanskiy to Oleniy Island, and beyond to the Yanov Islands and Cape Voronov, was formed. Hummocks were formed on the land floe, and gaps remained in places. They were frozen over on 26 Nov. Beyond the land floe, 8-ball-hummocky fields were floating.

Until 8 Dec the land floe remained within its former limits, sometimes extending to the line formed by the Oleniy, Yanov, Morozov and Ragozin Islands, and sometimes stopping at the line of the Oleniy and Voronov Islands. A shore gap, decreasing in area, remained between Oleniy Island and Cape Bolvanskiy, abutting directly upon the shore. On 8 Nov the gap in the said location was about 3 miles in diameter with the channel approaching the station shore. On 11 Dec the gap between Cape Bolvanskiy and Oleniy Island was covered with unstable sheet ice which broke up on 12 Dec. On 10 Dec an ice band which combined with the land floe, was formed at Cape Bolvanskiy. On 23 Dec a gap extended along the land floe on the side of the strait and along the north shore of Vaygach. Large ice pieces and hummocky ice fields remained beyond the gap until 1 Jul. They moved slowly with the winds and the tidal currents along the edge of the land floe, sometimes approaching it or moving off to form a gap.

In the beginning of Mar 1934 the gap changed its form, dividing from time to time into several gaps. On 11 Mar the whole surface beyond the land floe was covered with hummocky fields and was not open again until 21 Mar when the winds shifted to the south rhumbs. Afterwards it was sometimes clear and sometimes covered, depending upon the winds and the currents, until the end of May. On 10 May water appeared under the snow on the land floe, and on 26 May part of the land floe was broken up at the mouth of Dolgaya Bay by waves and floating ice. On the parts of the land floe remaining between the islands, many pools of melting snow and small lakes, which froze when the temperature dropped, appeared.

On 1 Jun the edge of the land floe passed from the Ragozin Islands, enveloped the Morozov, Zanov and Oleniy Islands, and proceed from there to Cape Bolvanskiy and along the north shore of Vaygach Island to a width of about 3 miles. Beyond the edge of the land floe, floated hummocky ice fields and large and small ice pieces becoming denser toward the horizon.

The disintegration of the above-mentioned land floe began on 2 Jun between Oleniy Island and Cape Bolvanskiy, and on 5 Jun part of the land floe was torn away from the outer side up to Voronov Island. On 6 Jun a gap was formed between Oleniy and Vaygach Islands. On 7 Jun it combined with the open area between Oleniy and Vaygach Islands. The outer part of the land floe was broken up from day to day by west winds. And by 11 Jun it remained between Cape Voronov Noc, Yanov Island and Oleniy Island, from which the edge proceeded south to a point across from the station and beyond to the north along the east shores; this limited the ice band to a width of about 3 to 4 cable's lengths.

On 22 Jun the greatly disintegrated land floe moved off Yanov and Oleniy Island, and on 23 Jun its edge passed from the cape on which the station was located to Voronov Island and from there to Cape Voronov Nos. Between the cape where the station was and Cape Bolvanskiy there was a strip of ice left by the land floe as it passed. Floating ice continued to fill the whole visible part of the horizon, and in it large ice pieces predominated over hummocky fields.

On 26 Jun several cracks and thawed gaps were noted on the land floe. On 30 Jun the strait was navigable.

On 1 Jul the horizon was clear of floating ice, except that remaining in a very small band on the northwest part of the horizon, at Oleniy Island and the station shore. The land floe remained only in the bays south of the station and at the shore of the station. On 3 Jul there was no more fast ice, making the bay navigable. Large and small ice pieces remained at the shores. The whole remaining surface of the strait and the open sea was cleared of ice by a strong southeast wind. On 5 Jul only sparse small ice pieces remained within the limits of visibility. From 6 to 11 Jul the bay and the visible part of the strait were clear of ice. From 11 Jul to the end of the month, with predominating northeast winds, from 1 to 5 balls of ice, shifted about by the winds and currents, remained in the strait and the sea.

Thickness of Ice in Karskiy Vorota Strait at Vaygach Island

| Date | Thickness (cm) | Date | Thickness (cm) |
|---|---|---|---|
| 24 Nov | 20 | 20 Mar | 93 |
| 30 Nov | 31/2 | 31 Mar | 110/25 |
| 10 Dec | 41/8 | 10 Apr | 102/27 |
| 20 Dec | 54/9 | 20 Apr | 105/28 |
| 30 Dec | 63/10 | 30 Apr | 106/32 |
| 10 Jan | 65/13 | 10 May | 100 |
| 20 Jan | 72/14 | 20 May | 116/28 |
| 30 Jan | 72/21 | 31 May | 134/0 |
| 10 Feb | 73/35 | 10 Jun | 107 |
| 20 Feb | 78/20 | 20 Jun | 89 |
| 28 Feb | 85/29 | 30 Jun | 52 |
| 10 Mar | 92 | 2 Jul | 44 |

NOTE: See preceding table.

d. Yugorskiy Shar (69° 49' N, 60° 45' E)

On 1 Nov, young, small ice pieces appeared in the strait with southeast winds. They extended across the strait to the visible part of the Kara Sea. On 2 and 3 Nov the whole visible expanse of water was clear of ice, and on 4 Nov brash ice and slush appeared at the east shore. On 9 Nov slush also appeared at sea. The amount of slush and brash ice in the strait increased from day to day, and on 14 Nov fast ice was formed in the north part of the strait due to the freezing of the slush and brash ice. It occupied an area of 8 balls, as a result of which steamer traffic was impossible. On 16 Nov half of the land floe in the strait was broken up, and a field of young ice, which remained until 19 Nov when the strait was covered with a smooth ice sheet, appeared from the direction of the Kara Sea. On 21 Nov the ice broke up again, and on 22 Nov a new land floe was formed in the strait. On 24 Nov a gap appeared between Cape Kanin and Cape Kamennyy, separated by an ice barrier from the clear water beyond the line of Sokoliy Island and Cape Kanin. On 25 Nov the whole visible surface of the water was covered with an ice sheet, in which a channel of clear water, extending N 8 miles, to the limit of visibility, in the middle of the strait, appeared on 2 Dec. On 6 Dec the channel widened far enough to be navigable although the ice of the land floe was 48 centimeters thick. Until 11 Dec, observations could not be made due to poor visibility. Until 13 Dec there remained only a small gap, where the channel had been, in the middle of the strait between the radio station and Cape Kanin. The flat ice cover in the strait, where the channel of clear water had been, had a hummocky strip.

The land floe remained stable on the shores of the Kara Sea, east of the outlet from the strait, while west of the strait, until 19 Dec, clear water, extending to Cape Belyy, was observed from time to time.

During the winter the land floe was stable, with a width of about 3 miles; it remained at the shores of the open sea and combined with the ice sheet in the strait; the rest of the water surface visible from the station was covered sometimes with fast ice, sometimes with heavy floating ice, and sometimes was completely clear. For the greater part of Jan 1934, clear water was observed beyond the indicated limits of the land floe, beyond which an ice sky could be seen.

In February the horizon of the Kara Sea was very often clear, and with the exception of days of poor visibility, there was clear water for 22 or 23 days.

In March an even ice sheet or a hummocky ice cover predominated on the visible area of the Kara Sea. It was distinguished from the ice wedged into the middle of the strait from the north. On 11 Apr part of the land floe was torn away by strong winds, and it remained about a mile wide at the shore and less than a mile wide at the headlands. A wedge of clear water extended to a point opposite Cape Kanin, but on 18 Apr the visible water surface was again covered with a hummocky ice sheet, beyond which large and small ice pieces and ice fields appeared from 22 May on. On 4 May water was observed beneath the snow on the ice, and on 25 May cracks appeared; on 26 May pools of melting snow could be seen.

On 5 Jun successive separations of the land floe from the shores began. On 6 Jun the land flow was torn away at Cape Yarossel and other capes to the east of it. A wedge of clear water was formed at Cape Kanin, while fields of fragments of the land floe, torn off by the west and southwest wind, were floating on the sea. On 16 Jun, in the middle of the strait, to the south of a point opposite Cape Kanin, a gap was formed; on 18 Jun this combined with the narrow channel from the open sea, filled with small ice pieces.

On 22 Jun, after a brisk northeast wind, the gap in the ice of the strait, having been filled with large and small ice pieces from the fields of the detached land floe, widened to 4 miles. With the formation of the gap which joined the Kara Sea, the strait became navigable in the vicinity of the station.

From 28 Jun on, the gap in the strait, as well as the breach in the land floe, began to be cleared of ice by the southwest and west winds. From 29 Jun to 23 Jul, large and small ice pieces, brought by north winds into the north half of the strait, were observed. These ice pieces were carried out into the Kara Sea by southwest winds after 23 Jul, and only separate ice blocks remained in the strait up to 26 Jul. By 27 Jul the strait was completely cleared.

Thickness of Ice in Yugorskiy Shar Strait

| Date | Thickness (cm) | Date | Thickness (cm) |
|---|---|---|---|
| 27 Nov | 21 | 28 Feb | 90 |
| 7 Dec | 48 | 16 Mar | 90 |
| 19 Dec | 59 | 1 Apr | 90/35 |
| 30 Dec | 65 | 16 Apr | 93/36 |
| 10 Jan | 67 | 15 May | 113/10 |
| 20 Jan | 72 | 25 May | 121/10 |
| 31 Jan | 76 | 10 Jun | 75 |
| 10 Feb | 80 | 19 Jun | 40 |
| 21 Feb | 85 | | |

NOTE: See preceeding table.

c. Cape Marc-Sale (66° 43' N, 66° 48' E)

On 9 Oct the small lakes nearby were covered with sheet ice, and on many, a wide ice patch was formed, and on the Marra-yaga River slush and pancake ice appeared on 9 Oct.

On 11 Oct all the lakes were covered with sheet ice, which in a few days became 7 to 10 centimeters thick. An ice patch with slush and brash ice of the same thickness was formed on the Marra-yaga River and at the seashore. On 15 Oct the river was cleared of ice by strong winds from the northeast, and the patch was torn away from the seashore, where only a band of brash ice remained. With the weakening of the wind on 16 Oct, a narrow patch formed again at the seashore. Beyond it, brash ice was observed in places, which had also filled up the Marra-yaga River. On 16 Oct the SS Arkos arrived. The brash ice on the river and at the seashore remained until 21 Oct, when the ice was washed ashore by brisk western winds and the surface of the water was cleared. On 22 Oct brash ice again appeared at the seashore, and on 24 Oct it froze at the shore and formed an ice patch. Brash ice appeared on the Marra-yaga caused by snow blown from the bank. On 25 Oct the river was clear, and ice remained in the form of a patch only at the seashore. The patch remained on the Marra-yaga River and at the seashore from this time until the end of the month, brash ice was floating beyond it. On 31 Oct during calm weather the whole visible surface of the sea was covered with pancake ice in the calm weather and the Marra-yaga River froze. On 27 Oct the SS Arkos left.

On 1 Nov the whole visible surface of the sea was covered with brash ice and pancake ice, which changed on 21 Nov into young ice. On 9 Nov hummocky fields were added to the young ice; their number increased until by 10 Nov there were 85. The floating fields remained until 12 Nov when the whole visible surface was covered with hummocky sheet ice.

On 19 Nov, as a result of a great drift, water appeared on top of the ice at the shore and in the brook. During the night from 21 to 22 Nov, the land floe was partly disintegrated by the pressure of ice from the sea, and new piled-up ice fragments appeared.

From the end of Nov to 10 May 1934 the hummocky land floe remained; sometimes it extended to the horizon and sometimes its seaward part was broken up making floating ice pieces or clear water visible. In most cases, the ice beyond the land floe was the heavy type and moved north and northwest.

On 10 May water appeared under the snow on the land floe. On 23 May the winter characteristics of the land floe persisted, but the amount of water under the snow increased considerably, and on 27 May several pools of melting snow formed, changing on 29 May into small lakes. On 2 Jun a water patch and thawed gaps were formed on the land floe; as a result, the waters on the ice surface was reduced.

On 13 Jun the seaward part of the land floe was torn away by a brisk east wind, and hummocky fields and large and small ice pieces appeared beyond the remaining edge of the land floe. From 13 Jun the disintegration of the land floe proceeded without interruption until its width on 1 Jul was about 4 miles. Beyond the edge of the land floe, clear water in most cases remained, and from time to time large and small ice pieces were observed.

A gap appeared across from the mouth of the Marra-yaga River on 25 Jun, and by 1 Jul it extended for several miles along the shore. On 5 Jul the part of the land floe between the gap and the sea was disintegrated by west winds, and beyond the edge, large and small ice pieces with hummocky fields appeared.

On 9 Jul there was no fast ice anywhere. Only a band of combined large and small ice pieces, driven by winds from the west half of the horizon to a shoal, was observed. When the west winds slackened, the ice was carried north by the current, and on 14 Jun the sea was clear of ice within the limits of visiblility. The ice reappeared (visible from Bayaratskaya Bay) from 15 to 16 Jul, but it vanished again with brisk winds from the north. Except for separated large and small ice floes and one field which appeared between 21 and 24 Jul, the sea was clear until 1 Aug.

Thickness of Ice off Cape Mare-Sale

| DATE | THICKNESS (cm) |
|---|---|
| 10 Jan | 80 |
| 20 Jan | 80 |
| 1 Feb | 81 |
| 10 Feb | 86 |
| 2 Mar | 101 |
| 20 Mar | 112 |
| 1 Apr | 111 |
| 10 Apr | 116 |
| 20 Apr | 120 |
| 30 Apr | 120 |
| 10 May | 123 |
| 20 May | 123 |

f. Belyy Island (73°30' N, 80°24' E)

The polar station at Belyy Island began to function 1 Nov 1933. Regular ice observations began 9 Oct 1933 from the cape where the station was set up. This cape is washed from the north by a channel about one mile long which connects with the sea. The channel has a bar and is unnavigable. From the south side of the cape runs a brook which flows into the channel. The brook is full of water only during the time when the snow is melting on the island and during the summer at the time of high tide. In summer there is sea water in the channel and in the brook.

The northern, highest shore of the cape on which the station is located is about 5 meters high, and the southern shore (where the brook is) about 2 to 3 meters. The shortest distance to the shore of the open sea on the west is about 800 meters. A special tower 8.72 meters above sea level was erected to observe the ice.

The horizon visible from the tower is open from the south through west to north-northwest. The northern sector was shut off by the high bank of Cape Rogozin, and the eastern half of the horizon was obscured by the island. With positive refraction, the part of the horizon beyond Cape Rogozin almost to northeast sometimes became visible. The extent of visible horizon of the sea from the tower is 6.14 miles. The object of observations was the ice cover of the channel and the open sea which could be observed due to low banks.

The first ice formation in 1933 began on the channel. Here, brash ice appeared on 16 Aug, reaching a thickness up to 20 centimeters. As a result, movement on the channel in a launch or motor boat became difficult. On 18 Aug, however, the channel was clear of ice.

After a snowstorm on 25 Aug thick sludge ice was formed. It was impossible to pass through in a motor boat, but a launch overcame the friction by rocking, and went ahead. At the same time, sludge ice also appeared at the shore of the open sea, but on 29 Aug it disappeared after a strong southwest wind. In the channel part of it was carried from the station toward the island. The motor and rowboats in the sludge and the pancake ice were carried in the same direction.

Pancake ice formed on the channel from the sludge and brash ice on 10 Oct after strong west winds and a drop in temperature. On 12 Oct it froze in places to such an extent that it could be walked upon. On 14 Oct the channels were covered with sheet ice, in spite of a brisk southeast wind on 13 and 14 Oct.

On 15 Oct floating ice was observed on the open sea, and at the shore sludge ice and small pieces of pancake ice formed, locally. On 16 Oct hummocky fields were visible on the horizon from the southwest to the northwest. They moved south despite a weak southwest wind. Small ice pieces which moved south with the same speed as the hummocky fields floated between them and the shore.

On 17 Oct the whole visible expanse of the sea was covered with pack ice which was driven forcibly by the southwest storm wind toward the shore and the hummocky ice. At 1900 on this day, as a result of a great drift of water, the ice in the channel was raised and its surface was covered with water. On 18 Oct an ice hatch with a hummocky edge was formed at the seashore, and along it ice slowly moved south at a distance of 2 miles from the shore until 20 Oct.

On 20 Oct, with the shift of the wind to southward, the amount of floating ice decreased to 3 balls. But on 21 Oct up to 10 balls of ice was carried in by a strong west-northwest wind again, and many hummocks were formed in the snowstorms.

On 25 Oct, due to winds from the north, drift ice was carried out from the shore, and a shore gap 4 to 5 miles wide was formed. Beyond this gap hummocky ice with gaps was moving south as far as the horizon.

On 23 Oct the first grounded floeberg was formed under the pressure of the ice on the shore, to the northwest of the station, within 3 to 4 miles of the shore. On 30 Oct the hummocky ice was driven by northwest winds to the shore and froze, forming a winter land floe to the horizon. The surface of the land floe, in accordance with its formation process, had a variegated appearance. A band of relatively even ice, 5 to 6 miles wide, extended from the shore. On it, for a distance of about 2 miles from the shore, was a series of small grounded floebergs, evidently resting on spurs extending into the sea beneath the surface of the water.

A second series of grounded floebergs, 5 to 6 meters high, limited the relatively even surface of the land floe. Beyond the grounded floebergs the surface of the land floe was very hummocky, evidently to the edge which was not visible.

The ice of the land floe was quite covered with cracks, a great abundance of which was observed near the hummocks and grounded floebergs. By observations of the water sky, the land floe had its greatest extent on 1 Jul 1943, i.e., about 20 to 30 miles, while the smallest width was observed northwest of the station, about 20 miles. In observing vibrations, about 0.5 mile from the seashore in the channel at the time of the westerly storm winds, a vibration of the surface of the water was noted. It was of short duration and of an amplitude up to 1.5 centimeters. Small surface vibrations similar to wind waves changed to a large amplitude, after 7 to 9 to 11 vibrations. After 1 to 2 such vibrations they stopped again. Similar small vibrations of the surface were noted only once in an opening cut in the ice by an observer.

The thickness of the ice, observed in the channel with a depth of 2.4 meters, was 0.85 meters on 1 Dec; on 19 Jan 1934, 1.28 meters; and its greatest thickness, 1.42 meters was reached in May (21 May). The snow cover on the ice was 1.5 meters high. From May on, the thickness of the ice, with a snow cover from 0.2 to 1.0 meters, began to decrease, slowly at first (on 13 Jun it was 1.38 meters), and then rapidly (on 5 Jul it was 89 centimeters). The ice of the land floe on 21 Dec was 0.68 meters thick, and was covered with snow to a depth of 0.16 meters. On 16 Jul the ice of the land floe was from 0.30 to 0.60 meters thick.

Until 29 May the ice of the channel remained without change, but on the morning of 30 May, after a marked lowering of the surface, the ice went to the bottom. In the evening, after a drift of water brought by the northwest winds, it could not rise again; water flooded the top of the ice, and new ice was formed on its surface. On the same day a water sky was observed from southwest to north-northwest. On 16 Jun in the same sector a water sky with blue bands interspersed with white, a height of 3 to 4 degrees over the horizon, was again observed. The bands moved slowly from north to south. As snow came from the surface of the tundra, ice mirages were observed repeatedly over the island, enveloping the horizon from the south through west to east.

On 23 June so much water collected on the ice of the channel and the brook that the ice could not be traversed on foot. The level of the water on the ice of the brook was higher than on the channel, and the water issuing from the brook passed on to the ice of the channel, and then flowed under the ice through an opening of about 70 to 80 centimeters in diameter. On 28 Jun the level of the channel was raised by this inflow, so that the ice of the shore opposite the station was raised.

As a result of the continuation of the flow of this water, the brook ran dry on 8 Jul, and the muddy water of the channel, passing above the old ice, spread out a considerable distance to the shores and formed a continuous washout of zigzag form. Due to the great speed of the current of the channel at the point where the water ran out under the ice of the land floe, a furrow 1.5 to 2.0 meters deep was formed. From 26 Jul on all the ice that had been under the water began to rise to the surface and to be carried out of the channel, breaking up the patch of new ice.

On 3 Aug the ice, except for that heaped onto the shore, was broken up and floating about the channel with the tidal currents, and the channel was completely cleared on 11 Aug.

