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SOVIETS GATHER GEOGRAPHIC DATA IN ARCTIC

[Comment: This report presents information on Arctic research conducted by the USSR, taken from Soviet newspapers and periodicals published September 1954-20 April 1955.

All temperatures are given in degrees centigrade.

The table and figures mentioned in the text are appended to the report. Numbers in parentheses refer to appended sources.]

The Polar Drift Stations

On 6 April 1955, the two Soviet drift stations completed approximately one year of operations. During the course of this time they have covered a significant portion of the polar area.

Severnyy Polyus-3, which was set on the ice at 86 00 N, 175 45 W, has drifted 2,100 kilometers (a straight-line distance of 820 kilometers) across the circumpolar area (1) at an average speed of 5.6 kilometers per day. On 10 April, Severnyy Polyus-3 was located in the Atlantic sector of the Arctic Ocean at 86 04 N, 35 00 W.(3)

Severnyy Polyus-4, which was set on the ice to the north of Ostrov Vrangelya (Wrangel Island) at 75 48 N, 178 25 W [Comment: This longitudinal coordinate is probably in error. According to all previous press sources, the station was established at 175 25 W.](1), had reached a point at 80 40 N, 176 06 W on 10 April (3) having drifted a distance of 2,500 kilometers (a straight-line distance of 520 kilometers).(1) The average speed of drift was 7 kilometers per day, but on occasion the drift reached 20 kilometers per day. It is significant that the floe on which the station is located made several complete circles during its drift. On 20 September, for example, the flow returned to its 25 August location, and on 27 March it returned to its 15 January location. In addition to drifting, the floe holding Severnyy Polyus-4 revolved, turning more than 300 degrees in a clockwise direction during the year.(2)

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The workers at both drift stations were put to the test many times during the year's drift by the severe polar winter. At Severnyy Polyus-3, beginning in December, the floe on which the camp is situated underwent terrific pressure from the surrounding ice field. This continuous pressure caused cracks to form in the field accompanied by hummocking and rafting. Several times in the course of the winter cracks passed through the camp site and even under some of the buildings. On occasion, the camp was cut into isolated sections by cracks, and the camp was forced to move to new locations four times during the polar night with temperatures as low as 46 degrees below zero.(1)

Excerpts from the diary of Yevgeniy Yatsun, photographer at Severnyy Polyus-3, reflect the severity of the ice pressure:

"A series of cyclones has passed over our camp accompanied by purgas and winds with velocities of 10-14 meters per second. Ice motion and hummocking has begun, and the dimensions of our floe are being reduced.

"12 February -- Ice motion continued throughout the night. Cracks have crossed the entire ice field, and pieces 50-60 meters long have broken off the south and southwest edge.

"15 February -- Ice motion and hummocking continued almost all day. At 0200 hours, hummocking began to the south and to the east beyond the first camp site. Stress is on the present camp location with hummocks 2-3 meters high.

"24 February -- Hummocking has continued for 2 weeks. At 2200 hours today, a terrific shock was felt at the camp, but no alteration in the floe can be determined.

"10 March -- Weather moderated. Polar night ended today with the appearance of the sun at 1435 hours."(4)

One complete relocation of Severnyy Polyus-3 is reported in January when the entire camp including houses and antennas was moved following an emergency created by splitting of the original ice floe.(5)

For the men on Severnyy Polyus-4, summer proved to be even more difficult than the winter. During the warm period, the ice pack receded from around the floe on which the station is located. At times there was so much clear water around the station that seas began to break over the edge of the floe, and the pack could barely be seen on the horizon. This station, too, experienced many partial breakups during the year (1) which reduced its size to 0.7 square kilometers, one tenth its original size.(3)

The weather at Severnyy Polyus-4 was cyclonic, with sharp weather changes as a consequence. Maximum air temperature was 3 degrees above zero in the summer and the minimum temperature was 49 degrees below zero recorded in February. The variability of air temperature is illustrated by temperatures recorded at the station during the month of December. In the period 10 December-20 December, the temperature rose to minus 11 degrees after a period of extreme cold, then dropped to minus 40 degrees after 3 days. In the period 20 December-30 December, a temperature of 5 degrees below zero was observed, and the very next day the temperature dropped to 35 degrees below zero.(2)

The scientific program was fulfilled by both the stations. Their drift routes were plotted by about 700 celestial fixes.(3) During the year, the two stations made more than 10,000 meteorological observations, launched about 3,000 radiosondes and balloons, and made over 2,000 actinometric measurements. Ocean depth was measured at more than a thousand places, several long-range hydrologic observations were made for measuring currents and water temperatures, and bottom samples were raised for hydrochemical analysis.(1)

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The meteorologists at Severnyy Polyus-4 alone took over 2,700 observations during the year and made about 800 radiosonde observations for upper air data. The hydrologists at the station, Dem'yanov and Izvekov, completed a great deal of work both at the station and at points off the station's floe which they reached by helicopter. All together they made over 750 soundings. (2) Ovchinnikov, chief of the aerometeorological section, also made 600 measurements of solar radiation accumulation and dispersion, and 875 measurements of radiation and radiation balance.(6)

This station made interesting studies of the animal life which visited the station during the spring and summer period.(2)

A thorough evaluation of the year's drift can only be made after more precise studies of the data collected, but certain things have been made clear already by the data sent from the stations. The numerous soundings made by Severnyy Polyus-3 have precisely defined the relief of the submarine range imeni Lomonosov in those areas crossed by the station. Soundings taken by the station Severnyy Polyus-4 outline the character of the continental slope in the region where the station began its drift. Soundings from both stations have been used to create a new bathometric chart of the Arctic Ocean.

The data from daily meteorological and aerological observations made at the stations have been transmitted without delay to all arctic weather bureaus, the Arctic Institute, the Central Forecasting Institute, and other weather service organizations which use them for synoptic operational charts.(1)

The personnel of Severnyy Polyus-4 also made some interesting studies on the floe which was occupied by Severnyy Polyus-2 in 1950. Pilot Cherevichnyy found the floe on 24 April, 1954 at 75 04 N, 189 40 W and the personnel of Severnyy Polyus-4 visited the floe when it was located at 75 35 N, 184 25 W. (2) [Comment: It has been observed in certain Soviet publications that geographic coordinates read in excess of 180 degrees in both east and west longitudes. For example, some of the maps reproduced in N. N. Zubov's article "Arctic Ice Islands and the Character of Their Drift," in the February 1955 issue of the Moscow periodical Priroda (pages 37-45) were drawn with meridians numbered easterly through 360 degrees, while others had the meridians numbered in the conventional manner.]

With the results of this first year of operation by the two drift stations taken into account, it is now considered essential to maintain not less than two drifting stations on a continuing basis in the Arctic Ocean. To assure continuance of the work begun in 1954, Glavsevmorput' (Main Administration of the Northern Sea Route) has organized another expedition which has already been sent into the Central Arctic Basin to maintain research through 1955-1956.

This new expedition is composed of two groups: one will replace the staff of Severnyy Polyus-4 which is expected to continue drifting in the Polar Basin, while the other will establish Severnyy Polyus-5 in the polar area to replace Severnyy Polyus-3 which now appears to be drifting out of the Polar Basin through the strait between Greenland and Spitsbergen. Until such time as Severnyy Polyus-3 actually leaves the Arctic Ocean, however, the camp will be maintained with a reduced complement.

The aerial phase of research in the Arctic will continue with particular effort directed at the area north of Zemlya Frantsa-Iosifa (Franz Josef Land) and Greenland. The high-latitude aerial expedition will continue to operate until the end of May or the beginning of June.(1)

As in 1954, the Arctic Scientific-Research Institute and the Academy of Sciences USSR are cooperating in the 1955 expedition.(3)

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The new staff of Severnyy Polyus-4 left Moscow by air on 31 March.(7) This group included P. A. Gordiyenko, who will replace Tolstikov as chief of the station.(1) By 20 April, the 1954-1955 staff of Severnyy Polyus-4 was reported to have returned to Tiksi.(8) Many of these men will be employed in studying and analyzing the results of the work they did while serving on the drift station.(2)

The personnel of the new drift station Severnyy Polyus-5 left Leningrad on 3 April with N. A. Volkov, the head of the station and Candidate of Geographic Science, senior scientific worker of the Arctic Scientific-Research Institute.(9)

On 16 April the flagship of the 1955 expedition landed on the ice at the site chosen for Severnyy Polyus-5. [Comment: The flagship was presumably the N-525, since the dispatch was radioed from this aircraft.] A group of the station's personnel, including N. A. Volkov, made final ice strength tests and other measurements required before establishment of the station.(8)

The majority of the men who will man the new station are from Leningrad and many of them are graduates of the Leningrad Higher Marine Engineering School imeni Admiral Makarov and the Leningrad Arctic School.(9) They include M. M. Nikitin and Z. M. Gudkovich, Candidates of Geographic Science and participants in the drift of Severnyy Polyus-2, polar radio operators K. I. Vil'pert, I. G. Galkin, and M. M. Lyuborets, and aerologist S. S. Gaygerov, Candidate of Geographic Science.

The new station will be furnished with equipment built using the experience gained from the expedition of 1954-1955.(3)

Material support for the drifting stations is being rendered by many plants in the USSR. The Kazan' Technical Rubber Products Plant is producing large sounding balloons for the stations (10), and the KINAP Plant in Kiev sent a power plant and Kiev-2 lighting fixtures to Severnyy Polyus-3 in the spring of 1955.(11)

In March, the Central Committee of Dosaaf organized a competition among short-wave radio operators for establishing contact with the drift stations. On 6 March, A. G. Rekach, Yu. N. Prozorovskiy, and A. A. Klimashin, using the short-wave radio station of the Moscow City Radio Club of Dosaaf (on the amateur 40-meter band), made the first direct radiotelegraphy contact Moscow--Severnyy Polyus-4.(12)

[Illustrations of the drift stations and activities there include: preparing to raise an antenna mast at Severnyy Polyus-3 (CIA Photo Accession No 151844); N. Ye. Popkov prepares to make astronomical observations (No 151845); A. F. Treshnikov, chief of Severnyy Polyus-3 (No P-56287); V. G. Kanaki prepares radiosonde equipment (No 151846); A. D. Malkov making heat balance observations (No 151847); raising a radio antenna at a drift station (No 151848); composite photograph of housing and equipment at a drift station (No 151849); general view of drift station (No 151850); and P. A. Gordiyenko and his staff are greeted by Yu. V. Savinov, deputy minister of the maritime fleet (No P-56288) and (No P-56289)].

Soviet Polar Flights

The 1948 high-latitude expedition began its operations from Mys Chelyuskin at the edge of the Asiatic Continent. Before departing for the polar area, the members of the expedition visited the houses of the polar station set among numerous wind-motor masts. They also studied the costly fog stations erected by Glavsevmorput'. These stations are equipped with both powerful sirens and lights to warn vessels of the shoreline as they pass through Vil'kitskiy Proliv (strait).

The plan of the 1948 expedition called for a 3-week drift accompanied by flying trips from the drifting base to the surrounding area, where scientists would spend 3 days making observations. The first of these flying trips was made by Ivan Ivanovich Cherevichnyy, I. S. Kotov, and V. I. Maslennikov when the drift station was located near the 87th parallel. This flight was to the North Pole and marked the second time in history that the flag of the USSR was raised there.

The oceanographers of the expedition, M. M. Somov and P. A. Gordiyenko, cut a hole in the ice and began making soundings immediately after landing. On the evening of 23 April, the group radioed back to the drift station reporting a depth of 4,039 meters.