On 2 Jun water appeared under the snow on the open sea land floe, a band of which extended along the shore to a width of about 200 meters. This band had a crack at its outer edge about 25 centimeters wide which also extended along the shore line. Evidently the water was on that part of the land floe which was frozen to the ground. On 26 Jun there was little snow left on the shore part of the land floe, and the water withdrew and appeared at a distance of 5 to 6 miles from shore in a band of hummock formations. On 28 Jun a water patch about 2 miles wide appeared at the seashore, beyond which the area of the land floe was covered with pools of melting snow and small lakes about 0.5 meters deep. Many new cracks were formed, proceeding from the edge of the land floe, where the nearer they were to shore the wider they were. The hummocks and the grounded floebergs turned black. Among them many seals were noted.

On 1 Jul many cracks were formed among the floebergs; the color of these changed from black to brown due to the sand which entered into the ice. The width of the land flow remained about 20 miles, and the ice became so crumbled that it could be crossed only with skis. On 15 Jul many new cracks which changed their width under the pressure of the drift ice were formed in the land floe. On 24 Jul the land floe was full of gaps and the width of the land floe remained more than 5 miles; its shore part about 1 mile wide had a dirty yellow color. Beyond, at a distance of 5 to 6 miles from the shore, a series of protruding grounded floebergs remained.

On 1 Aug a tidal comb (ice washed up on shore by the tide) was left, beyond which came a water patch about a mile wide filled with large and small ice pieces which shifted with the tide. On 4 Aug a breach began in the land floe, and on 9 Aug the quantity of ice left did not exceed 1 ball. On 15 Aug the sea within the limits of visibility was finally cleared of ice and on 23 Aug the first steamer arrived.

g. Dickson Island (73°30' N, 80°24' E)

By 1 Sep the straits and bays were clear of ice, and separate ice blocks which were scattered over the whole surface to the horizon were observed at sea. On 6 Sep the whole visible surface of the sea was clear of ice until when northeast and east winds brought separate floes again. The sea was once more cleared by 12 Sep. On 19 Sep slush appeared at the end of the bay, which quickly changed to pancake ice; on 20 Sep slush was observed at the seashore and slush with ice rind in the straits. On 22 Sep the pancake ice in the bay turned into young ice, 8 centimeters thick, and on the following day it extended into the straits, driven by the west winds. On 24 Sep separate ice blocks were observed at sea, and on 25 Sep the deep part of the bay was covered with fast ice while the straits were cleared by moderate north winds. On 26 Sep brash ice appeared in the straits, and on 27 Sep the bay was covered with 7-ball young ice; a conglomerate of small ice pieces of 10 balls was brought into the strait on the same day by northeast winds.

At sea the quantity of ice kept increasing slowly up to 27 Sep. On 28 Sep large ice pieces brought in by the northeast winds covered 7/10 of the whole surface; slush and young ice was drifting at the shores. From 27 Sep on, the area of fast ice in the bay kept increasing, and on 7 Oct the bay was covered by a sheet of fast ice, beyond whose edge separate ice flows drifted in the straits until 10 Oct; from 11 to 13 Sep the straits were completely cleared by weak, shifting winds. On 27 Sep the ship, Farvater, left, and on 13 Oct the icebreaker Lenin left. On 14 Oct slush which quickly changed to ice rind and young ice, formed for the second time in the straits, and on 15 Oct the straits were covered with a fast ice sheet. On the following day Chortov Bay froze; the process was hindered by the southwest and west winds.

From 28 Sep to 19 Oct there remained from 3 to 7 balls of small ice pieces at sea. These were chiefly concentrated in the north half of the horizon. The ice patch, having been observed until 19 Oct only in narrows and inlets of the open sea, widened considerably on 20 Oct, especially from the north side, and extended to the Dolgiye, Medvezh'i and Verns Islands. The north half of the horizon of the open sea was covered with 8-ball large and small ice pieces with ice fields interspersed. On 21 Oct when the wind changed to the west, closely packed hummocky ice fields were floating on the whole visible surface of the sea. On 24 Oct gaps were formed by brisk north winds among the conglomerate hummocky fields west of the Medvezh'i and Verns Islands, and were also observed north of the Dolgiy Island and northwest at the horizon. On 28 Oct the gaps at the islands were covered over and remained only at the horizon in the northwest portion. In this way the land floe which, in the course of the winter, proved unstable and underwent early disintegration, was formed.

On 24 Oct the foot of the hummocky land floe enveloped all the islands of the Dickson archipelago, and its edge extended from the Dolgiye Islands to the northeast, and from Verns Island to the southeast, where it joined with the level, continental land floe. Beyond the edge of the foot, the hummocky land floe remained without change until 12 Nov. On 13 Nov after the south winds, bands of clear water appeared at its border off the foot. On the following day, they were closed, and their reappearance was not noted until 24 Nov. On 25 Nov beyond the edge of the foot the ice broke up, and within the limits of visibility, 60 hummocky fields appeared. These froze again on 28 Nov and formed a continuous, fast land floe, hummocky in places.

From 1 Dec to 13 Jan 1934 there were no observations due to darkness. On 14 Jan beyond the foot large ice pieces and a field of 4 balls were observed. The next observations were made on 16 Feb when a hummocky land floe with gaps was observed beyond the foot.

On 22, 24 and 25 Feb a broad gap extended along the edge of the foot from west and north, beyond which lay an ice field. On 28 Feb the gaps remained only on the north side, and the remaining surface was covered with a sheet of hummocky ice.

The gap beyond the foot of the land floe between the Medvezh'i and the Dolgiye Islands remained until 9 Mar. On 10 Mar this gap was greatly widened, and the ice beyond the edge of the foot was broken up by the east wind and carried away, again the water was cleared. In the next observation made with good visibility on 15 Mar, a gap beyond the edge of the foot off the Medvezh'i Islands, rounding the edge from the north, had widened towards the east.

West of Dickson Island in the hummocky ice sheet were several gaps. On the following day the north gap was considerably extended by moderate east winds, and on 17 Mar the ice beyond the edge of the foot broke up into separate fields and was carried away from the edge.

From 24 Oct throughout the whole winter, the ice beyond the foot sometimes melted, sometimes disintegrated in the south and east winds. This ice moved, forming ice fields away from the edge of the foot.

Until 1 Apr the land floe with the gaps remained stable in the north winds. On 13 Apr, with the shift of the wind to the south rhumbs, the ice disintegrated markedly, not only in the west and north, but also south of Dickson Island. On 16 Apr when the wind shifted to the north, the field froze again, forming a continuous hummocky cover with gaps.

The disintegration of the cover began on 17 May with calm weather. Beyond the foot of the land floe the number of gaps increased, and the ice disintegrated, forming large ice floes, whose number increased daily, along with ice fields. Until the end of the month, regardless of northeast winds, the ice beyond the foot of the land floe did not freeze, moving between the edge of the foot and the hummocky ice sheet on the horizon under the influence of the tides and winds.

During June large and small ice pieces and hummocky fields of 2 to 7 balls remained on the sea. On 1 Jun the ice on the bay was cleared of snow in places, and pools of melting snow were formed. The seaward part of the edge of the land floe was torn away in the west and north by brisk north winds, and as a result, the southwest shores of Verns Island were freed of the land floe; on 15 Jun the west shores of Medvezh'i Island were freed.

On 30 Jun the edge of the fast hummocky ice proceeded from the continental shore to the northwest, and to the east shore of Verns Island. From there it went to the south shore of Medvezh'i Island, the east part of which was icebound. From the north shore of Medvezh'i Island, the edge of the ice proceeded to the Dolgiye Islands, then east and northeast along the continental shore.

The ice on the bay melted regularly during June, and there were several pools that were covered with new ice from time to time on its surface. On 25 Jun cracks appeared in the ice on the bay and the straits, and the water accumulated on the ice at the shores. On 25 Jun pools were observed on the ice of the straits, and on 30 Jun there were thawed gaps in the straits of Lena and Preven.

During July the foot of the land floe disintegrated regularly, and on 20 Jul Medvezh'i Island and the Dolgiye Islands, as well as the northwest shores of Dickson Island, were quite free of fast ice which remained between Dickson, Verns, and Oleniy Islands and had joined with the continental land floe. The ever widening washouts in the Lena and Preven Straits were joined on 20 Jul in the northern part with the open sea, and continued to extend south into Veg Strait. On the sea sparse large and small ice pieces were observed also drifting in the north straits off Dickson Island. On 10 Jul washouts were formed in the ice of the bay, and on 24 Jul the ice was broken up by brisk southwest winds at the same time as in Veg Strait. The remainder of the land floe was torn off from a point south of Dickson Island. On the same day an H-26 plane went aloft /to make observations/.

From 25 Jul on there was no more fast ice in the Dickson archipelago, and within the limits of the visible horizon, sparse small ice pieces were floating. To these large ice pieces brought in by the north winds were added on 28 Jul. On 26 Jul the bay and the straits were cleared of ice by the west winds. The first steamer, Tsirkul, arrived on this date.

Thickness of Ice at Dickson Island

| DATE | THICKNESS (cm) | DATE | THICKNESS (cm) |
|---|---|---|---|
| 9 Oct | 12 | 10 Mar | 141 |
| 20 Oct | 25 | 20 Mar | 145 |
| 30 Oct | 33 | 31 Mar | 150 |
| 4 Nov | 40 | 10 Apr | 156 |
| 10 Nov | 60 | 20 Apr | 162 |
| 20 Nov | 66 | 10 May | 173 |
| 30 Nov | 71 | 20 May | 182 |
| 10 Dec | 76 | 31 May | 184 |
| 20 Dec | 88 | 10 June | 177 |
| 30 Dec | 93 | 20 June | 168 |
| 10 Jan | 104 | 30 June | 140 |
| 27 Jan | 110 | 5 Jul | 105 |
| 11 Feb | 115 | 10 Jul | 95 |
| 20 Feb | 123 | 20 Jul | 74 |
| 28 Feb | 130 | | |

h. Domashniy Island, Severnaya Zemlya, South Kamenev Archipelago (79°31' N, 91°08' E)

Observations of the ice cover in the area of Domashniy Island were made from the home station at a height of 5 meters above sea level (when actual changes were noted in the ice, observations were made from a mast 18 meters above sea level), with 4.5 mile range of visibility. The objects of observations were the open sea and the channel south of the island.

The channel was bound throughout the winter by a sheet of fast ice, and was not opened up until Aug 1934. On 26 Jun 1934 water appeared on the surface of the ice, and on 30 Jun the whole surface of the ice in the channel was covered with pools which lasted until 14 Jul. At that time the water flowed from the surface of the ice into the cracks which had been formed.

A continuous hummocky land floe stayed on the open sea until 29 Sep 1933. Cracks appeared on the whole horizon along the edge on 30 Sep. In the first half of Oct a mist was observed on the whole horizon; on 17 Oct a water sky was seen.

There was a continuous hummocky land floe to the limit of visibility from the second half of Oct to Mar 1934, and on 1 Mar a narrow band of water sky which disappeared on 3 Mar, was visible in the south. From 18 to 20 Mar the mist remained over the horizon from south to northwest.

By 2 Apr the winter land floe was partially disintegrated and drifting hummocky ice appeared with a density of 2 balls. This condition lasted for 48 hours, after which it froze to the land floe. On 4 Apr a water sky apperred in the south-southeast and south; a mist was seen in the region of Golomyanniy Island. On 5 April there was solid mist which approached from Golomyanniy. On 12 April, beginning in the morning, the mist began to move off towards the horizon, and a water sky appeared over the horizon at the time. On 13 Apr the land floe partially disintegrated, and 2 balls of drifting hummocky ice were formed. Until 20 Apr the land floe slowly disintegrated, and its density remained about 5 balls; the rest of the visible surface was full of hummocky ice. On 21 Apr a large hummock formation was produced at the edge of the land floe, and a water sky was visible to the west-northwest. A 10-ball hummocky land floe remained from 21 to 26 Apr, and on 27 and 28 Apr it disintegrated again, leaving 2 balls of drifting hummocky ice.

Durin May the land floe remained at 10 balls, and its regular disintegration did not begin until 30 May. A water sky was observed from 4-8 May and on 21 May. Gaps and breaches began to form on the evening of 29 May.

From 30 May to 13 Jun the density of the land floe remained 5 to 6 balls; clear water, as well as floating hummocky ice, whose amount increased on 14 Jun, was observed. This ice remained until 18 Jun, being driven to the land floe by the wind. On 19 Jun, beyond the part of the land floe that was newly disintegrated, large and small ice pieces of 4 to 5 balls appeared for the first time and lasted until the end of the month. On 23 June pools of melting snow were formed on the ice of the land floe. They increased considerably on 25 Jun, and on 1 Jul small lakes which continued to grow formed among the hummocks of the land floe.

On 9 Jul a large gap formed on the south, and a narrow one on the west, from west-northwest to north-northwest. On 13 Jul a gap was formed along the whole land floe, several cracks appeared in the ice, and the water flowed through them from the surface of the ice. On 15 Jul the land floe was disintegrated by the north winds and carried to the south in pieces. The floating ice gradually thinned out, and from 22 to 27 Jul the sea was clear of floating ice; the land floe remained to the end of the month at a density of 10 balls.

i. Cape Chelyuskin (77° 44' N, 104° 06' E)

The fast ice remained in 1933 until 14 Jul, and after it disappeared (visibility from the station up to 10 miles), there was floating ice of variegated form, sometimes thinning to 1 ball and sometimes covering the whole visible surface.

On 15 Sep the ice fields that had been driven to the shore froze, forming fast ice, beyond which were floating hummocky ice fields. In the intervals of open water between the fast ice fields, the formation of young ice which joined the fields, and formed a land floe on 18 Sep was observed. From 18 to 24 Sep there remained a large accumulation of ice from the Laptev Sea side, and it became markedly hummocky from 21 to 23 Sep. On 25 Sep the direction of the moving ice changed to the east, and a noticeable accumulation of drift ice appeared in the west. Large and small ice pieces moved slowly to the east beyond the land floe; they changed on 30 Sep into the annual ice fields with breaches covered with hudge.

From 1 to 5 Oct, 3 to 4-ball-ice fields moved slowly east in the strait, and they changed on 6 and 7 Oct into large ice pieces. On 8 and 9 Oct the small ice pieces moved west, and from 10 Oct on, the ice drift changed east again, and 1-10 ball drift ice was observed up to 27 Oct. On 24 Oct plane reconnaissance showed that the strait was covered with young ice fields of 9 ball density, increasing in density toward Bolshevik Island. Towards the Beyberg Islands the ice thinned out to 8 balls, with breaches. From the Cape Chelyuskin meridian east, a narrow, gradually widening gap extended. A continuous land floe extended along the continental shore eastward, enveloping the Komsomolskoy Pravdy Islands. On 31 Oct the hummocky fields and small ice pieces beyond the land floe remained in place, and there were gaps north of the station.

From 1 to 5 Nov large and small ice pieces and fields remained beyond the land floe, and a large hummock formation appeared among them on 6 Nov. Afterwards, hummocky sheet ice was observed within the limits of visibility until 15 Nov. On 28 Nov several grounded floebergs 7 to 8 meters high were formed as a result of new shifts of the ice. The bed of these floebergs was about 1 mile from shore.

It was discovered by foot reconnaissance on 1 Dec that the bed of the floebergs was 300 to 500 meters wide, and the width of the land floe more than 6 miles. The strip of land floe was bordered by a strip of young ice, beyond which no displacement of old ice was discovered. Cracks, evidently formed by local compression, were encountered in places. Changes in the condition of the land floe were not noted on the foot reconnaissance of 3 Dec, but on the west (from the direction of the Kara Sea), a noise, characteristic of moving ice, was heard.

From 13 to 19 Feb 1934 the ice was observed from a plane; the observations proved that the autumnal strip of the land floe extended along the shore to a width of about 15 miles. Frozen, partly-hummocky fields of young ice were on the whole strait beyond the edge of the autumnal foot. In the western part of the strait, they changed into very hummocky fields, and among them old ice formations were found. In the eastern part of the strait along the continental shore, the edge of the land floe passed to the northwest as far as the latitude of Cape Chelyuskin and from there to the northeast. There was no ice beyond the edge of the land floe.

Thus, in Feb the whole strait was bound by sheet ice which was formed mainly from frozen drift ice. Hummocky ice was wedged into the land floe from the direction of the Kara Sea. Beyond the eastern edge of the land floe there was clear water, entering into the middle of the tidal flow between Malyy Taymyr and Komsomolsky Pravdy Islands.

Air reconnaissance on 19 Apr indicated that a strip of level fast ice extended along the shore to a width of about 20 miles, from Cape Vega to the Firnley Islands. This ice became hummocky to the north.

On 27 May it became noticeably warmer , and between 1 and 10 Jun, water appeared on the ice under the snow. This water spread over the ice in a lagoon in the interval between 10 and 20 Jun. Several pools of melting snow were formed on the land floe, and its shore part was covered with cracks. After 20 Jun the pools formed small lakes and the shore part of the land floe was cracked to a width of 100 to 200 meters.

Between 1 and 10 Jul, the shore band of the land floe disintegrated considerably from thawing, and a crack appeared 5 cables from shore in a large bed of hummocks resting on the bottom. The width of the crack varied with the tides. Small lakes located at the shore, combined, and melted ice at the shore formed a water patch. The lagoon was quite free of ice.

From 10 to 20 Jul a crack that had formed in the beginning of July opposite the station joined a large washout located east of it, so that a long gap formed, extending 1 to 2 miles to the north. The gap permitted ice floes, separated by cracks, to move about locally and form hummocks. From 20-30 July the width of the gap reached 200-300 meters. On 25 Jul it was discovered by foot reconnaissance to the north-northwest that at a distance of 600 to 700 meters from shore there were many wide cracks and hummocks formed in spring. At a distance of 1 to 2 miles from the shore, pools were completely absent on the land floe.

In the first 10 days of August the development of water patches and cracks continued, and the gap widened considerably to the north of the station. On 10 Aug part of the land floe west of the gap began to move out toward the Kara Sea in a strong southeast wind. During 10 and 11 Aug the ice was carried out of the area, so that it was north of the line of Cape Chelyuskin-Cape Vega. Part of the shore land floe remained to a width of 0.5 miles until 15 to 16 Aug when the final disintegration of the land floe was hastened by the action of the winds. At the end of the month only a strip of ice from the land floe about 200 meters wide, with a few large grounded floebergs, remained at the station.

On 30 July /sic/ the remains of the land floe were torn away by strong south winds and were carried out to sea along with the bed of floebergs. The western part of the strait was clear of ice.

2. Laptev Sea

/Source same as above/

a. Komsomol'skoy Pravdy Islands (Eastern Taymyr)

While the ships of the first Lena Expedition were wintering at the Komsomol'skoy Pravdy Islands, observations were made on the ice cover. Observations were begun on 26 Sep between the Komsomol'skoy Pravdy Islands. Ice breakers cleared away the last years ice that had a thickness of 1 to 1.25 meters. The distance from the ships to the edge of this ice was 2 to 3 miles. Approximately 4 miles to the northwest was Malyy Island, and 3-4 miles to the southeast was Bol'shoy Island and a group of small islands.

To the southwest the shore of Taymyr Island 12 to 15 miles away, was visible in clear weather.

Until 25 Nov the observations were carried on from the ship at an eye level of about six meters (a range of visibility of 5 miles). On 26 Nov, observations were made from the east cape of the island with an eye level of about 10 meters (range of visibility 6 miles).

On 26 Sep the edge of the smooth, fast, one-year ice extended from Malyy Island straight to Bol'shoy Island, and from the latter to the small islands lying to the north. In the middle of the land floe which extended within the range of visibility to the Taymyr shore, a channel was cut. Beyond the edge east of Malyy Island, there were 3-ball small ice pieces beyond which the visible horizon was clear.

On 5 Oct the artificially-made channel froze, and the small ice pieces at Malyy Island increased to 4 balls. On 21 Oct the land floe extended into the sea, and gaps were observed in the young land floe at the edge and beyond the edge to the east of Malyy Island. The small ice pieces remained in their former density.

In the subsequent observations on 16 Nov, the visible surface of the sea was covered with a fast ice sheet on which bands of hummocks which characterized the development of the land floe were visible. North of Bol'shoy Island, two grounded floebergs were formed.

The interrupted observations were renewed on 21 Jan 1934. Until this date there had been no changes in the land floe. On 21 Jan in the northeast sector of the horizon, a water sky was observed which was not noted in the subsequent observations of 19 and 28 Feb. The next observation was on 6 Mar, and the water sky was visible to the east-southeast. On 14 Mar the water sky was not visible, and on 24 and 31 Mar it was noted again. On 14 Mar the thickness of the ice in the strait among the islands was about 180 centimeters.

In the observation on 5 Apr, part of the land floe to the east broke away, and beyond its edge, small ice pieces and slob ice were floating. Until 14 Jun, there were no actual changes in the ice cover, and on 15 Jun, beyond the edge of the land floe observed on 5 Apr, there were sparse large and small ice pieces. A water sky remained over the eastern part of the horizon.