For the 3 days' work at the pole, 18 men were taken -- the crews of the planes piloted by Kotov and Maslennikov, two oceanographers, two magnetologists, a photographer, and a reporter.(13)

One of the earliest extensive flights in the polar area during the polar night was made in the autumn of 1945 by M. A. Titlov, who flew over 4,300 kilometers on ice survey.

Later flights in the area were made by members of the expeditions sent to the polar regions in 1948, 1949, 1950, and 1951. It was the sum of the experiences of these flights that allowed such extensive use of aircraft in the 1954 expedition. In this operation, dozens of aircraft were used to make flights to isolated corners of the Arctic where landings were made and scientific data gathered.

V. Akkuratov, chief navigator of the Polar Aviation Administration, was assigned the task of flying with Pilot Sorokin to the western hemisphere side of the Polar Basin to determine by means of soundings whether the submarine range imeni Lomonosov ends at Greenland or Ellesmere Island.

Akkuratov and Sorokin flew to the west until a suitable floe was sighted and a landing effected. The conditions under which these operations were executed are described in Akkuratov's notes on the trip:

"After several hours' work in this location, we crawled into our sleeping bags for a little rest, but sleep was impossible. The ice field beneath our tent began to crack and forced us to make a hasty exit. Outside we found a serious situation with the entire snow-covered ice field torn by dark cracks. One crack reached to the very nose of our plane and another ran across the field behind it. A greenish pressure ridge was moving directly toward the plane, grinding everything before it to pieces. Using the plane's motors and pushing by hand, we were able to move the plane onto some old pack ice, and in 5 minutes the area where it had been standing was a black chasm.

The next day, the rafting and ice motion ceased, and the cracks were closed or covered with young ice and snow. With considerable difficulty we were able to take off in the plane."(14)

Some time later Akkuratov was again on his way to the polar area by air, this time aboard the SSSR-N-474 (Cherevichnyy commanding, Patarushin radio operator) on a flight from Mys Chelyuskin to Severnyy Polyus-3 on the other side of the pole.

After take off from Mys Chelyuskin, the N-474 took bearings from radio stations on the mainland, but when plotted these bearings did not coincide with celestial bearings. As a result of electrical disturbances, the mainland stations were broadcasting ABT (bearings unreliable), and their use was abandoned.

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Communications were not yet established with Severnyy Polyus-3 at the 1,100-kilometers mark so an emergency action plan was outlined -- if unable to locate the draft station, a landing would be made at Zemlya Frantsa-Iosifa or at Dikson.

The flight eventually did reach the drift station, however, navigating solely by celestial means. This trip was one of four flights (two by Kotov with Morozov navigating and two be Cherevichnyy with Akkuratov navigating) that proved the possibility of flying to a small base on the ice during conditions of the polar night while using only celestial navigation.

Subsequently, massive flights to deliver heavy equipment to the polar ice were made throught the polar night for the first time in history.(15)

Activities of Hydrophysical Institute at Drift Stations

The climate and weather of a significant part of Europe and Asia in the winter is determined by air circulation caused by the basic pressure centers -- the Icelandic low, the East Siberian high, the Aleutian low, and the Canadian high.

The study of these areas and related weather has been pursued by many authors, including V. Yu. Vize, V. V. Shuleykin, and A. M. Gusev. These and other Soviet scientists have emphasized the necessity of studying these pressure centers for their circulation patterns and vertical structure. A peculiarity of the circulation emanating from these centers is the air temperature inversion. These temperature inversions are observed at shore stations along the Northern Sea Route and in the Central Arctic Basin, and research on their formation and dissolution is of great interest.

With the exception of the Canadian high, the basic pressure centers and associated air circulation have been studied to some degree (the Icelandic low and East Siberian high to a great degree, the Aleutian low to a lesser degree). Study of the Canadian high, (or more accurately the pressure field around the pole of relative inaccessibility), which is actually the pressure pole of the Arctic, must be intensified.

The work carried out by the two drifting stations in the central Polar Basin therefore is of considerable interest. One of the stations drifted through this area during the year. The observations of this station, coupled with those from the other station in the central part of the Arctic Basin and from shore stations, have made a very valuable contribution.

The institute's interest in Severnyy Polyus-3 was to organize specialized aerological observations in line with a program worked out in conjunction with the chief of the aerological section at the camp, V. G. Kanaki. With respect to many questions on climate and weather changes (these problems are contained in the work plan of the Marine Hydrophysical Institute, Academy of Sciences USSR), research at air levels from 0 to 3,000 meters was required. At the same time it was planned to study the formation and dissolution of temperature inversions in a special series of observations.

A similar program was worked out with the director of Severnyy Polyus-4 prior to the establishment of the station on the ice. On this station, detailed aerological research on the lower atmospheric layers began in the summer of 1954, but especially valuable observations were made during the winter period.

It is known that during the drift of Severnyy Polyus-1 in 1937, the passing of meteorological fronts was frequently observed. Later observations in the Arctic quite frequently detected temperature inversions, which testify to the presence of warm air masses at some height over the Polar Basin.

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These observations, coupled with the theoretical work done by Academician V. V. Shuleykin, indicate that there is no cold air "cap" and consequent high-pressure area over the North Pole as formerly supposed. By analyzing isolines of points where the mean observed temperature varies by the same amount from normal, V. V. Shuleykin determined that the cold pole lies not at the geographic pole but in the area of Verkhoyansk where the East Siberian high is located during the winter period.