On 22 Jun, there was water on the ice of the land floe under the snow, so that the ice turned blue. On 30 Jun many pools of melting snow which changed into small lakes were observed. On 4 Jul the water from these lakes began to run into the cracks which had formed, and on 10 Jul, the water on the ice covered only two-thirds of the visible surface. On 22 Jul the snow on the ice increased, and thawed gaps appeared in the land floe, but the edge of the land floe remained unchanged. On 28 Jul the quantity of cracks and gaps considerably increased, and water patches appeared along the shore.

In the next observation on 6 Aug, a marked erosion of the ice and disintegration of the land floe were noted; strips of open water formed around the steamers. On 13 Aug the seaward part of the land flow was detached, and beyond its edge there were 2-ball large and small ice pieces. Smooth fields appeared the following day.

On 17 Aug the channel was cut by the icebreaker from the edge of the land floe to the ships, and some of the latter were taken out to the clear water which was around the mouth of the channel. On this date the young land floe to the north of Bol'shoy Island was broken up, but it remained to the northeast of Malyy Island. Beyond the edge of the land floe, 4-ball large and small ice pieces and fields were floating.

On 20 Aug gaps formed in the old land floe, and the young land floe disintegrated still more. On 23 Aug there was nothing left of the young land floe in the limits of visibility, and on the old land floe a wedge was left which extended between the islands from the southwest. East of Malyy Island less than 1 ball of sparse, large and small ice pieces were floating. On 23 Aug the fast ice to the west was completely broken up, and floes were drifting in the straits with large and small ice pieces among them. The following day part of the ice was carried out by the southwest winds, and within the limits of visibility, less than 1 ball of large and small ice pieces remained. On 25 Aug the wind shifted to the north, 10-ball-large and small ice pieces with fields moved toward the strait and the visible part of the sea, and detached one grounded floeberg north of Bol'shoy Island. On 26 Aug the ice thinned with the northwest wind. On 27 Aug, in a weak northeast wind, the amount of drift ice increased, and the second and last grounded floeberg was detached by the movement of the ice field. On 27 Aug the Sibiryakov arrived in the strait.

b. Anabarskaya Gulf

On 21 May 1934 Anabarskaya Gulf was covered with a hummocky winter ice sheet, smooth in places. There were a few cracks on it which ran mostly parallel to the shore. Hummocks of various sizes were visible at the north of the bay. On 26 May in the sector from north-northeast to northeast, a water sky was observed for the first time. On 29 May the water sky extended to the north.

On 4 Jun, the water sky increased. On 5 Jun pools of melting snow appeared out of which small lakes formed on 10 Jun. On the same day, a water patch and gaps appeared, and at the same time the cracks increased in number and width. On 13 Jun, at a distance of 6-8 miles from the shore, a narrow gap formed and extended to the sea. This gap increased on 18 Jun, having approached the western shore of Bus-Khaya. On 29 Jun the gap from Bus-Khaya to the sea considerably increased, and several new gaps appeared. On 30 Jun in calm weather a movement of ice took place.

On 1 Jul 9-ball large ice pieces, within the limits of visibility were shifting about with the tides. On 12 Jun many small ice pieces appeared along with the large ice pieces, and the ice decreased to 6 balls. Shifting winds alternating with calms evidently delayed the clearing of the bay, so that by 20 Aug there was still 4 balls of ice left. The schooner, Laptev, arrived in this ice. After 20 Aug the ice thinned greatly under winds from the eastern half of the horizon, and by 25 Aug there were only 2 balls left. On that date observations ceased.

c. Tiksi Bay

Observations on conditions of the ice cover on Tiksi Bay were made from the region of the meteorological station located at a height of 6 meters above sea level (the range of visible horizon was 5 miles). From this point the bay was visible in the sector, $0^{\circ}$-$80^{\circ}$.

The shore line extended from the point of observation north, and in this direction the surface of the bay was visible to the nearest cape which was 1.5 miles away. The horizon of visibility was limited by this cape and by the northwest part of Brusnev Island, which also bordered the northeast part of the bay, 4 miles from the observation point. The south-east part of Brushev Island merged with Cape Mostakh on the horizon.

On 5 Oct slush appeared in the bay at the station shore and on 7 Oct was carried out into the bay by a west wind. On 8 Oct the whole bay was covered with young ice about 2 centimeters thick. On 10 Oct the bay was cleared of ice by a weak south wind, and on 12 Oct sludge ice appeared at the station shore. It covered the whole visible part of the bay by 14 Oct. On 15 Oct young ice about 3 centimeters thick was formed, and on 17 Oct the bay was covered by a fast ice sheet 8 centimeters thick.

After the freezing, the ice cover of the bay remained unchanged until 10 Mar 1934; cracks appeared for the first time on 11 Mar.

On 6 May the snow cover on the ice began crumbling and on 22 May pools of melting snow were formed; they increased in number and size every day and formed small lakes.

On 1 Jun part of the water from the ice leaked through the cracks underneath the ice. On 8 Jun washouts were formed and a water patch appeared along the shore. On 15 Jun the patch became transparent and water from the small lakes flowed into it. On 19 Jun all the water left the ice, and the ice cover of the bay looked as though it were divided into sections separated by cracks. The patches and washouts increased, and on 4 Jul a movement of ice took place in the strong tide during calm weather. After this, about 1 mile from the shore, a gap into which the schooner, Temp, and the Chelyuskim sailed was formed.

On 6 Jul in calm weather the ice of the bay broke up. On the evening of the same day, the steamer Lena arrived in the area of Cape Mostakh. On 7 Jul large and small ice pieces were compressed by the north wind, and the remains of the land floe disintegrated; it remained only in the south-south-east part of the bay. On 9 Jul most of the ice was carried into the River Sogo, by a strong east wind and formed hummocks on the shore. Due to winds and currents, the friable large ice pieces crumbled to the size of small ice pieces on 12 Jul, and they continued to cover the whole bay; clear water was visible only 5 to 6 miles to the east. The small ice pieces continuously disintegrated until 15 Jul, and as a result the surface occupied by them steadily diminished and the expanse of clear water on the bay increased. With a shift of the wind to the south, there was 1 ball of ice left, and by 17 Jul the bay was completely cleared.

The condition of the ice cover on the open sea was observed from 17 May on from one of the small islands surrounding Dunay Island located northwest of the periphery of the Lena delta. The observation point was 3 meters above sea level (range of visibility was 3.6 miles)

At the shores of the island on the open sea side, a winter hummocky land floe with single ice fragments piled up edgewise extended to the horizon. On the land floe were noted two bands of hummocks; in the central band was a grounded floeberg.

On 1 Jun water appeared under the snow on the ice, and the upper layer of snow became soggy. On 3 Jun several cracks full of brine, appeared in places on the ice, and a snowy cover from 6 to 55 centimeters thick lay in a flat layer. On 9 Jun pools of melting snow appeared, and on 12 Jun, movement by foot on the ice became impossible due to the deepening of the water patch along the shore. The patch formed chiefly from melted water drained from the shore. On 14 Jun the water on the ice mostly concentrated at a distance of about 15 miles from shore, and most of the piled-up ice fragments melted considerably underneath. On 18 Jun the area of water on the ice diminished, since part of the water flowed under the ice. On the following day only a few pools remained on the ice surface; evidently the ice had cracked.

The amount of water on the surface of the ice diminished every day. On 10 Jul a transparent water patch formed, and on 14 Jul a gap formed at the shore. On the morning of 15 Jul this gap increased considerably and joined the patch. In the evening of 15 Jul a movement of ice took place on the whole bay under moderate southeast winds. Up to 20 Jul the only fast ice left was one grounded floeberg which remained along with large and small ice pieces and fields. On 21 Jul the sea was completely clear of ice within the limits of visibility. Sparse large and small ice pieces were formed again on 23 Jul under northwest and west winds. The amount of this ice diminished daily, and on 26 Jul, when the wind shifted to the north and the east, the sea was completely cleared. No ice appeared until the end of the month, despite strong west, north, east, and southeast winds.

Thickness of Ice in Tiksi Bay

| DATE | THICKNESS (cm) | DATE | THICKNESS (cm) |
|---|---|---|---|
| 8 Oct | 2 | 31 Jan | 145/7 |
| 20 Oct | 13 | 10 Feb | 152 |
| 24 Oct | 19 | 20 Feb | 162 |
| 20 Nov | 56 | 11 Mar | 204 |
| 30 Nov | 75 | 22 Mar | 207/6 |
| 10 Dec | 90/3 | 15 Apr | 197/7 |
| 20 Dec | 105/4 | 21 Apr | 199/10 |
| 31 Dec | 114/2 | 11 May | 102/6 |
| 20 Jan | 138/2 | 20 May | 103/9 |

NOTE: Denominators of fractions indicate snow cover on the ice.

d. <u>Kotel'niy Island</u> (Novosibirskiye Islands)

Observations from the north end of Kotel'niy Island were begun on 1 Jul 1933. The horizons on the surface of the sea from the observation point were open from 27° through north to 40°.

On 1 Jul, a smooth land floe still remained and was hummocky in the distance. Beyond its edge a band of open sea which extended to the west about 3-5 miles from shore was visible. To the northeast about 1 to 2 miles there were cracks in the land floe at the shore. The ice was covered with snowy water which flowed into the newly-formed cracks on 4 Jul. The cracks widened daily, and on 9 July the cracks at the shore formed a transparent water patch.

The land floe forming on 8 Jul broke up to a considerable extent and ice pieces were carried out to sea with the south winds; the area of open water increased due to the disintegration of the ice edge. On 13 Jul the land floe was detached by southwest winds of over 28 m/s. The floe broke up and was carried out to the horizon. Large and small ice pieces and fragments of fields to the extent of 3 balls were within the limits of visibility. The above-mentioned types of ice remained at a density of 1 to 10 balls throughout August.

The amount of ice increased with the northwest winds which generally brought ice fields. The northeast winds also brought heavy ice pieces---fragments of fields and large ice pieces. The sea was not completely cleared until 2 Sep. On 17 Sep the formation of ice crystals and slush began at the shore. From these a patch which lasted for 48 hours was formed on 18 Sep. On 19 Sep after a strong north west wind, 1-ball small ice pieces appeared again, and remained for 96 hours. After that the sea became clear. On 1 Oct sludge appeared on the sea, and on 2 Oct young ice and brash ice appeared and covered the whole visible surface of the sea on the following day. The young ice and brash ice remained until 11 Oct when the sea was completely cleared by strong south winds. More, sludge, however, formed on the following day, and on 13 Oct the brash ice and the young ice formed again, reaching 10 balls on 14 Oct. On 15 Oct hummocky ice was brought in by brisk northwest winds, recently formed in port. This froze and formed 10-ball fast ice. On 18 Oct the ice broke up due to very brisk west-southwest winds, and when the wind shifted to the south, the ice was carried out to sea. The visible surface of the water was completely cleared. On 21 Oct when the wind slackened, brash ice and young ice formed again, but the sea was cleared the next day when the wind strengthened and shifted to the southeast. On 25 and 26 Oct slush was formed as the wind slackened to 11m/sec, it vanished again when the south wind strengthened. Slush reappeared on 29 Oct as the wind weakened to 11m/sec and on 30 and 31 Oct when the wind weakened again, the whole visible surface of the sea was covered by a smooth, thin, ice sheet hummocky, some distance from the shore. The ice was unstable, and regardless of the calm weather, broke up probably due to surface vibration and the currents. This left an ice patch along the shore of no great width on 1 Nov. Now 3-ball ice fields floated on the sea.

On 9 Nov the patch was detached. On 10 Nov a formation of slush was noted, and a new patch formed on 11 Nov. This patch continually widened due to the freezing of the ice rind which formed on 14 Nov from the ice that had been brought in. It became a land floe covering the whole visible expanse on 13 Dec.

Between 7-12 Dec, the land floe sometimes left the shore (about 8 meters) and sometimes returned to it again, due to southwest winds of 11 to 17 m/sec. There were no changes in the condition of the ice cover from 13 Dec 1933 to 1 Dec 1934 when observations ceased. On 16 Mar 1934, at a distance of 675 meters from the shore, the ice was 165 centimeters thick; one mile from the shore it was 130 centimeters thick.

3. Observations of the Icebreaker Sibiryakov, 1932

[DB 303474: Ice Conditions in the Arctic Ocean Between Novaya Zemlya and the Bering Strait, According to Observations of the Icebreaker Sibiryakov, Central Meteorological Observatory, Aug 1943, translated from the Russian of V. Yu. Vize, Transactions of the Arctic Institute, Vol 1, All-Union Arctic Institute, 1933]

On the way from Matochkin Shar to Dickson Island, the Sibiryakov encountered the ice-margin at 73°22' N, 58°12' E on 1 Aug.

At 73°36' N, 60°35' E, the Sibiryakov entered clear water where we only rarely encountered scattered ice floes. After passing through about 40 miles of clear water the Sibiryakov again encountered ice at 73°43' N, 62°43'E; this situation continued as far as 73°52' N, 65°09' E, but after that point there was no ice for the remainder of the trip to Dickson Island.

The nature of the ice in this second sea-area was different from that of the ice in the first sea area. Here the ship encountered, at rare intervals, ice broken up into large pieces; the thickness of the ice was from 3/4 to 1 meter. The ice was dirty brown, greatly eroded, and was melting extremely rapidly. The ice density was 8 balls (at 73°48' N, 64°17' E it was 6 balls); however, the upper layers of the surface water lying among the ice had a temperature above zero (the water temperature of the first sea area was below zero). The ice in the second sea area, also, offered no hindrance to the navigation of our ship at all. However, it was exceptional to sail for 8 miles through a region where the ice density exceeded 9 balls.

During the trip from Matochkin Shar to Dickson Island, the Sibiryakov learned by radio from the Leningrad Soviet, a ship hunting marine animals, that an ice margin extending from west to east was encountered at 75°11' N, 71°E.

In the entire trip from Dickson Island to Sergey Kamenev Islands (11-14 Aug), the Sibiryakov encountered no ice except icebergs west of Samoylovich Island ( 79°08' N, 91°32' E).

While sailing northward along the west coast of Severnaya Zemlya, the Sibiryakov encountered, on 15 Aug, an ice margin at 81°07' N, 93°08'E. The ice was finely broken up and in an extreme stage of disorder (1-2 balls). Ice broken up into large sizes was encountered at 81°25' N, 96°37' E; the density of the ice had increased to 4-6 balls. At 81°28'N, 96°54' E, the icebreaker approached the margin of a hummocky ice field which was thought to form the southern limit of the polar ice pack (thick paleocrystic ice). The margin of this ice curved sharply south and blocked the eastward progress of the icebreaker. At 81° N the ice was in very close contact with the east coast of Komsomolets Island. Here it was a flat winter ice field ½ to 3/4 meter thick, not the above mentioned polar ice-pack with piled or rafted hummocks. As a result of thawing, the surface of these ice fields was black and on the surface many gaps could be seen. When the icebreaker was passing through this ice, the ice was under strong compression and therefore, since the ice-density was 10 balls, the low hummocky ice was forced to upheave at the edge of the icefields.

Occasionally, ice formed in the spring, about 30 centimeters thick, was encountered. Many icebergs, some rather large, were sighted. The Sibiryakov was occasionally caught in the sheet of ice stretching from Komsomolets Island towards the east and was often forced to retreat. At one time it was necessary to alight from the ship. At another time five amanol land mines were put under the ice in order to free the ship.

On 17 Aug at 80°17'N, 98°44'E, the icebreaker approached a flat ice field which was not in motion and appeared to be winter land floe that had not cracked yet. On the periphery and in the center of this ice field there were 129 icebergs composed of brilliant milk-colored ice in the form of innumerable ice columns. The great majority of these icebergs seemed to have their bases on the ocean bottom; therefore, a possible explanation is that these were masses of land floe which had not yet cracked, being the whole eastern land floe from the entrance of the Krasnaya Armiya Straits. Since, connected to this ice field, there was another ice field with rafted hummocks which blocked our passage to the east, there was no other course but to force our way south of it through winter ice fields with black watery spaces. The thickness of the ice in the northern part of the ice field was 3/4 to 1 meter. The icebreaker was hardly able to advance one-third of the length of its hull for each single ramming thrust. Often the ship was caught tightly in the ice and at such times it was necessary to blast the ship out with amanol which was not too effective. As we progressed deeper and deeper into the ice field, the ice gradually became thicker and thicker; it reached 1.5 meters; also, we encountered fewer and fewer gaps. At 80°12'N, 99°11'E the icebreaker entered clear water. It had required 40 hours to traverse the 5 miles of uncracked ice fields.

On 18-19 Aug starting from Matusevich Fjord, there was some clear water off the east coast of Oktyabraskaya Revolyutsiya Island. Ice existed from the coast eastward for a distance 10-15 miles. The Sibiryakov proceeded southward, following the margin of ice which was a flat ice field formed in winter and upon whose surface could be seen innumerable small lakes. From 18 to 19 Aug, the temperature of the night air fell as low as -1.7°; consequently, a belt of young ice appeared along the ice margin, 3 meters wide and ½ meter thick.

On the side opposite the north entrance to Shokal'skiy Straits, the Sibiryakov entered ice, which was broken up into large pieces and small pieces. This ice was obviously in close contact with the northeast coast of Bol'shevik Island. As the ship advanced east-southeast, the ice density increased and furthermore it encountered pancake ice, i.e. paleocrystic ice fields with rafted hummocks. The density of the ice between 79°16'N, 98°50'E and 105°48'E was as much as 9-10 balls; it took us 53 hours to sail thr ugh this region of ice so heavy that sometimes it was necessary to use amanol to blast our way through. Since this ice was of the paleocrystic type which had been forced upward by internal ice pressure, it was frequently a dirty brown and sometimes a chocolate color. The average thickness of the ice in this region was not less than 3 meters.

South of 78°50'N, while following the east coast of Bol'shevik Island the Sibiryakov encountered year-old ice; sometimes it ran into brash ice-fields about 30 centimeters thick generated in the spring; furthermore, the ice-density decreased.

On 22 Aug, at 78°06'N, 105°26'E, the icebreaker entered clear water near the eastern entrance to Vil'kitskiy Straits.

On the way from Severnaya Zemlya to the mouth of the Lena River, on 22 Aug, at the entrance to Vil'kitskiy Straits, 77°56'N, 106° 19'E it ran into ice, running east and west of Malyy Taimyr Island. As far as 77°33'N, 108°40'E it ran into rather finely broken ice of low density (2 balls). Further south the ice encountered became chiefly paleocrystic ice broken up into large pieces, along with brash ice-fields. Faddeya Bay did not seem to have any ice, judging from the appearance of the water sky in its direction. Between 77°20'N and 76°50'N, the ship encountered large pieces of predominately paleocrystic ice; further south, year-old ice masses, flat or hummocky were visible. As the ship approached the margin of this ice, the ice density varying between 4 and 6 balls, for the most part, decreased, starting at 76°29'N. On 24 Aug, the Sibiryakov entered clear water at 76°05'N, 116°36'E and did not encounter any ice thereafter until it reached the delta of the Lena River.

On the northeast coast of Taimyr Peninsula, the ship often ran into dirty black-brown ice. This kind of ice was encountered between 77°12'N, 110°36'E and 76°52'N, 112°54'E.

On the trip from Tiksi Bay to Bol'shoy Lyakhovskiy Island from 30 to 31 Aug, the Sibiryakov navigated upon a sea that had absolutely no ice. Laptev Straits likewise had no ice. According to data of the Marine Meteorological Observatory on Bol'shoi Lyakhovskiy Island, in 1932 the ice in Laptev Straits began to break up 10 Jul and was completely gone by 6 Aug. By 14 Aug, ice was seen only rarely, but after that date, absolutely no ice was seen either in the straits or in the open sea outside.

On 1 Sep the Sibiryakov set sail from Bol'shoy Lyakovskiy Island for Medvezhi Island. On our way, except for a large mass of ice hung on a shoal at 73°10'N, 145°37'E no ice was seen. This point, according to chart No 985, is comparatively shallow and hence the presence of this ice mass hung on the bottom is quite understandable and proves the shoal's existence.

While the Sibiryakov was approaching Medvezhi Island, scattered ice was seen for the first time on 3 Sep at 71°41'N and 158°03'E. At 71°32'N, 159°13'E, the ice-margin was clearly seen to the north. The ice encountered by the Sibiryakov north or east of Medvezhi Island was broken up into large and small pieces, frequently piled-up or hummocky. For the most part, the density of the ice did not exceed 1 ball and only in certain places did it reach as much as 2 balls. The Sibiryakov sailed south, keeping Medvezhi Island sighted to the west; at 70°05'N, 162°35'E the ship entered clear water; from this point to the coast there was no ice.