Research on water heat and water dynamics in the Polar Basin as carried out by A. F. Treshnikov at Severnyy Polyus-3 has added new data to knowledge of the pressure system of the Northern hemisphere. It can now be stated with assurance that under the influence of heat carried in water of the Gulf Stream penetrating to the most eastern regions of the Polar Basin and heat carried by waters of the Kuro-Siwo Current through the Bering Strait, the cap of cold air is not only displaced from the geographic pole, but it is also split into two parts. One part is located in the area around Verkhoyansk and the other is located in northern Canada and the region known as the pole of relative inaccessibility. The character of the ice cover in the area of the pole of relative inaccessibility (old ice) and the closed orbit of its circulation (clockwise) gives the basis for assuming the presence of a high atmospheric pressure area. The shifting of the high-pressure area from the North Pole to the south and the consequent influence of the underlying land in the summertime, explains the peculiarity of these centers -- the seasonal changes with a reduction in pressure. This peculiarity cannot be natural to the high pressure over the pole of relative inaccessibility since the underlying surface there assures high pressure throughout the year.

The second phase of the work was concerned with research on electric current in the sea. It is known that the great mass of sea water on the earth's surface does generate electric current. According to the hypothesis of Academician V. V. Shuleykin, these currents influence the magnetic field of the earth, the affect of which is to determine in part the relation of the field's configuration to the configuration of the shore and the separation of the magnetic and geographic poles. Experiments carried out in the Marine Hydrophysical Institute, Academy of Sciences USSR, verify these suppositions. It was also determined that fish react in a fixed manner to electric current in the sea. The suggestion has been made that these currents serve as means of orientation for fish during their migrations. Thus, observations on electric current in the open sea have a practical as well as a theoretical interest.

Electric current research near the North Pole is of special interest since a substantial magnetic anomaly is produced there.

Electric current measurements at the drift stations were carried out with the aid of lead electrodes (developed and produced by the Black Sea Division of the Marine Hydrophysical Institute) and millivoltmeters. The lead electrodes are distinguished by small natural potential, stability, and sturdy construction in relation to the possible mechanical action to be encountered. Observations were made on two base lines (baza), one 340 meters long and the other 350 meters long. The compass alignment of one of the bases was periodically checked by astronomical observations.

The observations on the two bases made it possible to determine the magnitude of potential electrical current in the sea as well as the direction of its gradient and consequently the direction of the current. The electrodes were lowered through the hydrological sounding holes, three new ones of which were drilled in the ice with mechanical borers.

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The results of the observations agree closely with the theoretical determination of electric current direction as being toward the circumpolar area in the northern hemisphere. It was assumed during all these computations that the speed of drift of the ice floe during these observations (4 centimeters per second) was too slow to affect the potential current recorded.

The third phase of the work was research on hydrochemistry, namely the amount of phosphorus in sea water. Phosphorus exists in sea water in two basic forms: mineral (phosphates) and organic. The phosphates are one of the edible salts necessary for the growth of phytoplankton, while organic phosphorus is composed of living and nonliving organic matter found in sea water. Thus, phosphorus in sea water, like other biogenous elements, serves as an indication of the activity of living creatures. The method used for determining the presence of phosphorus in sea water is twofold: mineral phosphorus is determined by colorimetric tests, then the over-all amount of phosphorus is determined by treating concentrated specimens with oxidizing agents. The difference between the two figures is the amount of organic phosphorus in the water.

Research on the volume of phosphorus in sea water is included in the work plan of the physiochemical laboratory of the Marine Hydrophysical Institute. The data on measuring mineral phosphorus at the hydrologic station with coordinates 89 29.5 N and 294 16.9 E is given in Table 1 appended. This data is of particular interest since it was near this point that Professor A. Ye. Kriss made his microbiologic observations. [Comment: See 00-W-31256 for report on the work of Professor Kriss.]

It would be difficult to overestimate the importance of the work being done by the stations drifting in the central part of the Polar Basin. Their importance is enhanced by the possibility they offer for scientists to carry out research in the area at a variety of times. The Marine Hydrophysical Institute considers its work on the drifting ice of September 1954 merely preparatory and preliminary in nature. In 1955, this work will be significantly broadened and expanded with new areas being added -- heat in the sea and thermal balance in the atmosphere.(21) [Comment: This periodical also contains a technical article by P. A. Shumskiy on the structure of ice in the Arctic Ocean; i.e., crystal length and size, density, etc.]

Parachute Jump at the North Pole

[Comment: It is interesting to note that the following exploit as narrated by the man who accomplished it, A. Medvedev, Master of Sport, has apparently not been mentioned in any other press or periodical source.]

It was in the spring, during the planning of a high-latitude expedition which expected to land geologists and geophysicists at the North Pole. Aircraft making preliminary survey flights over the area, however, were unable to locate a landing strip because of a light snow cover which obliterated all hummocks and cracks. When the day for departure of the expedition arrived, no landing strip had been found as yet.

The chief of the expedition called me in at this time and explained where the scientific group was to land. He stated that it was impossible to make out a landing area from the air and that only one method remained -- a parachute landing at the pole. He suggested that I think over the project and send him my decision.

I had made many jumps, but such an undertaking as a jump at the North Pole was quite a different thing considering the wind and weather.

On 9 May, however, we set out for the pole with carefully packed parachutes. Two of us were to make the jump -- Dr Vitaliy Georgiyevich Volovich, who is now on the drift station Severnyy Polyus-3 and I. [Comment: Dr Volovich is a medical doctor serving as medical officer at the station. He has also been described as helping in meteorological work and a variety of other endeavors. He was a member of the drift station Severnyy Polyus-2 in 1950.]

The day of our departure was clear and the flight was made without difficulty. After arrival at our destination, we decreased altitude to 75 meters in order to survey the area. It was extremely difficult to discern anything under the snow cover, but after circling several times we found an area about 30 by 50 meters which appeared to be suitable. The pilot of our plane, Metlitskiy, dropped smoke flares to enable us to study wind direction and velocity. The plane then climbed to 250 meters for a final circling of the area, and we jumped.

We landed without mishap, and the plane returned to its base. About 2 kilometers from where we landed, we found a broad, flat area for a landing strip. The plane which was to follow ours in case of an emergency was able to land on the strip we prepared and radioed to the chief of the expedition that the landing area was ready and the expedition could proceed.

When the plane piloted by V. N. Zadkov arrived with the chief of the expedition as well as equipment and supplies, we were sent back to the shore base to rest.

This was my 970th parachute jump -- the first in the history of aviation at the North Pole.(16)

<u>Soviet Island and Continental Possessions in the Arctic</u>

The northern Soviet territory of Ostrov Vrangelya is subjected to severe winter 9 months of the year, and even during the summer months the sea around the island is full of floating ice. In early times, many navigators set out for the shores of the island, but the severe weather and heavy ice drove them back. It was not until the expedition of Lt F. P. Vrangel' of the Russian Navy (1820-1824) that the island was mapped to any extent.

At the end of the 19th and the beginning of the 20th century, the island was visited by several expeditions, but it was only after the revolution that scientific research was carried out there. On 20 August 1924, an expedition of 55 men under the leadership of B. V. Davydov raised the Soviet flag on the craggy shore of the island. The group set up a polar station which has carried on weather and climate studies ever since.

The island has an area of 7,300 square kilometers and is crossed by three ranges of mountains running from east to west. The central section is the highest with the maximum elevation of 1,100 meters at Gora Sovetskaya. The northern part of the island is lowlands with typical tundra cover of bryophyte and lichen. The southern mountain slopes are grass and vine covered, and in the mountain valleys arctic willow grow to a height of 70-80 centimeters.

Tremendous numbers of birds nest on the island in the spring, and the area is also rich in marine life. Walrus, beluga, sea hare, and seal abound in the water around the island, and polar bear prowl the shore both singly and in pairs.

When the Soviet government assumed control of Ostrov Vrangelya, the Eskimos and Chukchees who inhabited the island lived in hide tents as they had for centuries. These tents were soon replaced by well-built log houses. With the opening of the trading post, the diet of the local inhabitants changed completely to include the daily staples of a normal diet.

Since Soviet men first settled on the island 30 years ago, the appearance of the island has changed a great deal. A completely electrified settlement has sprung up containing an equipped polar station, a trading post, an infirmary, school, baths, and a motion-picture room for the hunters and their families.

The polar station on Ostrov Vrangelya is very important, pursuing a program of meteorological and aerological observations throughout the year regardless of weather conditions. Hydrologists move out many miles from the shore by dog sled to study ocean currents and ice drift in the area.

In the course of years of study, a good deal of information has been gathered on the nature of the island. It has been determined that its mountains were formed during the Paleozoic and Mesozoic eras. Mammoth teeth and tusks have been found in several locations affirming the belief that the island was once part of the Asian mainland and was separated from it in recent geologic times.(17)

Bol'shoy Lyakhovskiy Ostrov also has a polar station and settlement. Vladimir Voronin, a recent graduate of the Leningrad Arctic School, was assigned to this station. On his arrival at the station, he was met by the personnel working there including Semen Ivanovich Bubnov, chief. Bubnov escorted him through the polar settlement where he saw only the polar station building and a few boxes for the dogs. He also escorted him around that part of the island lying nearby.

On Mys Kigilyakh, Voronin was shown a tremendous pile of rock which has been worn by the elements into the likeness of a man. The cape on which this "sculpture" stands is called Kigilyakh because this means "stone man" in Yakut. The cave where mammoth remains were found is in this same area.

Because of the extremely variable weather the entire island is outfitted with timber huts at 30-40 kilometer intervals. Each of these huts is equipped with a stove and provisions for personnel who might be forced to take shelter in them.

Voronin met a Yakut family that lives at the Dymnoye stopping point, on the shore a few dozen kilometers from the polar station at Kigilyakh. There are two brothers and two sisters in the family who made 150,000 rubles in 1954 with a catch of 280 arctic fox.(23)

A great deal of work is currently being done in the Arctic to improve both medical services and communications for Soviet workers. Tiksi is typical of the work being done in the field of public health. This town has a hospital which contains maternity, surgical, and general departments. In the outpatient section, patients may consult a surgeon, a therapist, a neurologist, an occulist, a pediatrician, and other doctors.(18)

In the Nenetskiy National Okrug, the expansion of radio facilities to serve all kolkhozes has been completed. In Nizhne-Pechorskiy and Kanino-Timanskiy rayons more than 20 kolkhoz wired radio centers have been built.(19)

The city of Nar'yan-Mar, founded 20 years ago at the mouth of the Pechora River, is continuing to grow. In 4 years of the Fifth Five-Year Plan, dozens of houses, a library, a communications center, and a Pioneer home have been built.

The city now contains 7 schools, 3 middle specialist schools, a house of culture, several clubs and motion-picture theaters, and over 20 libraries.

In 20 years the city has become an administrative, cultural, and industrial center of the Soviet Arctic.(20)

Arctic Ice Islands and Their Drift

There are many large or medium-size floating ice islands which have been discovered in the central part of the Arctic Basin by Soviet polar aviators. I. S. Kotov discovered one in the area to the northeast of Ostrov Vrangelya in March 1946. I. P. Mazuruk sighted another at 82 00 N, 170 00 E in April 1948, and V. M. Perov found a third in the area to the northeast of Ostrov Geral'd in March 1950. Kotov's island was 30 kilometers long and 24 kilometers wide, Mazuruk's island was 32 kilometers long and 28 kilometers wide, and Perov's island was 17 kilometers long and 8 kilometers wide.

Arctic ice fields in general do not exceed 3-5 meters in thickness (excluding hummocks), but their horizontal dimensions may be very great (tens of kilometers). On the other hand, the largest east Greenland iceberg measured was about 70 meters high with a length of about one mile. Thus, the vertical dimension of an iceberg is large in proportion to its horizontal dimension while in the ice field it is small. In this respect the ice islands occupy an intermediate position between field ice and icebergs.