The ship continued eastward and on 4 Sep sighted the first ice floes at 69°52'N, 162°35'E. These floes were extremely rare (generally of density less than 1 ball) and were of the hummocky type. On the same day at 69°58'N, 165°06'E the ice was encountered. The ice density, up to the point 70°06'N and 166° 57'E, did not exceed 4 balls; north of Aion Island the density reached 8 balls. Here large and small pieces of paleocrystic hummocky ice were encountered. Fields of brask ice were rare. The sea water between the ice floes was covered with fresh new ice about 6 centimeters thick.

The nature of the ice east of Aion Island was as follows. The density was from 2 to 8 balls, the average being 5 balls. On the coast of Chukotsk Peninsula, Sep 1932, the ice was for the most part huge paleocrystic masses which lay deep in the water and possessed large underwater spurs. The winter ice which was one year old before the Sibiryakov navigated along the Chukotsk Sea coast was almost completely melted. As the ship approached Cape Severnyy (Cape Schmidt or North Cape) the ice density increased and at times reached as high as 9-10 balls. The clear water was covered with young ice about 2 centimeters thick. Near Cape Severnyy, heavy dense ice was almost in contact with the coast; near the coast there remained a strip of clear water, barely 200 meters wide.

Here it was twice necessary to break an ice juncture, with amanol. According to the Chukotsk people who live on Cape Severnyy, the ice here had lasted three years, since 1930; sometimes, the ice increases year after year. The Chukotsk people said that the year 1932 was one of the years of greatest ice.

East of 179° W, the density of the ice decreased somewhat; beyond 176°45'W the density rose again, to 9 balls. Near Cape Omman, the compact ice was in close contact with the coast. During the difficult navigation through the dense ice not far from the coast, the Sibiryakov suffered, on 10 Sep, damage to four blades of its screw. From 10 Sep to 16 Sep while replacing these blades, the ship was drifting among the dense ice (8-9 balls) between Cape Omman and Kolyuchin Island. There was apparently no ice in Kolyuchin Bay.

On 16 Sep the Sibiryakov continued its eastward voyage; near Cape Dzhenretlen it again ran into dense ice of 9 balls. On the morning of 18 Sep at 67°08'N, 172°50'W, the propeller shaft was bent, the screw was lost, and the Sibiryakov began to drift; on 1 Oct it stopped north-northeast of Cape Dezhnev. There was broken ice, large and small, 18-20 Sep, between Cape Ikigur (66°45'N, 171°20'W) and IDORIDORI* Island; the density of this ice was 8-10 balls. The ice was in close contact with Cape Inkigur and Cape Serdtse Kamen. In the region northeast of Cape Inkigur where the Sibiryakov drifted 25-28 Sept, the ice-density was low, 5-7 balls. At 0900 on 27 Sep, at 66°55'N, 177°02'W, the ship spread its sails; thereafter, sails were used. On 28 Sep, young ice covered the clear water, but the next day, the young ice reached a thickness of 8-10 centimeters. At 1445 on 1 Oct, the icebreaker entered upon clear water at 66°17' N, 169°28' W.

The disposition of ice in Chukotsk Sea for Sep 1932 possessed extremely peculiar characteristics. Even previously, on rare occasions, there have appeared large inlets of clear water which indented the Longa Straits, from east to west (these are probably formed because the comparatively warm ocean water moves northwest.) Clearly it seems that these inlets grow most rapidly at the end of the period of navigation.

The Sibiryakov selected the most illogical and worst path when it chose to sail 2-3 miles offshore in its eastward voyage from Cape Severnyy. Captain V.I. Voronin had warned that ice conditions in the north were uncertain, when one advanced towards the coast over clear water usually cut by projecting points and capes. The Sibiryakov would have changed its course northward after reaching Cape Severnyy if the conditions regarding ice movements had been clearly known. There was without a doubt a

30-mile ice-strip which separated the icebreaker from the clear water where it was possible for a ship to navigate. In this case the icebreaker would have had absolutely no trouble at all. This reveals the tremendous significance of having planes in the Arctic Ocean to reconnoiter ice conditions; the poor example of the Sibiryakov is an important and noteworthy object lesson.

The ice conditions which the Sibiryakov and the Soviet discovered in the Chukotsk Sea in 1932 showed how extremely illogical it is to navigate near the Chukotsk Sea coast, the course chosen by the Captain who led the ship from the Bering Straits to Kolyma Straits.

When the Sibiryakov ended its observations on ice conditions encountered during its long northeastward voyage, it was learned that in 1932 the National Hydrographic Research Institute carried out for the first time ice forecasting for the whole region of the Soviet Arctic, that is, from Spitzbergen to the Bering Straits. In the future there will be attempts to forecast for the region through which the Sibiryakov passed.

Forecast for early May 1932: "Ice conditions probably better than usual in the eastern part of Kara Sea; Sergey Kamenev can be reached by icebreakers, after mid-August; no conclusions can be reached regarding the Eastern Siberian and Chukotsk Seas, but in the 1932 navigation season there have not been any changes in ice conditions."

Forecast for 16 Jun 1932: "Ice conditions appear better than usual in the latter half of the navigation season in the eastern part of the Laptev Sea; ice will probably disappear in the sea between Laptev Straits and the mouth of the Lena River after 20 Aug (or earlier); ice-margins the first of Sep will probably form north of the Novosibirskiye Islands; ice has accumulated in the western part and especially in the northwestern part of the Laptev Sea, becoming quite dense in places; this may bring about poor ice conditions at Vil'kitskiy Straits."

Forecast for 10 Jul 1932: "Ice conditions comparatively good during August in the northeastern part of Kara Sea and in the western area of Severnaya Zemlya; even ordinary ships can reach Sergey Kamenev Island; ice conditions on the Laptev Sea coast seem better than usual."

When we compare these forecasts with the results of the Sibiryakov voyage, we see essential agreement except in the case of the Chukotsk Sea. In the future when sufficient data can be obtained more complete ice forecasting can probably be carried out.

4. Freezes and Thaws of the Sea off Dickson Island

[DB 302467: Meteorology of the Krasnoyarsk/Dickson Island Air Route, Research Section, South Manchurian Railroad, 1939]

| | |
|---|---|
| First Appearance of Thin Ice: | 20 Sep |
| Latest Appearance of Thin Ice: | 22 Oct |
| First Appearance of Drift Ice: | 28 Sep |
| Latest Appearance of Drift Ice: | 26 Oct |
| First Date of Freezing: | 30 Sep |
| Latest Date of Freezing: | 6 Nov |

| | |
|---|---|
| First Movement of Ice: | 23 May |
| Latest Movement of Ice: | 29 Jul |
| Completely Thawed (Earliest): | 10 Jul |
| Completely Thawed (Latest): | 30 Aug |

C. Barents and Adjacent Seas

1. Barents Sea

["Data on Ice Conditions on the Soviet Arctic Coasts in the Winter of 1933-34," Transactions of the Arctic Institute, Vol 45, 1936]

a. Tikhaya Bay, Franz Joseph Land (80°20' N, 52°48' E)

Until 8 Oct 1933 the water surface was free of ice within the range of visibility, i.e., about 10 miles. On 8 Oct slush appeared, increasing on 10 Oct when young ice pieces drifted into the bay from the sea. On 11 Oct slush was observed in the strait changing into pancake ice, and on 14 Oct young ice was formed. On 15 Oct Melenius Strait was clear of ice, and the young ice remained only in the bay. On 16 Oct the strait and the bay were piled-up with young ice, and the formation of slush in the water continued. The British Channel was clear.

On 17 Oct snow blown by an off-shore wind formed sludge which, along with the young ice, completely covered the surface. On 18 Oct the ice pieces froze together, and formed a fast ice cover. North of Hooker Island and beyond Scott-Kelty Island, drift ice was observed. On 19 Oct the melting ice in the bay was partly broken up and in the vicinity of the station clear water appeared. Meanwhile, the British Channel was massed to the horizon with floating ice. From 21 to 22 Oct the bay was completely cleared of ice, but in the strait and in the British Channel beyond, the water remained filled with ice as before.

On 23 Oct 10-ball hummocky young ice came into the bay in which there were seven icebergs. Between the floes slush and sludge were observed. On 24 Oct this ice began to freeze, and on 28 Oct the bay and the strait within the range of visibility were covered with a sheet of hummocky fast ice with single ice fragments piled-up edgewise on a relatively even ice surface. A water reflection was observed on the western part of the horizon until 28 Oct. On 29 Oct the depth of the ice in the bay reached 12 centimeters.

During the course of the winter, the Melenius Strait ice cover presented a uniform picture in the bay, and not until 5 Jun 1934 was a strong water reflection observed over Hooker Plateau. On the same day wide cracks appeared beyond Cape Dundee. From 5 to 23 Jun a continuous fast ice cover was observed from the station.

From 23 to 24 Jun it was established by plane reconnaissance that the southern edge of the fast ice passed near Northbrook Island and McClintock Island, and proceeded further east. West of the British Channel the fast ice edge passed from

Cape Chade to the western extremity of Luigi Island. The sea side of the edge, about 4 to 5 miles wide, was covered with a great many cracks. Beyond the edge of the land floe large and small ice pieces were massed in fields which extended north within the limits of visibility to the height of 600 meters.

On 27 Jun pools of melting snow were formed on the land floe. On 30 Jun air reconnaissance to the north indicated that cracks in the edge of the land floe were opening up, and beyond the land floe there were large and small ice pieces, driven against the western islands. The edge of the land floe advanced beyond Luigi Island at the western extremities of Salisbury Island, Jackson Island and Alexander Island.

On 2 Jul in Melenius Strait off Scott-Kelty* Island, a large gap was formed and the entire surface of the land floe was covered with pools. Air reconnaissance on 3 Jul showed that the outer part of the southern edge of the fast ice was beginning to disintegrate in places, and south of Hooker Island it projected into the sea. This was probably because of the drift ice that was frozen to it. On 2 Jul gaps appeared in the land floe and grew larger. On 11 Jul in Melenius Strait between Cape Sedov and the eastern point of Scott-Kelty Island, a broad expanse of clear water appeared. The disintegration of the land floe was greatly hastened by the impacts of floating icebergs which were partially visible.

On 14 Jul air reconnaissance indicated that the southern shores of Bruce Island, Northbrook Island, and Hooker Island were free of the land floe, and in the strait between Cape Sedov and Scott-Kelty Island large and small ice pieces were floating.
On 15 and 16 Jul the fast ice remained in the bay, though in Melenius Strait it was partly broken up. It was discovered by air reconnaissance on 16-17 Jul that a markedly eroded land floe with cracks remained fast in the central part of the British Channel, joining the islands southeast of Hooker Island and extending further east. Between George Land and Kotlits Island, several cracks were formed again at the edge of the land floe. Beyond the edge of the land floe there was a conglomerate of large and small ice-pieces.
Until 26 Jul the bay was covered with 10-ball fast ice, and in the strait between Kotlits Island and Hooker Island, large and small ice pieces floated in a broad gap in the ice.

On 25 Jul air reconnaissance indicated that the southern approaches to the archipelago were piled with heavy pack ice, and the fast ice in the British Channel and Melenius Strait was riddled with fissures. From 27 to 30 Jul the ice was partially broken up in the bay and had a density of 9 balls; the sheet ice and ice pieces in the strait had a density of 5 balls.

At night from 29 to 30 Jul air reconnaissance indicated that a strongly corroded sheet of fast ice with cracks, channels, and gaps remained between Northbrook Island and Hooker Island, extending into the central portion of the British Channel and further north. A small accumulation of large and small ice pieces was drifting south of Hooker Island and Northbrook Island.

On 31 Jul the thoroughly eroded fast ice remained only northwest of Hooker Island in Allen Young Strait and further east among the islands. The strait between Hooker Island and Northbrook Island was clear of ice, and only south of Hooker Island were there any separate fields or parts of fields left. Between George Land and Kotlits Island there were combined large and small ice pieces which left a zone of clear water about a mile wide off George Land.

In the strait between Alexandra Land and George Land there was a conglomerate of large and small ice pieces, forming a large coastal gap in the bay at Alexandra Land.

The bay was not opened until 2 Aug, and the density of the ice was reduced to 3 balls. Air reconnaissance on 2 Aug showed that the sheet of ice remained north of Hooker Island and extended into the middle of the British Channel and between the islands north of Hooker Island. The northern and north-western parts of the British Channel, however, were piled with large and small ice pieces which changed into heavier forms to the north. The strait between Alexandra Land and George Land was full of large and small ice pieces. Between Hooker Island and McClintock there were separate accumulations of large and small ice pieces.

A fast ice sheet remained in the bay until 16 Aug, when its steady disintegration began. By 19 Aug its density had diminished to 2 balls. Air reconnaissance on 4 Aug showed that thoroughly eroded fast ice continued to remain northwest of Hooker Island and in the east among the islands. Beyond the northern edge of the land floe were large and small ice pieces, and in the strait between Northbrook Island and Hooker Island several accumulations of ice were floating. In Melenius Strait, on the south side of Scott-Kelty Island, there remained an ice barrier blocking the entrance to the strait from the south.

On 8 Aug the British Channel was observed from a plane. It was covered with large and small ice pieces from the north. The passages between George Land, Bruce Island, and Northbrook Island were blocked with ice. The barried south of Scott-Kelty Island remained. There was open water between Northbrook Island and Hooker Island.

On 9 Aug large and small ice pieces in separate fields were driven against George Land, which resulted in the formation of a wide and straight channel from south to north in the eastern part of the British Channel. The land floe remained only north of Scott-Kelty Island and around Ketlits Island. In Allen Young Strait separate, easily avoided ice accumulations floated. The barrier south of Scott-Kelty Island disappeared, and the approach to Tikhaya Bay from the south was quite free of ice.

On 14 Aug a few small ice pieces remained northeast of Hooker Island, and in places there were still barriers of fast ice between the islands. The main mass of drift ice was observed north of Cape Chado, leaving clear water about 5 miles wide along the western shores of Luigi Island and Salisbury Island.

b. Russkaya Gavan, Novaya Zemlya (76°14'N, 62°39'E)

Observations in the bay of Russkaya Gavan were not of a systematic nature, and were made by a meteorologist who was the station head at the same time. The usual place for observations was a rise to the south of the station with a height of about 30 meters above sea level (range of visibility about 11 miles). In some cases the observer went to the Shokalskiy glacier and the camp at Voronin Bay from which points it was possible to see the northern part of Otkupshchikov Gulf and the open sea. The observations were noted down in the observer's log, from which notes were taken, and on them was based the following description of the ice cover.

The first date of observations was 7 Dec, when ice fields which had been frozen together during a calm, were afloat in the bays. During December and January the ice cover changed frequently due to winds. Also, ice from the sea would fill the bays and freeze together, and then would break up and be carried out to sea. On 14 Dec a piece broke off the glacier, producing a large iceberg. Small pieces were continually breaking off, leaving Otkupshchikov Gulf always full of small ice floes.

On 23 Jan 1934 in the deeper part of the bay, a fast ice sheet was formed, the sea side of which had several cracks. Beyond this was a large gap, and farther out to sea floated a mass of small ice pieces. The gap was closed at times by young ice, which was broken up again by the winds. On 24 Jan the northern half of the bay was clear of floating ice; ice remained only around the iceberg and in the eastern part of Otkupshchikov Gulf.

In February sheet ice about 50 centimeters thick covered the bays, and the part facing the sea was at times covered with cracks. Drift ice remained in the sea for the whole month, in most cases up to the horizon.

During March the outer part of the land floe was broken up from time to time, and then it would form again by freezing together with the ice coming in from the sea. Beyond the land floe there were instances of the formation of large expanses of clear water between the land floe and floating ice.

On 4 Apr many cracks formed in the ice floe, and on 6 Apr the seaward part of the land floe disintegrated under the pressure of the ice. Until 8 May there was ice to the horizon with no signs of clear water, and only on 9 May did a zone of clear water appear on the horizon. On 21 May thinning fragments of ice fields were floating over a wide expanse at the horizon.

On 25 May so much water appeared on the ice of the land floe, that the ice looked blue, and having lost its former solidity, became more susceptible to disintegration. The edge of the land floe approached Bogatiy Island from the sea. On 26 May the land floe became still more blue, and many cracks appeared in it.

On 2 Jun the land floe left Bogatiy Island which was surrounded by ice pieces and clear water. On 12 Jun fast ice remained in the interior of the bays, and all the remaining surfaces of the bays and the sea were cleared of ice to the horizon by the south winds. The ice cover remained the same with few changes, as far as drift ice was concerned, until 25 Jun, when patches of water along the shore and washouts on the land floe appeared. Water came up through these on the surface of the ice.

Up to 28 Jun the washouts and the patches continued to increase, and the edge of the remaining land floe began to break-up intensively. The ice was carried out to sea by the wind and the currents, and the inner portions of the bays were cleared of drift ice from time to time. The land floe disintegrated greatly during the calm weather of 29 Jun due to the swell from the sea. The foot of the ice floe remained only in the bays and shore inlets. Pieces were chipped off the glacier more frequently, protruding portions of the icebergs were broken off, and the latter's contours were evened off.

On 1 Jul a thawing ice sheet remained only in the deeper part of the bay. Otkupshchikov Gulf, as a result of the intensive chipping of the glacier, was almost completely covered with small ice floes from the icebergs, and fast ice remained at its eastern shore. Only detached floes were noted out at sea.

On 4 Jul the sheet ice was completely broken up, and the remains of the land floe stayed only on the eastern shore of the Gulf of Otkupshchikov and in Voronin Bay. At the end of the day the floating ice began to be carried out to sea by the tide, and on 5 Jul the bay was completely cleared of ice by the south winds. On 6 Jul Voronin Bay was cleared, and a small quantity of fast ice remained on the eastern shore of Otkupshchikov Gulf. On 18 Jul the schooner Onega, arrived.

2. Ship Observations of Ice Conditions in the Arctic Seas, 1934

/DB 303474: Ship Observations on Ice Conditions in the Arctic Ocean During the Period of Navigation in 1934, Central Meteorological Observatory, Aug 1943, translated from the Russian of A. F. Laktionov, Transactions of the Arctic Institute, Vol 32, All-Union Arctic Institute, 1935/

The area of the ice-covered surfaces observed by the Persey in the Greenland sea in August was similar to the standard ice-covered surface, calculated according to the data of the Netherlands Meteorological Stations (The State of the Ice in the Arctic Seas). That is, the boundary of ice at 75° North latitude, east coast of Greenland, lay barely 5 to 10 miles east from the average eastern boundary for August. Also, the boundary of the ice situated at 80° North latitute in the northern Greenland Sea, lay, similarly, 30 to 40 miles west of the August average boundary.

Although navigation along the coasts of Spitsbergen was very easy, the passage from Greenland Sea by detouring around the north coast of Spitsbergen to the Barents Sea was quite difficult because of the ice which had arrived along the coast of Northeast Land on the north. In the seas north of 80° N latitude, between Franz Josef Land and Spitsbergen, the observations of the Taimyr, Leningrad Soviet, Persey, and planes showed that the passages were completely free, from Greenland Sea via Hinlopen Straits to Barents Sea, with even large gaps broken open in the compact ice.

As a result of the exploratory voyages of the Persey and N. Knipovich in Mar-Oct 1934, there has been clarifying information regarding freezing in the Barents Sea in 1934 and the recession of the northern and eastern boundaries of ice during the summer.

The ice boundaries in the Barents Sea move the farthest southwards and westwards in April. As indicated by Professor N. N. Zubov, the average area of ice at this time is 74 percent of the total area of the Barents Sea ("Hydrographic Survey Operations by the Destroyer Persey in the Southwestern Part of the Kara Sea in 1928", by N. N. Zubov, Vol II, No 4 of National Marine Studies Research Laboratory Publications). According to reports of the N. Knipovich and the Persey which navigated the Barents Sea in March and April, the area of the ice increased rather slowly until the end of April.

According to data from the Persey, the southern limit of ice in the seas near Medvezhi Island reached, for the most part, 74°16'N, 20°00'E. The N. Knipovich, however, which explored this same area 24 Apr, discovered that the boundary of drift ice was further south, at 74°03'N, 20°30'E. Therefore, we know that between 16 Mar and 24 Apr, the boundary of drift ice moved 13 miles southward along 20° East longitude with an average speed of 0.33 miles per day. Similarly, when we compare the two voyages of the N. Knipovich, we see that the margin of the drift ice, for the 32 days up to 12 Apr, moved southward with an average speed of 0.5 miles per day. From 14 to 25 Apr the Persey sailed along the margin of the drift ice, but when we compare the ice margin surveyed at that time and the average boundary of the Barents Sea drift ice, we see that the area covered by the drift ice was remarkably smaller than the average area in the month of April. (For the comparison we employed the monthly average boundaries of the Barents Sea ice, prepared by the Netherlands Meteorological Station.