The ice islands discovered by Soviet polar aviators were later found by American flyers and named T-1, T-2, and T-3.

In 1951, the American air forces conducted a special survey of ice islands in the sector between 30W and 180W, and in 1952, an aerodrome and meteorological station were established on T-3. At the same time many smaller ice islands were discovered in special flights to the northern shore of Ellesmere Island and through the straits of the Canadian Arctic Archipelago.

The discovery of these islands immediately led to much discussion as to the origins of ice islands. The first tendency was to assume that they were calved from glaciers, but there are no glaciers along the shore of the Arctic Ocean which are large enought to calve ice islands of such dimensions.

Icebergs themselves are created only from Spitsbergen, Zemlya Frantsa-Iosifa, Severnyy Ostrov (Novaya Zemlya), Severnaya Zemlya, northwestern Greenland, and northern Ellesmere Island, since only in these places are there glaciers which reach sea level.

In 1950, American fliers photographed fast ice on the northern shore of Ellesmere Island in very clear weather. [A photograph is included at this point which is reproduced from the Journal of the Arctic Institute of North America, July 1952.] It appeared that this fast ice extended along the northern shore of Ellesmere Island for at least 90 kilometers with a width of 18 kilometers and an undulating surface much like the surface of T-1, T-2, and T-3 -- especially T-3 which is the youngest of the group. (American research indicates that it began its drift in 1946.) The surfaces of the ice islands were somewhat smoother than the surface of the fast ice, however. From a height of 30 meters, the ridge peaks on T-1 rose only 0.6-0.9 meters above the ice surface, and on T-2 the ridges were even smaller. It may be deduced that the surface of the islands is worn away with time.

Further evidence that ice islands have their origin in this fast ice is supplied by other photographs. A photograph was taken of an ice island in 1947 off Cape Columbia, Ellesmere Island, and at the same time another picture was taken of a section of fast ice with uneven surface at Cape Ners (83 05 N, 71 40 W). The broken edge of the ice island fitted precisely to the outer broken outline of the fast ice.

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There are several theories on the formation of the fast ice from which these ice islands originate. Some believe they are remnants of glaciers which at one time reached to the sea in the area of northern Ellesmere Island, while others believe they have their origin in sea ice. (See F. Debenham, "The Ice Islands of the Arctic, a Hypothesis," Geographic Review, 1954.)

Theoretically, the thickness of fast ice may reach 10 or more meters under known conditions. It is also known that fast ice of sea origin may carry pebbles and gravel that are seen on the ice islands. Ships often sight ice in the Baltic Sea at the beginning of winter which was apparently formed on the ocean bottom and rises to the surface carrying gravel and other matter.

It is theoretically possible also that these pieces of ice fuse into a single piece of fast ice of large proportions by pressure and rafting.

Old fast ice can attain very great thicknesses. The smaller the original thickness of the ice and the greater the number of degree-days of freezing, the more rapidly the ice grows in thickness.

On the northern shore of Greenland and Ellesmere Island, the degree-days of freezing equal about 8,000 for the winter. It is assumed in general that ice thickness decreases as a result of thawing during the summer by 40 centimeters, but this is a little high for the area in question. There, for the first winter (8,000 degree-days of freezing), the thickness of the ice reaches 230 centimeters, according to the empirical formula developed by the author. (See Morskiye Vody i L'dy (Sea Water and Ice), by N. N. Zubov, 1938, Gidrometeoizdat; pages 334-342.) During the summer, the ice thickness decreases to 190 centimeters. In the second winter (8,000 degree-days of freezing) the thickness of the ice increases from 190 centimeters to 330 centimeters, and during the second summer it decreases to 290 centimeters, and so forth. If these computations are continued, it becomes apparent that when the ice reaches a thickness of 755 centimeters, a condition of equilibrium sets in; i.e., the ice will grow 40 centimeters in the winter and melt 40 centimeters in the summer.

In the area to the north of Greenland and Ellesmere Island, the maximum number of degree-days of freezing and the minimum summer thaw have been observed in comparison with any area in the Arctic Basin.

If we assume that the number of degree-days of freezing is 8,000 in this area while the summer thaw rate is much less -- perhaps 20 centimeters -- then the thickness of the ice will approach 15 meters.

These computations are based on formulas worked out by N. N. Zubov from observations in the seas of the Soviet Arctic. Since conditions in the area to the north of Greenland and Ellesmere Island are considerably different from those in the Soviet Arctic, these figures for ice growth may only serve as an approximation, but in any case it may be seen that ice in this area can attain considerable thickness.

It follows that ice originating in an area which develops ice 4 meters thick, will adjust itself to conditions of any new area it may enter as a result of drifting; i.e., it will grow further if it enters an area developing 5-meters-thick ice or it will thaw if it enters an area which develops 3-meters ice. Thus the ice islands T-1, T-2, and T-3 entered an area which produced thinner ice than the fast ice which spawned the islands, and they were consequently reduced in thickness. This process of reduction was, of course, a very slow one.

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The growth of these islands and the fast ice in general is quite different from the growth process of glacier ice. Snow falling on the surface of a glacier increases its growth while snow on the surface of sea ice may retard its growth. Glacier ice both grows and diminishes from the top, while sea ice grows from below and melts from above.

The undulating surface of the fast ice to the north of Greenland and Ellesmere Island may be caused by a variety of factors. This area is very susceptible to pressure from the pack, and this pressure may cause the uneven surface of the fast ice. It may also be that the waves are caused by movements of the water below the ice during its formation, or they may be due to temperature differences between the upper and lower surfaces of the ice.

Many of these questions are yet to be clarified by further research, as is the question of just what causes the ice islands to break off from the main body of fast ice.

Once separated from the fast ice, ice islands may be encountered far from the area of their origin, and in this there may be some analogy with the so-called "breakout" of icebergs, the reasons for which are still not clear.

In May 1929, for example, several small icebergs which calved from glaciers on Zemlya Frantsa-Iosifa were observed on the Murman coast and by June were already at Kanin Nos. It is significant that these icebergs in the course of their drift from Zemlya Frantsa-Iosifa to the Murman coast had crossed the warm Nordkaap Current. [Comment: Nordkaap Current is the designation for the southern branch of the Norwegian Current which rounds Noordcaap and flows into the Barents Sea.]

In this same year of 1929, the number of icebergs noted to the south of Newfoundland was almost three times greater than either before or after that year. Thus in 1929, the "breakout" of icebergs occurred simultaneously in the Barents Seas and south of Newfoundland. In 1939 and 1940, the iceberg breakout was observed to the southwest and southeast of Severnaya Zemlya.

In March 1943, in the area to the north of Zemlya Frantsa-Iosifa between 84 00 W and 84 30 W a hundred icebergs were discovered. In 1937, on the other hand, not a single iceberg was sighted during the repeated flights made over the area in connection with the establishment of the drift station Severnyy Polyus.

In the opinion of N. N. Zubov, the icebergs of 1943 were blown to the area from Severnaya Zemlya by the wind. In October of 1943, 3 kilometers to the northwest of Mys Molotov, a tabular berg was discovered with a length of 1,500 meters, width of 400 meters, and a height above the sea of about 10 meters.

In 1946, several grounded icebergs were found to the east of Ostrov Vrangelya, and in 1947 grounded icebergs were found to the west of the island. Up until that time no one had seen icebergs at Ostrov Vrangelya. It is indicated that these icebergs originated on the northwestern shore of Greenland.

According to data gathered from many years of observation, ice islands follow a complex and irregular orbit during their drift. Beginning in the area of Cape Columbia, they drift parallel to the coast of the Canadian Archipelago to Point Barrow, where they turn to the north and return in the direction of Cape Columbia, but in a higher latitude. Thus ice islands inscribe a clockwise orbit which follows the general water and ice circulation of the Arctic Basin. (Figure 1)

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In the Central Part of the Arctic Basin there are two basic ice drift systems. One is connected with the breaking out of ice from the Arctic Basin into the Greenland Sea. It is generated by the flow of shore waters, water from the Norwegian Sea driven by southwest winds, and the outflow of ice and water from the Arctic Basin into the Greenland Sea driven by northeast winds moving along the eastern shore of Greenland. The other drift is circular, moving in an anticyclonic direction. The center of the circular orbit is located near 82 N, 120 W. This drift is formed by winds generated by the regional high-pressure area over the Canadian Arctic Archipelago.

M. V. Lomonosov wrote on east-west ice drift in the Arctic Basin in 1763, and data from drifting ships have corroborated his opinions on the subject. Thus the ship Karluk in 1913-1914 drifted with the ice from near Point Barrow to Ostrov Vrangelya. In 1879-1881, the Jeanette drifted from Ostrov Vrangelya to Novosibirskiye Ostrova (New Siberian Islands). The Fram drifted from the Novosibirskiye Ostrova to the strait between Greenland and Spitsbergen in 1893-1896. The Maud drifted from Ostrov Vrangelya to Novosibirskiye Ostrova in 1922-1924. It is significant that the drift of the Maud almost duplicated the drift of the Jeanette, and the drift of the icebreaker SS G. Sedov (1937-1940) almost duplicated the drift of the Fram.

A continuous movement of ice from the east to west along the continental slope of the European-Asiatic mainland was also indicated by observations made during the sledge trips of Parry (1827) and Nansen (1895). Drift along the continental slope of America was observed by Stefansson (1913). This data is corroborated by observations made from shore posts and by Soviet expeditions. Thus, the ice drift is in one continuous line along the periphery of the Central Arctic Basin from 160 00 W to 0, enveloping all eastern longitudes.

It is known also that the ice lying to the north of "Peary separation" (running along the 84 30 N between Grant Land and the North Pole) flows into the Greenland Sea, and ice lying to the south of the "separation" is subjected to heavy pressure from the pack ice. Finally, the drift of Severnyy Polyus-1 shows that ice at the north pole drifts straight into the Greenland Sea.

The first indication of an anticyclonic ice drift to the north of Alaska was found by the Russian polar expedition of 1900-1903 under the direction of E. V. Toll'. This ice circulation was also shown in maps drawn by N. N. Zubov. (See N. N. Zubov, V Tsentr Arktiki (In the Central Arctic), Glavsevmorput', 1948.)

There have been other indications of this drift also. In April of 1950 at 76 10 N and 167 00 W the Soviet drift station Severnyy Polyus-2 was established. At the end of a year of operation, when the camp was located at 81 33 N and 162 01 W, the personnel were removed by plane but some tents and other materials were left. In the spring of 1954, the ice floe used by the station was again studied by Soviet scientists. It was located at 75 40 N and 176 05 W; i.e., almost the same area in which it was located when the station was established. Thus, in 4 years the ice had inscribed a closed orbit while moving on an anticyclonic circulation.

The drift of sea ice is ordinarily created by many factors, the most important being the wind. [Some of the findings of Nansen relating to wind effect on ice drift, etc., are discussed.]

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The drift of the G. Sedov was made at a time when the network of Soviet arctic meteorological stations had been established, so that accurate synoptic maps could be made during the drift. Analysis of this drift and comparison with atmospheric pressure charts prepared by the weather bureau allowed N. N. Zubov to state some general rules on ice drift. It is indicated that ice drifts along the isobars, and in the northern regions, the area of higher pressure lies to the right of the line of drift while the area of lower pressure lies to the left of the line of drift. The speed of the drift is proportionate to the pressure gradient; i.e., the speed of drift is in inverse proportion to the distance between isobars.