Only the ice margin at 20°E near Medvezhi Island was lying rather far southward, as compared with average positions. Also, in the region between 30° and 40°E it was 57 miles northward from the average boundary.

It is worthy of note that in the beginning of April the ice boundary moves from the average boundary line towards the northeast, east, and towards the Kara Sea entrance. Especially wide inlets indent the ice masses rather deeply in the northeast direction. Furthermore, the ice boundary comes 225 miles northeast of the average position. It goes without saying that these inlets or indentations are formed because the sea water temperature of the Atlantic Ocean rises and falls, and one of the currents heads towards the northwest coast of Novaya Zemlya. Even in the direction of the Kara Sea entrance rather deep inlets are produced.

Although here the difference in position of the ice boundary in April 1934 and position of the average ice boundary for April was 160 miles (towards the east), the ice boundary observed in 1934 between Kola Peninsula and Cape Kanin was remarkably far south of the average ice boundary.

The investigations of the Persey showed that there were rather wide protuberances which projected southward between 35° and 40° E. These projections are related to the central elevations in the Barents Sea. The formation of ice in the Barents Sea gives sufficient proof to Zubov's contention that in certain places where there are shoals this phenomenon is especially noticeable.

Furthermore, from 12 Apr to 14 May, the boundary of ice along the Kola Peninsula longitude, according to the 49th voyage of the Persey recedes northward 42 miles gradually with the arrival of the period of thaw. Therefore, the velocity of recession of the ice in this period is 1.3 miles per day, and this value agrees with the velocity given by Zubov (1 mile a day).

In Jun, according to the N. Knipovich (24-25 June) and the Persey (25 Jun - 4 Jul), the ice-boundary shifts quite remarkably northward, and actually the areas below 77°N latitude, the southern and central parts of the Barents Sea, are seen to be completely free from ice until June. Also, when we compare the ice margin in June and the average boundary of June, we see a considerable northward retreat. This almost agrees with the average boundary of August.

This recession is given in the following table (condensed): 20°: 105 miles; 30° : 120 miles; 40°: 182 miles; 50°: 210 miles.

As ships can call at the various ports in Franz Josef Land in mid-June, the Persey headed northward from 78°34'N along 47°50'E and cut across a belt of ice 85 miles wide, which was split considerably. Then on 30 Jun the ship entered the seas near Franz Josef Land and took almost a similar course on the return trip; it reached clear water on 2 Jul.

Although the width of the ice in a belt south of Franz Josef Land becomes broader in the east, on 5 Jul, the Persey easily entered port near Cape Zhelaniya where there was no ice. According to the observations of the Leningrad-Soviet, which was hunting marine animals, the width of this ice did not seem to contract very much even by July; the margin of 8-ball ice stretched to the line 79°06'N longitude.

In mid-August the whole of the Barents Sea was free of ice. The icebreaker Taimyr, headed from Archangel to Franz Josef Land, made port on 19 Aug, but saw no drift ice during all that time. Furthermore, in the northeastern part of the Barents Sea, the ice boundary ran from Wilczek Island toward the southeast (toward Zhelaniya). At 78°13'N, 61°21'E, the ice boundary had completely disappeared. Only a very small part north of 78° N and west of 43° 00'E, which is the north-western tip of Barents Sea, was covered with ice; south of 79°30' and 80°N the drift-ice boundary was rather difficult to record on maps. This was because of tidal currents which flow south along the east coast of Spitsbergen, and because of winds, and because, the ice in the lower seas was projecting in tongue shapes toward the south.

At any rate, it can be said that the Barents Sea was free of ice by the end of August. The drift ice, which was encountered by the Persey headed towards the northwestern part of the Barents Sea. Even when the ship reached 79°N, 43°E, it was very small in amount and were furthermore separated by ice-belts. Therefore, it can be said that ice conditions in the Barents Sea for 1934 were very good.

Finally, it is necessary to touch upon the October voyage of the N. Knipovich which navigated along the Kola Peninsula longitude. This voyage revealed clearly the conditions of beginning thaw in the region north of 76°N latitude. According to the various explorations of the Persey and the N. Knipovich, the boundary of drift ice recedes from the monthly average boundary (not the midmonthly boundaries of the ice margins as determined by the ships in 1934).

Although the various straits between the islands of Franz Josef Land were already navigable by the end of June as previously mentioned, navigation became difficult in July and August because of drift ice. Furthermore, as shown by ship and plane observations, the only navigable places were the various southern and central straits of Franz Josef Land, and there are some places which never completely thaw even in summer; the northern and western straits and the British and Austrian Channels were broken by continuous ice fields. One is forced to say that the bad ice conditions, in the British Channel, the northwestern parts of Franz Josef Land, and the Austrian Channel are considerably influenced by wind directions.

The following shows the percentages of wind direction, the average temperatures recorded in Tikhaya Bay from May to the end of July:

Wind Direction

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| May | N 15, | NE 13, | E 22, | SE 19, | S 8, | SW 3, | W 9, | NW 11 |
| June | N 33, | NE 11, | E 4, | SE 13, | S 9, | SW 7, | W 5, | NW 18 |
| July | N 13, | NE 1, | E 4, | SE 12, | S 4, | SW 26, | W 22, | NW 18 |

Average Temperature:

May : -8.8° July: ------

June : -0.1°

Thus, we see that ice conditions were not too good in 1934, in the various straits of Franz Josef Land.

Next, in examining ice conditions in the Kara Sea, we see that the southwestern part of the Kara Sea was completely filled up with drift ice by the end of July. It seems that only Baydaratskaya Bay, Ob' Bay, and the Gulf of Yenisey, for the most part, were free of ice. Furthermore, there was hard, thick, immovable coast ice at many places in the coastal areas of Baydaratskaya Bay, Belyy Island, and also in Malygin Straits (by 6 Aug, Malygin Straits had already thawed and become clear water).

Rather large holes, not yet frozen over, were seen along the western coast of Yamal Peninsula, and their northern limit was seen to extend farther towards the northwest. However, similar unfrozen holes, rather smaller than these, extended along the east sea coast of Novaya Zemlya from Yugorskiyshar Straits toward Matochkin Shar Straits, as far as 74° N.

A narrow strip of clear water was observed at the end of July along the east coast of Dickson, and generally as far as the entrance to the Pyasina River. Farther east along the coast, there continued a wide belt of coast ice, hard, thick, and immovable. By the end of July the northeastern part of the Kara Sea was covered for the most part, with compact ice; only east of Zhelaniya was split ice seen.

In the southwestern Kara Sea, ice of 8 to 10 balls in density extended southward from the Matochkin Shar Straits latitude.

During the navigation of the Kara Sea, north winds prevailed during later spring and early summer; therefore, ice was often blown in and became compact and hard. Wind conditions (percentages) between May and July were as follows:

Matochkin Shar (Straits):

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| May: | N 6; | NE 26; | E 19; | SE 10; | S 2; | SW 2; | W 7; | NW 28 |
| June: | N 5; | NE 17; | E 17; | SE 20; | S 6; | SW 2; | W 10; | NW 23 |
| July: | N 1; | NE 8; | E 2; | SE 12; | S 12; | SW 3; | W 20; | NW 42 |

Yugorskiy Shar (Straits):

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| May : | N 9; | NE 7; | E 19; | SE 11; | S 14; | SW 14; | W 9; | NW 17 |
| Jun : | N 15; | NE 20; | E 25; | SE 2; | S 0; | SW 14; | W 17; | NW 7 |
| Jul : | N 32; | NE 22; | E 11; | SE 3; | S 3; | SW 14; | W 10; | NW 5 |

Dickson Island:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| May : | N 25; | NE 15; | E 7; | SE 8; | S 18; | SW 8; | W 7; | NW 12 |
| Jun : | N 11; | NE 23; | E 6; | SE 8; | S 16; | SW 11; | W 14; | NW 10 |
| Jul : | N 40; | NE 35; | E 1; | SE 0; | S 1; | SW 5; | W 3; | NW 15 |

However, at the same time, it must be pointed out that the temperature in 1934 in the Kara Sea was higher than the average temperature for the whole year. This is shown below:

| | | | | | | |
|---|---|---|---|---|---|---|
| Cape Zhelaniya : | May | -7.0; | Jun | -1.2; | Jul | ---- |
| Matochkin Shar : | May | -3.8; | Jun | +0.9; | Jul | +6.2 |
| Yugorskiy Shar : | May | -2.8; | Jun | +0.8; | Jul | +5.3 |
| Dickson Island : | May | -6.6; | Jun | +0.0; | Jul | +1.7 |

Also, if we compare the average temperature over many years, we have the following:

| | | | | | | |
|---|---|---|---|---|---|---|
| Matochkin Shar : | May | +1.7; | Jun | +0.4; | Jul | +0.9 |
| Yugorskiy Shar : | May | +2.0; | Jun | -0.3; | Jul | -0.8 |
| Dickson Island : | May | +2.3; | Jun | +0.3; | Jul | -1.5 |

As is clear from the above comparisons, in the southwestern part of Kara Sea, ice conditions proved to be good in early August, in spite of the prevalent north winds. This was due to the fact that the late spring and early summer were somewhat warmer than usual.

The course at the end of July and in early August from the Barents Sea to Dickson Island was via Yugorskiy Shar (Straits). In the area from Matochkin Shar to Belyy Island there were accumulations of drift ice composed of ice fields and fields of ice flows, making passage to Dickson Island via Matochkin Shar remarkably difficult.

During the end of July, the area between Cape Zhelaniya and Vize Island, ice that is comparatively broken up, is encountered. This is because the warm water of the Barents Sea melts the ice which is north and northeast of Cape Zhelaniya. The influence of this warm water, as related previously, does not extend very far. The fields of ice floes in the southwestern part of Kara Sea gradually become smaller, but these ice fields melt very rapidly, especially from the south towards the north. The following shows the conditions of contraction of these ice fields in the line between Matochkin Shar and Belyy Islands.
The first figure gives the width of the ice fields; the second figure gives the amount of contraction in one day.

| | | |
|---|---|---|
| 17-25 Jul: | 165 miles; | 10 miles |
| 26 Jul: | 155 miles; | 3.5 miles |
| 5 Aug: | 120 miles; | 2.5 miles |
| 13 Aug: | 100 miles; | 6.2 miles |
| 29 Aug: | clear water | |

Thus, between 25 Jul and 29 Aug, the ice which had moved deeply into the Kara Sea completely disappeared. The width of the ice floes extending 165 miles between Matochkin Shar and Belyy Island contracted an average of 4.7 miles per day.

The area covered by ice in the southwestern part of the Kara Sea (the area southwest from the line of Dickson Island and Cape Zhelaniya) contracted remarkably in the period 5-13 Aug; for example, the ice at the latitudinal line of Matochkin Shar on 13 Aug, projected below the sea area. The protruding part of this ice, however, was not too large.

As the area of drift ice rapidly contracted because of the melting, it became obvious by mid-August that the regions between Yugorskiy Shar and Dickson Island, and Matochkin Shar and Dickson Island had already become navigable.

When we compare (1) the boundary of drift ice shown here; and (2) the boundary of sea ice in the Kara Sea during mid-August, according to the data of V. Yu Vize (Drift Ice Conditions in the Kara Sea) then the ice-covered surface of the southwestern part of the Kara Sea in 1934 is seen to be remarkably smaller than the average.

The northeastern part of the Kara Sea was covered, for the most part, with ice by the first part of August. Only between Dickson Island and Pyasina Bay, along the coast, was a strip of clear water observed. From there towards Cape Chelyuskin there was a wide strip of coast ice, hard, thick, and immovable.

At the end of the first part of August, the ship encountered a wide belt of ice (1 to 4 balls in density) which was split near 77°N and 78°40'E. As a result of the influence of the warm water of the Barents Sea, it was greatly affected after the end of July. Similarly, in the area east of 80° E it freezes even in early August.

The area north of the thick, hard, immovable land floe near the Laptev coast was completely buried under ice, which made the course to Cape Chelyuskin very difficult. However, there was a rather narrow strip of clear water lying between this hard, immovable land floe and the heavy drift ice. In mid-August, ice conditions between Dickson and Chelyuskin become somewhat better. The hard and thick, immovable coast ice along the shore contracted, and even the ice northeast of Dickson began to crack to some degree. Furthermore, toward Cape Chelynskin, some clear water started to form. On 18 Aug the first steamer arrived at Cape Chelyuskin, but at that time Vil'kitskiy Strait had a long belt of unbroken ice, 19 miles wide, which blocked through-passage. According to observations of the Sibiryakov, this ice finally broke up 27 Aug.

Other data concerning thawing in Vil'kitskiy Straits follows; Vil'kitskiy Straits were almost free of ice in early Aug 1933. The straits began to thaw 14 Jul 1933, and 24 Aug 1934. Furthermore, to indicate the temperatures in Vil'kitskiy Straits, the following are the average monthly temperatures at Cape Chelyuskin: May, -8.5; Jun, -0.9; Jul, +0.9; Aug, +0.5.

In early August the ice between Dickson Island and Cape Chelyuskin showed many changes. In the eastern half of the course between these two places (from Russkiy Island to Cape Chelyuskin) there was a rather wide belt of clear water, but the western half showed no great change from mid-August. At the same time, new ice began to form at the end of August in a belt several miles west of Russkiy Island and Bryuzevits Island. Furthermore, in the course from Dickson Island to Chelyuskin, the places of greatest difficulties were in the area west and southwest of Russkiy Island. There, ice of 8 - 10 balls density was encountered.

Looking at the ice conditions at the middle and end of August, in other places of the northeastern Kara Sea, it is necessary first of all to presume that the ice density was not greatly different from that of early August. The warm water of the Barents Sea has influence only northeast and east of Cape Zhelaniya, and one can expect a considerable decrease in the area of the ice-covered sea there. Because of the effect of this warm water, the ice near Uyedineniya Island, is sometimes around 2 balls in density by the end of August.

The area east of 80°E and generally north of the Cape Chelyuskin latitude was completely locked in ice in the middle and end of August. In the region west and northwest of Sergey Kamenev Island, navigation was very difficult even for an icebreaker. The only exception was the strip along the west coast of Severnaya Zemlya and according to aerial observations on 30 Aug, one could use the coast to navigate from Cape Chelyuskin to Sergey Kamenev Island. Similarly Shokal'skiy Straits apparently had no ice by the end of August. In Vil'kitskiy Straits there was a rather wide belt of land floe, hard and immovable.

When we look at the weather conditions of the eastern half of the Kara Sea, especially at the wind direction, we note that July has mostly west winds, with east and southeast winds prevailing in August. Therefore, ice conditions along the west coast of Severnaya Zemlya were very bad, and even at the end of July and in August, in Severnaya Zemlya, it was difficult for icebreakers to approach from the west. By the end of August, when east and southeast winds prevail, the ice in the eastern part of the Kara Sea shifts towards west. Between the west sea coast of Severnaya Zemlya and the drift ice, the coast strip of ice which is considerably broken is formed. One can use this in order to reach Sergei Kamenev Island from the south.

The followig table shows wind conditions (percentages) near Severnaya Zemlya Island and Cape Chelyuskin, indicative of wind directions in the northeastern Kara Sea for 1934:

Sergey Kamenev Island:

| | N | NE | E | SE | S | SW | W | NW |
|---|---|---|---|---|---|---|---|---|
| May: | 21 | 31 | 6 | 11 | 11 | 2 | 2 | 16 |
| Jun: | 13 | 23 | 17 | 10 | 5 | 7 | 14 | 11 |
| Jul: | 21 | 7 | 5 | 10 | 9 | 2 | 36 | 10 |
| Aug: | 14 | 5 | 11 | 42 | 16 | 4 | 0 | 8 |

Cape Chelyuskin:

| | N | NE | E | SE | S | SW | W | NW |
|---|---|---|---|---|---|---|---|---|
| May: | 2 | 17 | 20 | 9 | 6 | 9 | 27 | 10 |
| Jun: | - | 15 | 34 | 10 | 5 | 3 | 23 | 10 |
| Jul: | 2 | 9 | 30 | 6 | 2 | 3 | 44 | 4 |
| Aug: | 3 | 10 | 40 | 23 | 3 | 4 | 9 | 8 |

The comparatively low temperature in July at Severnaya Zemlya seems to influence the ice on the west sea coast. The following are the average temperatures recorded at Sergey Kamenev Island in 1934: May, -9.2; Jun, -0.5; Jul, +0.1; Aug, +0.4.
The hard and immovable ice along the west sea coast of Severnaya Zemlya in 1934 began to thaw finally by the end of August.

During the latter half of August the areas north and northwest of Vize Island, in the northeastern Kara Sea, and also the area northeast of Liyedineniya Island were frozen. However, the ice here was not too thick, and, as V. Yu. Vize has already indicated, the comparative shallowness of the Kara Sea has some relation to icing conditions in this sea.

The region between the two longitudes of Vize Island and the eastern limit of the islands in Franz Josef Land north of 78° N was locked in ice completely by the end of August. Furthermore, the piled-up ice lay north of 80°N, west of 72°E, but it seemed to extend along the eastern sea coast of these islands.

The passage eastward, that is, toward the eastern sea coast of Franz Josef Land from Vize Island, was extremely difficult, even for an icebreaker. This region had already begun to freeze over with new ice in mid-August.

In the region between cape Chelyuskin and Dickson Island in the northeastern Kara Sea, ice conditions became fairly good around Sep 10. The strip along the coast which is not frozen at that time extends generally from Dickson to Taimyr Island. North of here, that is, north and northeast of Izvestiya Island and west of Russkiy Island and Bryuzovits Island, there is a region of piled-up ice (density: 8 to 10 balls); sometimes cracked ice can be seen, but generally navigation is impossible. The straits between the various islands of Nordenskjold Archipelago were completely frozen by 10 Sep. Along the entire course from Cape Chelyuskin to Arkticheskogo Instituta Island and north of it, new ice was discovered. Towards the east from Cape Zelaniya a bay of clear water extended into the Kara Sea, but not beyond 80°E. The part of the Kara Sea that came under the influence of the warm water coming from the Obi and Yenisiy Rivers did not have good ice conditions during the entire period of navigation. In mid-September, only Sverdrup Island had practically no ice; the ice boundary was south of the standard position. Even by the end of September, this ice boundary did not extend beyond Arkticheskogo Instituta Island, but to the west and northwest, ice of 4 to 6 balls in density was seen.

Even the Sedov investigated this region, but ice conditions were poor. From its report we can presume that in 1934 the force of the warm water from the Obi and Yenisey Rivers was comparatively weak, and furthermore, the temperature of the warm water was rather low.

According to observations of recent years, it is clear that the boundary of ice north of Dickson Island, and the general condition of ice depend upon the force of the previously-mentioned warm water. For example, in these regions there was absolutely no ice in 1932, and the ice boundary reported in 21 Aug 1930 at 76° 54'N, 79°17'E shifted to 76°52'N in 19 Sep 1933. Furthermore, in 1934, as previously stated, it seemed not to exceed the Arkticheskogo Instituta Island latitude.

At the end of September, from Cape Zhelaniya almost to Matochkin Shar Straits, ice remained here and there along the whole coast, but this is in agreement with the standard conditions for ice in this area. It is well to note that ice conditions in 1934 along the eastern sea coast of Novaya Zemlya and to the east, were remarkably more difficult than in 1933.

In early October ice begins to form rather suddenly, even in Yenisey Bay, and also, possibly, even in the southwestern Kara Sea, and Obi Bay. The new ice in early October extends along the course from Dickson Island to Yugorskiy Shar, generally up to 65°40'e.

Upon completion of the investigation into ice conditions in the northeastern Kara Sea during the 1934 season, the question is raised regarding the influence of the warm water of the Barents Sea on the ice in the Kara Sea. Although all the Barents Sea is free of ice by mid-August, its influence is noticeable only in a very small region north of the Kara Sea, and does not extend south of the Cape Zhelaniya latitude. That is, the influence of the warm water of Barents Sea is chiefly directed east of Cape Zhelaniya.

In 1934, however, this influence was rather weak and did not reach farther than 80°E.

The periods when new ice appeared in the Kara Sea are as follows:

| Date | Position | Ship |
|---|---|---|
| 19 Aug | 80°28'N, 71°06'E | Sedov |
| 29 Aug | 80°06'N, 84°03'E | Sadko |
| 29 Aug | 77°37'N, 91°20'E | Yermatsk |
| 30 Aug | 76°00'N, 87°40'E | Malygin |
| 30 Aug | Samoylovich Island | airplane H-2 |
| 31 Aug | 76°16'N, 91°20'E | Tsirkul |
| 3 Sep | Uyedineniya Island | Sedov |
| 7 Sep | 77°04'N, 78°49'E | Yermatsk |
| 9 Sep | Scot Hansen Island | airplane H-2 |
| 11 Sep | Between Russkiy I and Cape Chelyuskin/ | Yermatsk |
| 11 Sep | Medvezhi Bay (Novaya Zemlya) | Arktik |
| 18 Sep | 75°51'N, 88°52'E | Sedov |
| 23 Sep | Cape Pyaty Palets (Novaya Zemlya) | |
| 23 Sep | Cape FURISHINGEN* | Sedov |
| 27 Sep | 73°09'N, 65°40'E | Rusanov |
| 1 Oct | Yenisey Bay | Rusanov |
| 8 Oct | 73°09'N, 65°40'E | Rusanov |

As is clear from the above list, new ice first appears north of 80°N in the northeastern part of the Kara Sea. Also, it appears rather early even in the eastern part of the Kara Sea; for example, in 1934 new ice appeared in the area west of Russkiy Island 10 days earlier than in 1934/sic/.

In 1934, because the temperature of the surface water in the Kara Sea approached the freezing point, new ice began to form rather early and seemed to freeze very quickly. Furthermore, the following will show the increase in new ice in the southwestern Kara Sea for the years 1933 and 1934: the ice limit between Dickson Island and Yugorskiy Straits was observed on 8 Oct 1934 at 73°09(N, 65°40'E, and on 15 Oct 1933 at 73°00'N, 67°00'E.

Thus, although the date on which new ice was observed was earlier, the new ice in 1934 in this area was 30 miles farther west than usual.

The ice in the southern part of the Laptev Sea is no hindrance to navigation, and even ordinary steam or sailing vessels can sail in this sea in early and mid-August; only occasionally, does a ship encouter ice exceeding 1 ball in density. Laptev Straits in early August, and Sannikov Straits in mid-August (12 Aug) could be seen only northeast of PIYOTORU* Island. Furthermore, even east of Bogichev Island, there was only a small quantity of ice at the end of mid-August but that caused no hindrance to navigation. However, the natural passage from Laptev Sea to Kara Sea was not open until the end of August.

In the region around Komsomolskaya Pravda Island, the ice lasts for a considerable length of time, until mid-September.

Ice conditions of 1934 in the East Siberian Sea and especially in the Chukotsk Sea were much better than in 1932 and 1933. The poor ice conditions experienced by the icebreaker, Litke, east of 180°E from mid-July to 25 Jul were purely temporary in nature.

The most important elements which determine ice conditions in the East Siberian Sea are wind direction during the navigation season, and wind direction during the spring before the navigable season. The north and the northwest wind which blow chiefly in July are a very good influence on ice conditions in the Chukotsk Sea. However, after the end of August, the region from the Kolyma River mouth to the Bering Straits is completely free of ice. In early September, east of 180°E, ice disappears even in the Chukotsk Sea south of Wrangel Island latitude. The following table shows wind directions (percentages) during May - July in this area:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Schmidt Island** | | | | | | | | |
| May: | N 3 | NE - | E 1 | SE 45 | S 1 | SW 4 | W 18 | NW 28 |
| Jun: | N 4 | NE 4 | E 22 | SE 47 | S 2 | SW 1 | W 10 | NW 10 |
| Jul: | N - | NE 7 | E 9 | SE 20 | S 3 | SW - | W 28 | NW 33 |
| **Wrangel Island** | | | | | | | | |
| May: | N 18 | NE 18 | E 7 | SE 2 | S 7 | SW 24 | W 9 | NW 15 |
| Jun: | N 3.5 | NE 33 | E 30 | SE 5 | S 9 | SW 14 | W 3.5 | NW 2 |
| Jul: | N 17 | NE 6 | E 8 | SE - | S 13 | SW 26 | W 4 | NW 26 |
| **Cape Dezhnev** | | | | | | | | |
| May: | N 34 | NE 8 | E 6 | SE - | S 26 | SW 14 | W 5 | NW 7 |
| Jun: | N 17 | NE 17 | E 8 | SW 1 | S 32 | SW 20 | W - | NW 5 |
| Jul: | N 21 | NE 10 | E 1 | SE 1 | S 31 | SW 17 | W - | NW 19 |

The reason that broad areas were formed between the continent and the Bering Straits and Wrangel Island is that the warm water from the Bering Straits was higher in temperature than usual, and even the ice from Chukotsk Sea was remarkably influenced. Furthermore, in 1934, the temperature of Chukotsk Sea and the East Siberian Sea was comparatively high, and can be said to have influenced thawing.

The following shows the average temperatures for various months:

Schmidt Island:

May -6.0; Jun, +1.9; Jul, +2.5

Wrangel Island

May, -6.3; Jun, +0.1; Jul, +2.6

Dezhnev.

May, -3.9; Jun, +2.7; Jul, +5.1

Below is a comparison between the ice forecasts for the Arctic Ocean as calculated by V. Yu. Vize of the Hydrographic Institute and by N.N. Zubov (EdN: enclosed in quotes), and the results of on-the-spot ice observations (EdN: enclosed in paren).

<u>Forecast for 4 Jun 1934 by Hydrographic Institute</u>

"Franz Josef Land can be reached by ordinary vessels after mid-August or before that date." (This forecast was correct. The Persey reached port on 30 Jun. Furthermore, by mid-August the Barents Sea was free of ice.)

"The ice conditions in the various straits between the islands of Franz Josef Land are fairly good." (This forecast was incorrect. Only the straits in the southern part were free of ice; the others were generally blocked by ice that was uncracked.)

"The northwestern sea coast of Novaya Zemlya and the sea near Cape Zhelaniya will probably thaw by mid-July." (This forecast was completely correct. The Persey easily arrived at Cape Zhelaniya on 5 Jul; on 23 Jul the boundary of ice was 7 miles north of Cape Zhelaniya.)

"In the southwestern Kara Sea, i.e., southwest of the line, Cape Zhelaniya-Dickson Island, ice conditions are probably good. Moreover, after 20 Aug, the sea should be free of ice. Although much ice may be still encountered in early August, this ice will probably be already greatly weakened." (This forecast was perfectly correct for the area south of the Matochkin Shar Straits latitude. This area was free of ice by 20 Aug. Although ice remained north of here, it did not hinder navigation.

"Ice conditions between Cape Chelyuskin and Dickson Island in the northeastern Kara Sea should be better than in 1933, but worse than in 1932." (This forecast was correct.)

"It is believed that Vil'kitskiy Straits should be ice-free in early August." (This forecast was not correct. The western part of the straits were finally free on 27 Aug.)

"There are places west of Novaya Zemlya where the ice is very hard. Although mid-August will see no change, in late August and in September, the western sea coast can probably be reached by icebreakers. It is necessary to conclude that the thawing of the hard and immovable land floe along the western sea coast of Severnaya Zemlya will be late, probably by mid-August." (This forecast was not correct. West of Severnaya Zemlya huge pieces of ice remained during the summer. It was not impossible for icebreakers to approach Sergey Kamenev Island from the west. By the end of August ships were able to use the coastal strips which contained ice that was cracked. Finally, they were able to arrive from the south.)

"Uyedineniya and Vize Islands probably can be reached after mid-August by ordinary vessels." (This forecast was correct. The icebreaker, Sedov, reached Vize Island on 30 Jul. On 8 Aug, in the Uyedineniya Island latitude, ice which was considerably cracked was observed towards the west.)

"In late August and in September ice conditions in the southern part of the Laptev Sea, i.e., south of 75°N, will probably be good." (This forecast was correct. In the area south of 75°N there was no hindrance to the free navigation of ships.)

"Ice conditions between the Bering Straits and Kolyma should be better in August than they were in 1932 and 1933." (This forecast was correct. Ships returning to the Bering Straits from the mouth of the Kolyma River saw no ice at all in late August.)

Forecast for 16 Feb 1934, by N. N. Zubov

"During navigation in 1934, the ice density will probably be found to be greater than in 1933 in most of the Arctic Ocean east of Spitsbergen. Ice density in the area up to the Bering Straits, east of Wrangel Island, will probably be, for the most part, the same as in 1933, that is quite low". (In Chukotsk Sea, it was remarkably lower than in 1933; in the Kara Sea, it was greater than in 1933)

"Ordinary vessels will be able to reach Franz Josef Land 60 percent of the time, and icebreakers, 90 percent of the time." ( After late July, ordinary vessels were able to reach Franz Josef Land.)

"Icebreakers will be able to reach Cape Zhelaniya 60 percent of the time, and KURANSHIN* type icebreakers, 90 percent the time." (After July, Cape Zhelaniya could be reached 100 percent of the time, even by ordinary vessels.)

"Icebreakers will be able to reach Sergey Kamenev Island 60 percent of the time, and KURANSHIN* - type icebreakers, 90 percent of the time; icebreakers will be able to reach Cape Chelyuskin 60 percent of the time, and KURANSHIN* - type icebreakers, 90 percent of the time. The relief for those passing the winter at Lyahov will be carried out at the mouth of the Lena River." (Sergey Kamenev Island was able to be reached only from the south by icebreakers. Further, even icebreakers were able to reach Cape Chelyuskin; Lyahov Island was easily reached from the mouth of the Lena River; the relief was carried out at the mouth of the Lena River but passage was actually possible even from the west via the Vil'kitskiy Straits.)

"Ordinary vessels can reach Wrangel Island from the Bering Straits by taking a course towards Herald Island with ice boundary to the west--- 90 percent of the time, while the icebreaker Litke can reach it all the time." (This forecast was incorrect. The KURANSHIN* easily made a direct passage from the Bering Straits.)

"With the aid of the icebreaker KURANSHIN* ordinary vessels will be able to reach the Lena River from Archangelsk 60 percent of the time, and icebreakers, 90 percent of the time; for the return, ordinary steamers, 40 percent, icebreakers, 70 percent." (This forecast was incorrect. With the aid of the icebreaker Yermatsk, ordinary steamers were able to go as far as the Lena River from Murmansk and back at all times.)

"Although there, difficulties may be encountered by the Kara Sea Survey Expedition, it should be possible to proceed with the aid of the icebreaker Lenin and KURANSHIN*." (This statement was incorrect. After mid-August, there were no difficulties encountered by the Kara Sea Survey Expedition because the area south of the Matochkin Shar Strat in the southwestern Kara Sea was free of ice at that time).

3. Murmansk Harbor (68°57'N, 33°10'E)

/DB 368798: Study of Sea Ice and the Freezing of Harbors, HAYASHI Takeshie and KURATSUKA Yoshio, 1941/

Murmansk is a river mouth harbor, and is the only ice-free harbor of European USSR. Ice is prevented from becoming thick by the Gulf Stream Current. In addition to acting as the winter harbor for Leningrad, it is the western starting point for the Arctic sea routes, and is the base of operations for the Arctic Ocean icebreakers. In a very severe winter a certain amount of ice is encountered, but there is no need for icebreakers throughout the entire year. Freighters entering the harbor can break up the ice with their own hulls.

D. White Sea

1. General

/Bol'shaya Soviet Encyclopedia, Vol 5, 1927/

According to Mud'yug Lighthouse data for the years 1888-1920, ice in the White Sea appears close to the estuaries of the North Dvina on the average of 26 October, with fluctuations between 11 October and 18 November. Ice appears latest at Cape Svyatoi Nos (68°10' - 39°50'), on the average, on 5 February (the earliest on 11 January); in some winters there is no ice at all at Svyatoi Nos. The sea at Mud'yug Lighthouse is cleared of ice, on the average, by 20 May, with fluctuations between 6 May and 9 Jun. The open White Sea is never covered with continuous stationary ice; usually there is only ice along the coast, extending places to 50-60 kilometers from shore. On the other hand, gulfs, bays, and small straits freeze solid; large gulfs, however, do not freeze completely. Evidently due to strong tides the Mezen Gulf is not covered with firm ice at all. The thickness of the coastal ice and of the ice fields on the White Sea does not exceed one meter; usually it is 45-60 centimeters. Pack ice and ice floes usually do not rise more than 4-6 meters above the water. At the estuaries of the North Dvina, the ice attains its greatest thickness in the period from the second half of January to the middle of April. During this time, the entire visible stretch of sea is covered with ice; in other places of the White Sea the ice does not attain such thickness. The White Sea is completely free of ice, on the average, during the period from 1 Jun to 26 Oct when navigation, even for sailing craft, becomes possible.

2. Harbors

/DB 368798: Study of Sea Ice and Freezing of Harbors, HAYASHI Tskeshio, KURATSUKA Yorshio, 1941/

a. Umba Harbor

(1) Location: 66°38' N, 34°20' E
(2) Type of Harbor: River Mouth harbor
(3) Ice Conditions and Freezing Period
Freezing period: End of October
Thaw: End of May

b. Kem Harbor

(1) Location: 64°58' N, 34°45' E
(2) Type of Harbor: Sea Harbor
(3) Ice Conditions and Freezing Period
Harbor open: Beginning of May
Harbor closed: Late November

c. Soroka Harbor

(1) Location: 64°40' N, 34°30' E
(2) Type of Harbor: River harbor
(3) Ice Conditions and Freezing Period

Onega Bay is normally open from the middle of May. The routes from the ocean to the White Sea, however, may be closed until the middle of June or even later. Navigation of the area becomes impossible between 15 Oct and 1 Nov, but the passage of ships normally ceases at the end of September or the beginning of October.

d. Arkhangelsk Harbor

(1) Location: 64°33' N, 40°33' E
(2) Type of Harbor: River harbor
(c) Ice Conditions and Freezing Period

The Dvina River and the White Sea are frozen for at least six months in the year. Ships cannot reach the town for three weeks after the ice has been broken. In 1913, the harbor was open on 16 May and closed on 28 Oct. Ships normally begin to leave at the end of May and stop at the end of October.

Arkhangelsk has two extremely powerful icebreakers, the Stepan Makarov (4570 tons) and the Feodor Litke (2570 tons). With the Stalin, Kaganovitch, Leonid, Krasin, and Ermak, it would be possible to lengthen the period during which the harbor remains open. With Murmansk, this harbor acts as the western starting point for the Arctic sea routes and as a base of operations for ice breakers in the Arctic Ocean.

e. Mezen Harbor

(1) Location: 65°51' N, 44°17' E
(2) Type of Harbor: River harbor
(3) Freezing Period: Mid October to late May

f. Petchora Harbor

(1) Location: 68°30' N, 54°0' E
(2) Type of Harbor: River mouth harbor
(3) Ice Conditions and Freezing Period
Harbor open: 1-20 Jul
Harbor closed: End of September

The river is open before July, but the river mouth remains frozen till July.

## III ICE CONDITIONS IN OTHER SEAS

### A. Baltic Sea

#### 1. General

/Bol'saya Soviet Encyclopedia, Vol 4, 1926/

Ice usually appears at the beginning of November in the north of the Gulf of Bothnia where it remains longer than anywhere else in the Baltic Sea, disappearing, on the average, only at the beginning of June. The Baltic Sea attains the greatest development of ice covering at the beginning of March. At that time when important parts of the Gulfs of Finland and Bothnia are covered with stationary ice, ice appears at the Kurland Peninsula and in the region of Gotland and Oland Islands. The central part of the Baltic Sea, even at this time of the year, is usually free of ice.

In general, the quantity of ice in the Baltic Sea varies greatly from year to year. At Kronstadt the appearance of ice takes place, on the average, on 13 Nov, freezing on 11 Dec, breaking up on 12 Apr; on 6 May the Baltic is free of ice.

The duration of the ice covering of the Baltic Sea is distributed by regions: the northern part of the Gulf of Bothnia is covered by ice an average of 210 days a year; the central part of the Gulf of Bothnia, 185 days; Neva Bay, 145 days; the western part of the Gulf of Finland, 130 days; Moon Sound (between the Gulf of Finland and the Gulf of Riga), 100 days; off the Stockholm Cliffs, 70 days; the Gulf of Riga, 30-40 days. The sea does not freeze south of the latitude of Libau.

#### 2. Harbors

/DB 368798: Study of Sea Ice and Freezing of Harbors, HAYASHI Takeshio and KURATSUKA Yoshio, 1941/

a. Danzig Harbor

(1) Location: 54° 22'N, 18° 39'E
(2) Type of Harbor: River harbor
(3) Ice Conditions and Freezing Period:

The east wind causes the temperature to drop to -6°C in October. The temperature of the entire surface of the river will normally drop to 2°C. With any fall in the atmospheric temperature in mid-November, the water temperature of 2° to 4°C will drop suddenly to approximately zero, and ice will form. The movement of ships is only very slightly hampered by the ice.

Freezing begins in late November. The thaw begins in mid-March. The freezing period is 110 to 115 days long.

Routes to the sea are kept open by harbor ice-breakers.

b. Neufahrwasser Harbor

(1) Location: 54° 24'N, 18° 39'E
(2) Type of Harbor: River Mouth Harbor
(3) Ice Conditions and Freezing Period: Same as for Danzig.

Shipping channels are kept open by harbor ice-breakers.

c. Konigsberg Harbor

(1) Location: 54° 42'N, 20° 30'E
(2) Type of Harbor: River harbor
(3) Ice conditions and Freezing Period

| | |
|---|---|
| Period of Observation | 1870-1894 |
| No of days of freezing during this period | 1221 |
| Average no of days per annum | 51 |

Freezing Periods from 1870/71 to 1889/90

| Month | No of Days of Freezing | 1-5 | 6-10 | 71-15 | 16-20 | 21-25 | 26-31 |
|---|---|---|---|---|---|---|---|
| Oct | 8 | 1 | 1 | | | | |
| Nov | 90 | 21 | 3 | 2 | | | |
| Dec | 255 | 33 | 14 | 3 | 3 | | |
| Jan | 301 | 35 | 8 | 3 | 1 | 3 | 1 |
| Feb | 256 | 30 | 10 | 3 | 1 | 2 | 1 |
| Mar | 128 | 28 | 5 | 1 | 1 | | |
| Apr | 3 | 2 | | | | | |
| Oct-Apr | 1041 | 150 | 41 | 12 | 6 | 5 | 2 |

| | |
|---|---|
| Average annual maximum number of days of freezing | 15.8 days |
| Absolute maximum number of days of freezing | 30 days (19 Dec 1870-17 Jan 1871) |

The harbor is kept open the year round by powerful fresh-water lake ice-breakers.

d. Pillau Harbor

(1) Location: 54° 40'N, 19° 56'E
(2) Fresh-water lake harbor
(3) Ice Conditions and Freezing Period

Beginning of Drift Ice in the Offing

| | |
|---|---|
| Earliest | 20 Nov |
| Latest | 24 Jan |

End of Drift Ice in the Offing

| | |
|---|---|
| Earliest | 11 Jan |
| Latest | 23 Apr |

The route between Pillau Harbor and Konigsberg is kept open during the winter by powerful ice-breakers.

e. Stettin Harbor

(1) Location: 53° 27'N, 14° 33'E
(2) Type of Harbor: River harbor
(3) Ice Conditions and Freezing Period

The amount of drift ice on the Oder, especially on the lower reaches near Stettin Harbor, is insignificant. The freezing of a fresh-water lake is the same as that of a normal lake, changing with a west or northwest wind.

| | |
|---|---|
| Period of Observation | 1850-1890 |
| Number of days of freezing during this period | 1278 |
| Annual average number of days of freezing | 32 |

Freezing Periods From 1850/51 to 1889/90

| Month | No of Days of Freezing | 1-4 | 5-9 | 10-14 | 15-19 | 20-24 | 25-on |
|---|---|---|---|---|---|---|---|
| Oct | 2 | 1 | | | | | |
| Nov | 90 | 30 | 5 | | | | |
| Dec | 333 | 72 | 13 | 3 | 4 | | |
| Jan | 409 | 57 | 21 | 4 | 3 | 2 | 1 |
| Feb | 306 | 63 | 10 | 2 | 4 | 2 | |
| Mar | 138 | 33 | 9 | 1 | | | |
| Oct-Mar | 1278 | 256 | 58 | 10 | 11 | 4 | 1 |

| | |
|---|---|
| Average Annual Maximum Number of Days of Freezing | 11.3 days |
| Absolute Maximum Number of Days of Freezing | 28 days (19 Dec 1860-15 Jan 1861) |

The route to the sea is kept open by powerful ice-breakers.

f. Gdynia Harbor

(1) Location: 54° 32'N, 18° 34'E
(2) Type of Harbor: Sea harbor
(3) Ice Conditions and Freezing Period

When there is a continuous east wind, either floe ice or pack ice will accumulate in the southwest section of the bay.

The harbor is kept open by ice-breakers and tow-boats.

g. Memel Harbor

(1) Location: 55° 42'N, 21° 10'E
(2) Type of Harbor: Fresh-water lake harbor
(3) Ice Conditions and Freezing Period

The violent northwest wind causes ice to accumulate in the harbor mouth, preventing access.

| | | |
|---|---|---|
| Beginning of Ice | (earliest) | 1 Jan |
| End of Ice | (latest) | 31 Mar |

The harbor is generally kept open throughout the winter by harbor ice-breakers.

h. Libau Harbor

(1) Location: 56° 30'N, 21° 1'E
(2) Type of Harbor: Sea harbor
(3) Ice Conditions and Freezing Period

There is very little ice along the southern shores of the Baltic Sea, and there are occasions during winter when there is no ice at all. With a few exceptions, it is possible to navigate the year round.

During the freezing season, the lanes are kept open by ice breakers.

i. Riga Harbor

(1) Location: 56° 57' N, 24° 3'E
(2) Type of Harbor: River harbor
(3) Ice Conditions and Freezing Period

Ice is very prevalent in Riga Bay. The bay freezes in mid-December and thaws gradually in early April.

| | |
|---|---|
| Beginning of Ice | 29 Nov |
| Harbor closed | Mid-Jan |
| Thaw | 7 Apr |
| Harbor open | Mid-Apr |

The powerful ice-breaker, Krisjanis Valdemars, (2670 tons), constantly stands by. With a few exceptions, the harbor can be kept open throughout the year.

j. Tallinn (Reval) Harbor

(1) Location: 59° 27'N, 24° 29'E
(2) Type of Harbor: Sea harbor
(3) Ice Conditions and Freezing Period

The north and northeast winds cause drift ice to accumulate and form an icefield during January and February. Small vessels can enter the harbor for a period of about three weeks during these two months with the help of ice-breakers.

The very powerful icebreaker, Suur Tool (3620 tons), constantly stands by, and the harbor can be kept open the year round.

k. Narowa (Narva) Harbor

(1) Location: 59° 22'N, 28° 11'E
(2) Type of Harbor: River mouth harbor
(3) Ice Conditions and Freezing Period

Ice is extremely prevalent in the Gulf of Finland, east of 28°E, from November to early May, forming an ice field during January and February. During 1913, the harbor was actually open from 19 Mar to 19 Nov but was formally declared open on 15 Apr and closed on 13 Jan.

The period when the port is open can be prolonged if supplementary powerful icebreakers are employed.

l. Pernau (Parnu) Harbor

(1) Location: 58° 22'N, 24° 31'E
(2) Type of Harbor: Sea harbor
(3) Ice Conditions and Freezing Period

Ice is extremely prevalent in Riga Bay. The bay normally freezes in mid-December and thaws at the end of April. The passage of shipping is normally stopped in mid-December and begins again in mid-April.

m. Leningrad Harbor

(1) Location: 59° 56'N, 30° 18'E
(2) Type of Harbor: Sea harbor
(3) Ice Conditions and Freezing Period

| | |
|---|---|
| Begin freezing | 25 Nov |
| Earliest | 3 Nov |
| Latest | 20 Dec |
| Thaw | 2 Apr |

This is one of the areas of the Baltic where salinity is lowest and the freezing most severe. The ice field stretches from Leningrad to Gottland Island, covering the entire breadth of the Gulf of Finland. During the extreme cold of winter, it reaches as far south as Reval. Leningrad Harbor remains open for about seven months from May to December.

With the help of very powerful icebreakers, (see paragraph on Kronstadt below), the season during which the harbor remains open could be prolonged easily till January, and when there is a warm winter, till February. Until the present, however, the plan to keep the harbor open throughout the winter by icebreakers has not met with the least success.

n. Kronstadt Harbor

(1) Location: 59° 59'N, 30° 5'E
(2) Type of Harbor: Sea harbor
(3) Ice Conditions and Freezing Period
(See paragraph on ice conditions for Leningrad.)

| | |
|---|---|
| Freezes | 21 Nov |
| Earliest freeze | Mid-Oct |
| Latest freeze | 12 Dec |
| Thaw | 3 May |
| Earliest date for ship to enter | 20 Apr |
| Latest | 20 May |

Kronstadt is the outer harbor for Leningrad and has more icebreakers than any other harbor in the world as well as the most powerful icebreakers in the world, the J. Stalin and the L. Kaganovitch (both with a displacement of 11,000 tons), the Leonid Krasin (8,870 tons), the Ermak (7,875 tons), the Lenin (6,000 tons), and the Trouvor (1,450 tons). There are also some smaller icebreakers which are used for ice-breaking in the Arctic Ocean north of the White Sea on the Far East route.

B. Black Sea

1. General

/Bol'shaya Soviet Encyclopedia, Vol 61, 1934/

Ice covers the northern shore of the Black Sea every year but never lasts long. This is especially true in the northwest part. The Dnepr-Bug estuary freezes solid every year. At Odessa there is ice yearly; during heavy freezing it extends to Ochakov. The estuary of the Dnestr also freezes every year. Karkinitski Gulf freezes at times. In Crimea there is usually ice in the closed bays, but it does not last long.

2. Harbors

/DB 368798: Study of Sea Ice and Freezing of Harbors, HAYASHI Takeshio and KURATSUKA Yoshio, 1941/

a. Odessa Harbor

(1) Location: 46° 29' N, 30° 46'E
(2) Type of Harbor: Sea harbor
(3) Ice Conditions and Freezing Period

Ice is only present for one month and some years does not even occur at all.

Even during the freezing period, vessels can enter the harbor with the help of powerful icebreakers

b. Nikolayev Harbor

(1) Location: 47° 7'N, 32°E
(2) Type of Harbor: River harbor
(3) Ice Conditions and Freezing Period

| | |
|---|---|
| Freezing period | About four months |
| Beginning of ice | Late Nov-late Dec |
| Thaw | Mid Mar-late Mar |

With the help of icebreakers, ships can, with a few exceptions, enter the harbor throughout the year.

c. Kherson Harbor

(1) Location: 46° 39'N, 32° 32'E
(2) Type of Harbor: River harbor
(3) Ice Conditions and Freezing Period

| | |
|---|---|
| Freezing period | About three months |
| Harbor open | Late Feb |
| Harbor closed | Late Dec |

d. Mariupol Harbor

(1) Location: 47° 6'N, 37° 35'E
(2) Type of Harbor: Sea harbor
(3) Ice Conditions and Freezing Period

The area is frozen for a minimum of one month and a maximum of five months, normally from mid-December to early March.

The sea lanes are kept open by icebreakers. In a year of heavy ice, vessels would be damaged when breaking through the ice, but normally vessels can enter the harbor throughout the year.

e. Taganrog Harbor

(1) Location: 47° 13'N, 38° 56'E
(2) Type of Harbor: Sea harbor
(3) Ice Conditions and Freezing Period

| | |
|---|---|
| Freezing Period | 3-4 months |
| Beginning of ice | 15 Nov-15 Dec |
| Harbor open | Late Apr |
| Average period during which harbor is open | 8 months 10 days |
| Thickness of ice in harbor | Average 20 cm<br>Maximum 30 cm |

f. Rostov Harbor

(1) Location: 47° 12'N, 39° 42'E
(2) Type of Harbor: River harbor
(3) Ice Conditions and Freezing Period

| | |
|---|---|
| Freezing Period | 3-4 months |
| Harbor open | Late Mar |
| Harbor closed | Early Dec |

## IV. LIST OF ICE OBSERVATION STATIONS

Sources:

(a) DB 273908: East Asia Meteorological Data: Vol IV, Siberia, Central Meteorological Observatory, "Confidential", Jan 1942

(b) DB 356872: Weather of Far Eastern USSR, Manchuria, Sakhalin, and the Kuriles, Hydrographic Office, "Confidential", Oct 1939

(c) DB 303556: Meteorological Outline of the USSR, Central Meteorological Observatory, "Confidential", Jun 1941

(d) DB 302097: Arctic Sea Routes, Research Section, Foreign Ministry, Oct 1939

(e) DB 302468: New Data on Geography of Far Eastern USSR, South Manchurian Railroad, Mar 1935

(f) DB 357487: Classified Weather Reports, No 13, Hydrographic Office, "Confidential", Jan 1938

(g) DB 244833: Weather of Central Kuriles, KAMIO Hideji, Report No. 47, Kobe Oceanographic Observatory, Jun 1932

(h) DB 368798: Study of Sea Ice and the Freezing of Harbors KURATSUKA Yoshio and HAYASHI Takeshio, 1941

(*) Indicates that coordinates were obtained from sources other than documents listed.

| Sakhalin | Lat | Long | Elevation(m) | Sources |
|---|---|---|---|---|
| Alexandrovskiy Post | 50 50 | 142 07 | 28 | a, c |
| Alexandrovskiy Sakhalinsky | 50 54 | 142 09 | 15.7 | b |
| Ambetsu | 49 59 | 142 09 | 82.1 | b, f |
| Galkino Vrasskoye (Ochiai) | 47 20 | 142 44 | 15 | a, b, c |
| Honto | 46 40 | 141 52 | 5.5 | b |
| Korsakovskiy Post (Otomari) | 46 39 | 142 48 | 29.9 | a, b, c, f |
| Kririon Phare | 45 54 | 142 05 | 44.3 | a |
| Maoka | 47 03 | 142 03 | 29.6 | b, f |
| Nayasi | 49 30 | 142 09 | 10 | a |
| Okha | 53 30 | 143 00 | | b |
| Onor | 50 14 | 142 35 | 150 | a |
| Pogobi | 52 10 | 141 35 | | b |
| Rykovskoye | 50 47 | 142 55 | 125 | a, c |
| Seraroki | 47 54 | 142 31 | 10 | a |
| Shikuka | 49 14 | 143 07 | 3.5 | b, f |
| Tymovskaya | 50 49 | 142 39 | 105 | a, b |
| Voskresenkoye | 46 44 | 142 33 | 20 | a |
| Zhonkierskiy Light | 50 53 | 142 07 | 62.9 | a, b |

| Kuriles | Lat | Long | Elevation (m) | Sources |
|---|---|---|---|---|
| Buroton Bay, Shimushiru Island | 47 08 30 | 152 15 30 | | g |
| Harumukotan Anchorage, Harumukotan Island | 49 09 35 | 154 30 00 | | g |
| Kita Island, Ushishiru Island | 47 32 30 | 152 50 05 | | g |
| Kobune Bay, Uruppu Island | 45 56 30 | 150 10 30 | | g |
| Mishima Bay, Uruppu Island | 46 12 30 | 150 20 40 | | g |
| Minami Bay, Ketoi Island | 47 18 10 | 152 29 00 | | g |
| Nakatomari Shimushiru Island | 46 59 20 | 152 02 20 | | g |
| Nemo Bay, Onnekotan Island | 49 31 25 | 154 49 00 | | g |
| Paramushiro | 50 29 | 156 08 | 22 | b |
| Shana | 45 14 | 147 53 | 39.3 | b |
| Shimushiru Bay, Shimushiru Island | 46 51 30 | 151 52 00 | | g |
| Sonraku Bay, Rashowa Island | 47 42 00 | 152 58 00 | | g |
| Tokotan Bay, Uruppu Island | 45 51 20 | 149 48 30 | | g |
| Yamato Bay | 48 05 00 | 153 15 40 | 70 | b, g |

| Kamchatka | Lat | Long | Elevation (m) | Sources |
|---|---|---|---|---|
| Klyutchevskoye | 56 20 | 160 48 | 30 | a, b |
| Mirkovo | 54 44 | 158 20 | | b |
| Petropavlovsk Light | 52 53 | 158 47 | 111.1 | a,b,c |
| Tigil | 57 45 | 158 19 | 22 | a,b,c |
| Ust Bolsheretsk | 52 40 | 156 14 | 20 | a,b,c |
| Ust Kamchatsk | 56 12 | 162 26 | 2 | a,b,c |

| Gulf of Tartary | Lat | Long | Elevation (m) | Sources |
|---|---|---|---|---|
| Belkina Light | 45 49 | 137 41 | | e |
| Cape Dzhaore | 52 40 | 141 17 | | e |
| De Kastri Bay (Klostakempsk Light) | 51 26 | 140 53 | | b |
| Langr | 53 18 | 141 28 | 4 | a |
| Nikolayevsk | 53 08 | 140 45 | | b,c |
| Nikolayevskiy Light | 48 58 | 140 22 | 63.9 | a |
| Pronge | 52 51 | 141 15 | 4.9 | a |
| Sovetskaya Gavan | 48 58 | 140 17 | 17 | a,b |
| **Okhotsk Sea** | **Lat** | **Long** | **Elevation (m)** | **Sources** |
| Ayan | 56 28 | 138 17 | 10 | a,b,c |
| Chumikan | 54 43 | 135 18 | | e |
| Gizhinsk | 62 02 | 160 40 | 12 | a,b,c,e |
| Nayakhan | 61 55 | 158 59 | 29 | a,b |
| Okhotsk | 59 21 | 143 17 | 3.9 | a,b,c |
| Ola | 59 35 | 151 13 | 5 | a,b,c,e |
| Tauisk | 59 44 | 149 22 | | e |
| Vorovskoye | 54 14 | 155 49 | | e |
| Yamsk | 59 35 | 154 21 | | e |
| **Bering Sea** | **Lat** | **Long** | **Elevation(m)** | **Sources** |
| Anadyr (Anadyr Gulf) | 64 44 | 177 32 | | d, (*) |
| Bering | 65 00 | 184 13 | | e |
| Cape Dezhneva (Bering Strait) | 66 12 | 190 21 | | d,e |
| Karaga | 59 10 | 163 02 | | e |
| Kresta Gulf | 65 33 | 181 44 | | e |
| Kyneerkhym (Anadyr Gulf) | 64 44 | 177 32 | | d,(*) |

| Bering Sea (cont'd) | Lat | Long | Elevation(m) | Sources |
|---|---|---|---|---|
| Nikolskoye | 55 12 | 165 59 | 6.8 | a,b,c |
| Novo Mariyinskiy Post | 64 45 | 177 33 | 3 | a,b,c |
| Olyutorskoe | 60 37 | 168 17 | | e |
| Preobrazhenskoye | 54 49 | 167 28 | 15 | a,c |
| Provideniya Bay | 64 25 | 190 21 | | d,e |
| Vladimirskiy Post | 64 25 | 186 50 | | d,e |
| Uelen | 49 00 | 143 00 | | d,(*) |

| Chukotsk Sea | Lat | Long | Elevation(m) | Sources |
|---|---|---|---|---|
| Ambarchik | 69 40 | 162 20 | | d,(*) |
| Cape Billings | 69 53 | 176 08 | | d,(*) |
| Cape Dzhenretlen | 67 07 | 173 38 | | d,(*) |
| Cape Serdtse Kamen | 66 55 | 174 24 | | d,(*) |
| Cape Shalaurova (On Bolshoy Island in the Lyakhovskiye Islands) | 69 52 | 174 38 | | d,(*) |
| Cape Shelagski | 70 06 | 170 26 | | d,(*) |
| Cape Vankarem | 67 51 | 175 48 | | d,(*) |
| Chetyrekhstolbovoi Islands, Medvezhi Islands | 70 40 | 162 08 | | d,(*) |
| Nizhne Kolymsk | 68 30 | 161 00 | 5 | c,d,(*) |
| Russkoye Ustye | 71 01 | 149 26 | 6 | a,c,d |

| Kara Sea | Lat | Long | Elevation(m) | Sources |
|---|---|---|---|---|
| Blagopoluchiya Gulf | 75 40 | 63 40 | | d,(*) |
| Cape Bolvanskiy Nos | 70 30 | 59 00 | | d,(*) |
| Cape Chelyuskin | 77 43 | 104 15 | | d,(*) |
| Cape Sokoli | 70 00 | 61 00 | | d,(*) |
| Cape Sterlegova | 76 51 | 100 56 | | d,(*) |

| Kara Sea (cont'd) | Lat | Long | Elevation(m) | Sources |
|---|---|---|---|---|
| Domashni Island | 69 30 | 161 53 | | d,(*) |
| Dickon Island | 73 24 | 80 26 | 12.5 | a,c,d |
| Golchikha | 71 43 | 83 32 | | d,(*) |
| Kazache | 66 00 | 151 30 | | d,(*) |
| Khatanga | 71 30 | 102 00 | | d,(*) |
| Komsomolskoy Pravdy Islands | 77 28 | 107 12 | | d,(*) |
| Kotelny Island | 75 30 | 138 50 | | d,(*) |
| Mare Sale | 69 43 | 66 48 | 14.1 | a,c,d |
| Matochkin Shar | 73 15 | 56 30 | | d,(*) |
| Norilsk | 69 20 | 88 04 | | d,(*) |
| Pronchishchevoy Bay | 75 30 | 112 30 | | d,(*) |
| Uedineniya Island | 75 30 | 80 15 | | d,(*) |
| Vaygach Island | 70 00 | 59 30 | 11 | c,(*) |
| Yugorskiy Char | 69 50 | 60 45 | 13 | a,c |
| Yugorskiy Shar Straits | 70 00 | 60 30 | 13 | c,d,(*) |
| Yuryung Tumus Peninsula | 74 01 | 111 23 | | d,(*) |

| Barents Sea | Lat | Long | Elevation(m) | Sources |
|---|---|---|---|---|
| Cape Svyatoy Nos | 68 10 | 39 45 | 75 | c,(*) |
| Kanin Peninsula | 68 00 | 45 30 | 48 | c,(*) |
| Kola | 69 00 | 33 00 | 7 | c,(*) |
| Malye Karmakuly | 72 30 | 53 00 | | d,c,(*) |
| Murmansk | 68 57 | 33 10 | | h |
| Oksino | 67 30 | 37 00 | 13 | c,(*) |
| Port Vladimir | 69 30 | 33 00 | 10 | c,(*) |
| Russkaya Gavan | 75 20 | 60 15 | | d,(*) |

| White Sea | Lat | Long | Elevation(m) | Sources |
|---|---|---|---|---|
| Arkhangelsk | 64 33 | 40 33 | 6 | c,h |
| Kandalaksha | 67 00 | 32 30 | 14 | c,(*) |
| Kem' | 64 58 | 34 45 | 9 | c,h |
| Mezen | 65 51 | 44 17 | 13 | c,h |
| Morshovets Light | 66 43 | 42 30 | 20 | c,(*) |
| Onega | 64 00 | 38 00 | 8 | c,(*) |
| Orlov Light | 67 11 | 41 20 | 72 | c,(*) |
| Soroka | 64 40 | 34 30 | | h |
| Sosnovka | 66 30 | 40 00 | 18 | c,(*) |
| Umba | 66 38 | 34 20 | | h |
| Zhizhgin Light | 65 12 | 36 50 | 27 | c,(*) |

| Baltic Sea | Lat | Long | Elevation(m) | Sources |
|---|---|---|---|---|
| Danzig | 54 22 | 18 39 | | h |
| Koenigsberg | 54 42 | 20 30 | | h |
| Kronstadt | 59 59 | 30 05 | 5 | c,h |
| Leningrad | 59 56 | 30 18 | 6 | c,h |
| Libau | 56 30 | 21 01 | | h |
| Memel | 55 42 | 21 10 | | h |
| Narowa | 59 22 | 28 11 | | h |
| Neufahrwasser | 54 24 | 18 39 | | h |
| Parnu | 58 22 | 24 31 | | h |
| Pillau | 54 40 | 19 56 | | h |
| Riga | 56 57 | 24 03 | | h |
| Tallinn | 59 27 | 24 29 | | h |
| Travemunde | 53 57 | 10 51 | | h |

| Black Sea | Lat | Long | Elevation(m) | Sources |
|---|---|---|---|---|
| Batumi | 41 40 | 41 37 | 3 | c,(*) |
| Feodosiya | 45 02 | 35 23 | 8 | c,(*) |
| Kerch | 45 23 | 36 39 | 4 | c,(*) |
| Kherson | 46 39 | 32 32 | | h |
| Mariupol | 47 06 | 37 35 | | h |
| Nikolayev | 47 07 | 32 00 | | h |
| Novorossisk | 44 42 | 37 42 | 37 | c,(*) |
| Odessa | 46 29 | 30 46 | | h |
| Rostov | 47 12 | 39 42 | | h |
| Sevastopol | 44 38 | 33 30 | 23 | c,(*) |
| Sochi | 43 35 | 39 44 | 78 | c,(*) |
| Sudak | 44 52 | 34 59 | 41 | c,(*) |
| Sukhumi | 43 30 | 41 00 | 9 | c,(*) |
| Taganrog | 47 13 | 38 56 | | h |
| Tarkhankut Light | 45 21 | 32 30 | 4 | c,(*) |
| Yalta | 44 30 | 34 20 | 41 | c,(*) |
| **Caspian Sea** | **Lat** | **Long** | **Elevation (m)** | **Sources** |
| Baku | 40 30 | 49 57 | -13 | c,(*) |
| Chikishlyar | 37 35 | 53 54 | -23 | c,(*) |
| Fort Shevchenko (Fort Aleksandrovski) | 44 32 | 50 14 | 23 | c,(*) |
| Krasnovodsk | 40 04 | 53 00 | -15 | c,(*) |
| Lenkoran | 38 45 | 48 40 | -19 | c,(*) |
| Makhachkala | 43 00 | 49 57 | -13 | c,(*) |

## V LIST OF HYDROLOGICAL SURVEY STATIONS

/DB 302476: "Hydrological Survey and Drift Ice Conditions from the East Siberian Sea to Bering Sea," Far Eastern USSR and Outer Mongolia Research Data No 54, Research Section, South Manchurian Railroad, Dec 1939, from the Russian of I. A. Kireev, 1936/

A. Stations in the East Siberian Sea
(Compiled by Survey Ship, F. Litke, 1932)

| Station No | Location | Depth (m) | Ice Conditions | Transparency (m) |
|---|---|---|---|---|
| 1 | 70°05'N, 170°22'E | 28 | | 4.75 |
| 2 | 69°44'N, 162°24'E | 8.4 | | |
| 3 | 69°46'N, 162°24'E | 11 | | 1.2 |
| 4 | | 25 | Fresh Ice | 2.0 |
| 5 | 70°05'N, 170°18'E | 16.5 | Compact Ice | 4.0 |
| 6 | 70°14'N, 170°18'E | | " " | |

B. Stations in Chukotsk Sea, Bering Sea, and Bering Straits
(Compiled by Survey Ship, Dal'nevostochnik, 1932)

| Station No | Location | Depth (m) | Ice Conditions | Transparency (m) |
|---|---|---|---|---|
| 1 | 52°24'N, 158°36'E | 96 | | |
| 2 | 52°49'N, 158°03'E | 156 | | 4.0 |
| 3 | 52°42'N, 159°03'E | 830 | | |
| 4 | 52°31.6'N,159°31.7'E | 1500 | | 20.0 |
| 5 | 55°24'N, 165°43'E | 120 | | 7.0 |
| 6 | 55°41'N, 164°33'E | 690 | | 10.5 |
| 7 | 56°05.4'N,163°26'E | 800 | | |
| 8 | 58°25.5'N,165°57'E | 1530 | | |
| 9 | 60°00.5'N,170°08.8'E | 12.7 | | 5.5 |
| 10 | 59°54'N, 170°36'E | 62.4 | | 8.0 |
| 11 | 59°44.5'N,171°09.2'E | 2000 | | 11.0 |
| 12 | 59°27.9'N,172°12'E | 2000 | | |
| 13 | 59°13'N, 173°17'E | 3800 | | 10.5 - 12.0 |
| 14 | 60°08'N, 172°55.7'E | 3000 | | 11.6 |
| 15 | 60°55'N, 172°41'E | 74 | | 8.2 |
| 16 | 61°11.5'N, 172°30'E | 12.8 | | 5.0 |
| 17 | 61°39'N, 175°49'E | 73 | | 11.5 |
| 18 | 62°13'N, 179°15'E | 49 | | 4.0 |
| 19 | 63°29.5'N,176°37'W | 74 | | 14.5 |
| 20 | 64°16.7'N,173°50'W | 55 | | 13.0 |
| 21 | 65°08.1'N,171°02'W | 42 | | |
| 22 | 65°38.5'N,168°15.5'W | 42-15 | | 7.5 |
| 23 | 65°41.1'N, 168°24'W | 48 | | 5.5 |
| 24 | 65°43.5'N, 178°47.5' W | 35-36.8 | | 4.0-5.0 |
| 25 | 65°44.3'N, 168°52'W | 36 | | 8.5 |
| 26 | 65°44.2'N, 168°33'W | 51-53 | | 11.5-15.0 |

| Station No | Location | Depth (m) | Ice Conditions | Transparency (m) |
|---|---|---|---|---|
| 27 | 65°43.4'N,168°48'W | 32 | | 12.5-15.0 |
| 28 | 65°52.5'N,169°00'W | 46-48 | | 5.0- 9.0 |
| 29 | 65°55.3'N,169°15'W | 49.4 | | |
| 30 | 66°08'N,169°27.5'W | 46-49 | | 4.0- 4.9 |
| 31 | 66°31.5'N,169°12'W | 45.5 | | 10.0 |
| 32 | 66°44.5'N,169°35.5'W | 45 | | |
| 33 | 67°08'N,168°39'W | 46.2 | | 6.0 |
| 34 | 67°27'N,167°38'W | 49 | | 10.5 |
| 35 | 67°36.4'N,166°27.5'W | 53 | | 10.0 |
| 36 | 66°39.5'N,167°51.1'W | 29 | | 3.5 |
| 37 | 65°49.1'N,168°51.5'W | 9 | | 8.5 |
| 38 | 65°44.2'N,168°33'W | 51 | | |
| 39 | 65°38.5'N,168°15.5'W | 50 | | 4.0 |
| 40 | 64°39.5'N,167°40'W | 3 | | 7.0 |
| 41 | 63°49.7'N,167°03'W | 28 | | |
| 42 | 62°47.2'N,166°12'W | 20 | | 4.5 |
| 43 | 62°57'N,167°18'W | 32 | | |
| 44 | 63°02.2'N,169°09'W | 27-29 | | 6.5- 8.0 |
| 45 | 62°58.6'N,168°32'W | 47 | | 12.0 |
| 46 | 63°53.5'N,171°45'W | 35 | | 8.0 |
| 47 | 64°05'N,172°02'W | 53-56 | | 11.0-15.0 |
| 48 | 64°15.5'N,172°27'W | 27.5 | | 7.5 |
| 49 | 64°25.9'N,173°17.6'W | 144 | | 4.0 |
| 50 | 64°18.3'N,174°01.5'W | 65 | | |
| 51 | 64°20'N,176°23.9'W | 81 | | 16.0 |
| 52 | 64°21.2'N,178°45.6'W | 66 | | |
| 53 | 64°22'N,179°46'E | 44 | | 7.5 |
| 54 | 64°45.2'N,177°31.5'E | 11 | | |
| 55 | 64°11.9'N,179°05'E | 27 | | 11.0 |
| 56 | 63°34.4'N,179°49'W | 49 | | |
| 57 | 62°46'N,179°35'E | 81 | | |
| 58 | 62°13'N,179°15'E | 34 | | |
| 59 | 61°53.8'N,179°59.8'E | 130 | | |
| 60 | 61°33.5'N,179°09'W | 128 | | 12.5 |
| 61 | 61°22.5'N,178°03'E | 360 | | |
| 62 | 61°10'N,175°17.5'E | 292 | | 7.5 |
| 63 | 90°51'N,173°05'E | 92 | | |
| 64 | 59°51'N,170°42'E | 123 | | |
| 65 | 59°43.1'N,171°14'E | 700 | | |
| 66 | 59°28'N,172°14'E | 1554 | | 12.0 |
| 67 | 59°10'N,173°27'E | 3867 | | 16.5 |
| 68 | 58°59.1'N,174°24'E | 1200 | | 10.5 |
| 69 | 55°21.9'N,165°58.3'E | 22 | | 12.0 |
| 70 | 55°24.7'N,165°44.5'E | 200 | | 10.0 |
| 71 | 55°02.4'N,163°51.8'E | 500 | | |
| 72 | 54°46.5'N,162°26'E | 500 | | |
| 73 | 52°43.3'N,150°00'E | 500 | | 12.0 |
| 74 | 52°49.9'N,158°50.7'E | 114 | | 11.0 |
| 75 | 52°59.3'N,158°39.3'E | 19.5 | | 5.0 |

C. Stations in Chukotsk Sea, Bering Sea, and Bering Straits
(Compiled by Survey Ship, Krasnoarmeyets, 1933)

| Station No | Location | Depth (m) | Ice Conditions | Transparency (m) |
|---|---|---|---|---|
| 1 | 62°30'N, 180°00'E | 87 | | 10.0 |
| 2 | 62°15'N, 178°26.5'W | 98 | | |
| 3 | 62°02'N, 177°05'W | 110 | | 15.0 |
| 4 | 61°40'N, 175°24'W | 99 | | 14.5 |
| 5 | 61°03'N, 173°38'W | 81 | | 14.2 |
| 6 | 61°52'N, 173°11.5'W | 66 | | 14.7 |
| 7 | 62°29'N, 172°27'W | 49 | | 14.5 |
| 8 | 63°84'N, 171°42'W | 55 | | 15.0 |
| 9 | 63°31'N, 171°52'W | 30 | | 12.5 |
| 10 | 63°09'N, 175°00'W | 67 | | 15.5 |
| 11 | 62°45'N, 174°10'W | 74 | | 14.5 |
| 12 | 63°08'N, 175°34'W | 85 | | 16.0 |
| 13 | 63°24.5'N, 176°46'W | 91 | | 14.0 |
| 14 | 62°53'N, 177°00'W | 93 | | 15.8 |
| 15 | 62°59'N, 178°21'W | 93 | | |
| 16 | 63°16'N, 179°16'W | 78 | | |
| 17 | 63°42'N, 179°53'W | 48 | | 2.5 |
| 18 | 64°03'N, 178°48'W | 66 | | 10.5 |
| 19 | 64°29'N, 177°37'W | 75 | | 11.0 |
| 20 | 64°46'N, 176°32'W | 59 | | 11.0 |
| 21 | 64°30'N, 175°15'W | 69 | | 10.5 |
| 22 | 64°12'N, 173°58'W | 5 | | 11.0 |
| 23 | 63°58'N, 172°52'W | 63 | | |
| 24 | 64°18'N, 173°34'W | 36 | | 7.0 |
| 25 | 64°09.5'N, 171°58'W | 40 | | 12.5 |
| 26 | 64°37.5'N, 171°09'W | 43 | | |
| 27 | 64°58'N, 170°00'W | 49 | | 14.5 |
| 28 | 65°18'N, 168°52'W | 51 | | 4.0 |
| 29 | 65°39'N, 168°18'W | 52 | | |
| 30 | 65°43'N, 168°20'W | 53 | | |
| 31 | 65°44.5'N, 168°38'W | 51 | | |
| 32 | 65°52'N, 169°00'W | 48 | | |
| 33 | 65°57'N, 169°15'W | 49 | | |
| 34 | 66°02'N, 169°27.5'W | 43 | | 5.0-7.0 |
| 35 | 65°58'N, 169°52'W | 37 | | 6.0 |
| 36 | 66°17'N, 169°30'W | 45 | | 4.0 |
| 37 | 66°24'N, 170°00'W | 36 | | 9.0 |
| 38 | 66°39'N, 170°50'W | 25 | | 9.0 |
| 39 | 67°05.5'N, 171°27.5'W | 35 | | 6.0 |
| 40 | 67°15.5'N, 171°27.5'W | 42 | | |
| 41 | 67°35.5'N, 171°27.5'W | 47 | | 10.0 |
| 42 | 68°05.5'N, 171°27.5'W | 47 | | 8.0 |
| 43 | 68°05.5'N, 173°14'W | 48 | | 10.0 |
| 44 | 68°29'N, 175°06'W | 50 | | |
| 45 | 69°02'N, 175°12'W | 51 | | 14.0 |
| 46 | 60°22'N, 175°35'W | 46 | | |
| 47 | 69°45'N, 175°45'W | 57 | | 14.0 |
| 48 | 70°14'N, 174°35'W | 53 | | |
| 49 | 70°49'N, 173°57'W | 72 | | 14.0 |
| 50 | 71°17'N, 173°47'W | 68 | | 25.0 |

| Station No | Location | Depth (m) | Ice Conditions | Transparency (m) |
|---|---|---|---|---|
| 51 | 71°05'N, 172°51'W | 45 | | |
| 52 | 70°54'N, 171°30'W | 45 | | 32.5 |
| 53 | 70°41'N, 170°23'W | 41 | | 25.0 |
| 54 | 70°25'N, 172°11'W | 31 | | 14.5 |
| 55 | 69°36'N, 173°12'W | 52 | | 29.5 |
| 56 | 69°12'N, 171°35'W | 53 | | 30.5 |
| 57 | 68°52'N, 169°50'W | 53 | | 24.5 |
| 58 | 68°41'N, 168°31'W | 52 | | |
| 59 | 68°27'N, 167°15'W | 49 | | 10.5 |
| 60 | 68°10.5'N, 168°02'W | 13.5 | | 13.5 |
| 61 | 67°54'N, 168°46'W | 57 | | 12.5 |
| 62 | 67°36.5'N, 169°37'W | 47 | | 18.0 |
| 63 | 67°19'N, 170°15'W | 48 | | |
| 64 | 67°04'N, 171°22'W | 35 | | |
| 65 | 66°53'N, 169°40'W | 47 | | |
| 66 | 69°30'N, 168°48'W | 56 | | 8.5 |
| 67 | 66°02'N, 169°27'W | 38 | | 8.5 |
| 68 | 65°57'N, 169°20'W | 52 | | |
| 69 | 65°55'N, 169°12'W | 51 | | |
| 70 | 95°52'N, 169°32'W | 45 | | 3.5 |
| 71 | 65°34'N, 170°14'W | 40 | | |
| 72 | 65°20'N, 169°43'W | 43 | | |
| 73 | 64°5[illegible]'N, 168°40'W | 47 | | 7.5 |
| 74 | 64°31'N, 167°42.5'W | 33 | | 9.0 |
| 75 | 64°23'N, 166°25'W | 31 | | |
| 76 | 64°05'N, 167°03'W | 33 | | |
| 77 | 63°46'N, 167°44'W | 31 | | 9.5 |
| 78 | 63°25'N, 168°27'W | 34 | | 8.0 |
| 79 | 63°46'N, 169°43'W | 37 | | 10.0 |
| 80 | 64°16'N, 169°45'W | 38 | | |
| 81 | 64°00'N, 171°45'W | 36 | | 10.0 |
| 82 | 64°09'N, 171°58'W | 44 | | 14.0 |
| 83 | 64°21'N, 172°12'W | 36 | | 8.0 |
| 84 | 64°09'N, 172°32'W | 45 | | 14.0 |
| 85 | 64°26'N, 173°17.6'W | 147 | | 46.5 |
| 86 | 63°41'N, 175°30'W | 81 | | |
| 87 | 63°15'N, 176°52'W | 89 | | 12.5 |
| 88 | 62°51'N, 178°09'W | 93 | | 12.5 |
| 89 | 63°00'N, 179°35'W | 73 | | 11.0 |
| 90 | 63°03'N, 179°48'W | 53 | | |
| 91 | 62°35'N, 179°36'W | 41 | | 5.0 |
| 92 | 62°26'N, 180°00'E | 88 | | 15.5 |
| 93 | 62°00'N, 175°15'E | 82 | | 9.5 |
| 94 | Outlet of Imatra Bay | 40 | | 6.0 |
| 95 | 59°06'N, 172°16'E | 500 | | |
| 96 | 59°18'N, 171°30'E | 560 | | 9.5 |
| 97 | 59°38'N, 170°58'E | 500 | | 13.5 |
| 98 | 59°48.5'N, 170°32'E | 87 | | 8.5 |
| 99 | 59°53'N, 170°26'E | 32 | | 9.0 |
| 100 | 55°32.5'N, 164°35'E | 500 | | 15.0 |
| 101 | 55°46'N, 163°53'E | 500 | | 12.5 |
| 102 | 55°58'N, 163°12.5'E | 500 | | |
| 103 | 52°34'N, 159°32.5'E | 500 | | |
| 104 | 52°42'N, 159°12'E | 500 | | 12.5 |
| 105 | 52°46.5'N, 158°57.5'E | 143 | | 12.0 |
| 106 | 52°50'N, 158°51'E | 126 | | 13.0 |

D. Stations in Chukotsk Sea, Bering Sea, and Bering Straits
(Compiled by Survey Ship, F. Litke, 1932)

| Station No | Location | Depth (m) | Ice Conditions | Transparency (m) |
|---|---|---|---|---|
| 1 | 66°13'n, 169°34'W | 52 | | 13.75 |
| 2 | 66°52'N, 171°04'W | 41 | Open ice | |
| 3 | 66°20'N, 169°36'W | 33 | | 8.0 |
| 4 | 65°38.2'N, 171°01'W | | | |
| 5 | 66°28'N, 170°18'W | 43 | | |
| 6 | 67°01'N, 172°09'W | 12 | Very open ice | |
| 7 | 67°08'N, 173°26'W | 10.5 | Open ice | 5.0 |
| 8 | 67°30'N, 175°06'W | 9 | Very open ice | |
| 9 | 67°47.5'N, 175°44'W | 12 | Open ice | |
| 10 | 68°21'N, 177°44'W | 10 | Open ice | |
| 11 | 68°55'N, 179°26'W | 9 | Open ice | |

Hydrological Survey Stations in
Chukotsk Sea, Bering Sea, and Bering Straits
(Data compiled by survey ship, Suchan, 1932)

| Station No | Location | Depth (m) | Ice Conditions | Transparency (m) |
|---|---|---|---|---|
| 1 | 66°24'N, 170°27'W | 30 | Close ice | |
| 2 | 66°31'N, 170°22'W | 42 | | |

E. Stations in Chukotsk Sea, Bering Sea, and Bering Straits
(Compiled by Survey Ship, Soviet, 1932)

| Station No | Location | Depth (m) | Ice Conditions | Transparency (m) |
|---|---|---|---|---|
| 1 | 48°27.2'N, 154°46.5'E | | | |
| 2 | 64°37.8'N, 178°12.5'E | | | |
| 3 | 64°26'N, 173°10'W | | | |
| 4 | 64°23.2'N, 172°21'W | | | |
| 5 | 64°25'N, 172°16'W | | | |
| 6 | 65°08'N, 171°00'W | 41.2 | | |
| 7 | 65°39'N, 170°45'W | | Small ice pieces | |
| 8 | 65°36'N, 170°47'W | | " " " | |
| 9 | 66°01'N, 169°50'W | | Growlers | |
| 10 | 67°02'N, 167°58'W | | | |
| 11 | 68°00'N, 168°C0'W | | | |
| 12 | 68°33'N, 169°11'W | 54.8 | | |
| 13 | 69°22.5'N, 171°24'W | 53 | | |
| 14 | 70°07'N, 173°21'W | 47.8 | | |
| 15 | 70°46'N, 174°30'W | 62 | Small and large ice pieces | |
| 16 | 71°06.2'N, 176°05'W | 46 | Close ice fields | |
| 17 | 70°53'N, 176°44'W | 45.3 | Close ice pieces | |
| 18 | 71°03.2'N, 176°23'W | | Open ice pieces | |
| 19 | 70°51.2'N, 177°25'W | 38.8 | Hummocky ice | |
| 20 | 70°31'N, 178°38'W | | Large ice pieces | |
| 21 | 70°24.2'N, 178°34'W | 42 | Ice fields | |
| 22 | 70°08'N, 178°15.1'W | | Large ice pieces | |
| 23 | 70°09'N, 177°22.5'W | 52 | | |

| Station No | Location | Depth (m) | Ice Conditions | Transparency (m) |
|---|---|---|---|---|
| 24 | 70°55.2'N, 176°21'W | 46.7 | Large ice pieces | |
| 25 | 71°10.9'N, 175°49'W | 44.5 | Open ice | |
| 26 | 71°04.1'N, 177°00'W | 36.5 | | |
| 27 | 70°56.5'N, 177°00'W | 37.1 | Large ice pieces | |
| 28 | 70°56.5'N, 177°00'W | | Ice fields | |
| 29 | 70°29.8'N, 176°41'W | 53.1 | Open, large ice fields | |
| 30 | 67°40'N, 172°20'W | | | |
| 31 | 66°13.5'N, 169°39'W | | Open small ice pieces | |
| 32 | 66°05'N, 169°24'W | | " " " " | |
| 33 | 65°41.5'N, 170°12.5'W | 33.5 | Small and large pieces | |
| 34 | 64°25.6'N, 172°19'W | 15.2 | | |
| 35 | 64°25.1'N, 173°14'W | 26 | | |

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