These basic rules are very useful in answering a number of questions relative to ice drift in the Arctic Basin.

Figure 2 appended shows the average winter isobars for the area and figure 3 appended shows the summer average. Arrows on the isobars of both maps show the theoretical ice drift according to isobars. The eastern orbit is clearly seen (anticyclonic) as well as the western drift from the Arctic Basin into the Greenland Sea.

It is interesting to note that the 1020 isobar (in winter) or 1015 isobar (in summer), which inscribes the anticyclonic drift of ice in the Pacific sector of the Arctic Ocean, crosses the shore line in the area between Greenland and Ellesmere Island. Since the ice is flowing along this isobar and the isobar intersects the land, it seems quite possible that this may explain the heavy concentrations of ice along the northern shore of Ellesmere Island. This explains also why the ice island T-1 ended its drift on the shore of Ellesmere Island at the end of 1951. Apparently T-2 is now also on the shore of Ellesmere Island. Island T-3 was close to Ellesmere on 5 May 1954, with coordinates of 84 35 N and 81 00 W.

The formulas and drift rules developed by N. N. Zubov are applicable only to ice fields of lesser thickness. Ice islands and icebergs with large underwater areas drift somewhat differently. The speed of ocean currents decreases with depth while the angle of deflection of the current as caused by the earth's rotation [Coriolis force] increases. Therefore, the deeper an ice formation sits in the water, the slower is its drift and the greater is it deflected from the wind direction. This explains why icebergs and ice islands drift differently from surrounding sea ice and why there are always large or small polynya around these bergs or ice islands.

Since icebergs and ice islands are deflected from the wind more than the ice fields, it follows that in regions of high atmospheric pressure they will move to the center of the system, while in areas of low pressure they will move to the periphery. Thus it may be seen why the three ice islands discovered in 1946-1950 were drifting in the anticyclonic drift, why they were drawn to it, and why they would leave it only under a combination of unusual circumstances.

Computation of general ice drift for a period of several years made by N. N. Zubov and M. M. Somov showed that barometric averages varied from season to season and year to year. As a result of these differences, individual icebergs, ice islands, or ice fields may transfer from one regional or ocean circulation to another.

No large ice islands now remain in the central part of the Arctic, but it is possible that in the near future another such formation will break off the fast ice of Ellesmere Island and begin its drift.(22)

Table 1. Distribution of Phosphorus

Depth (meters)	Phosphorus (mg/cu m), not corrected for impurities in reagent	Depth (meters)	Phosphorus (mg/cu m), not corrected for impurities in reagent
5	3.6	300	14.4
10	--	400	--
25	9.8	500	14.2
50	2.4	625	13.7
60	--	750	19.5
75	18.9	1000	19.8
100	20.2	1500	23.8
125	--	2000	13.5
150	10.0	2500	17.9
180	2.5	3000	20.5
200	--	3500	--
225	16.3	4000	15.9
250	--	4100	13.5

[Appended figures follow on next page.]

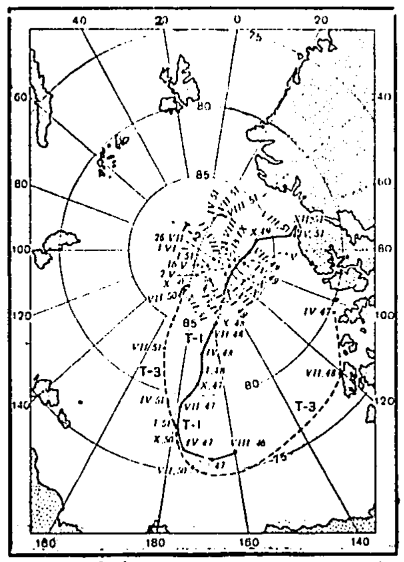

Figure 1. Drift of the Ice Islands T-1, T-2, T-3

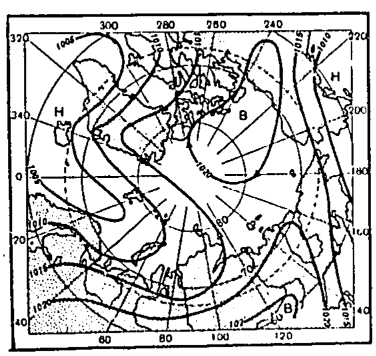

Figure 2. Mean Atmospheric Pressures, Winter (in millibars)

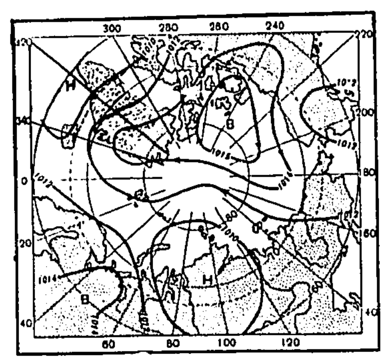

Figure 3. Mean Atmospheric Pressures, Summer (in millibars)

C-O-N-F-I-D-E-N-T-I-A-L

SOURCES

1. Moscow, Pravda, 6 Apr 55
2. Moscow, Ogonek, No 15, 10 Apr 55
3. Moscow, Vodnyy Transport, 12 Apr 55
4. Moscow, Izvestiya, 13 Mar 55
5. Vodnyy Transport, 22 Jan 55
6. Ibid., 7 Apr 55
7. Izvestiya, 1 Apr 55
8. Pravda, 20 Apr 55
9. Vodnyy Transport, 5 Apr 55
10. Izvestiya, 13 Jan 55
11. Kiev, Vechirniy Kiyev, 12 Mar 55
12. Petrozavodsk, Leninskoye Znamya, 9 Mar 55
13. Moscow, Novyy Mir, No 9, Sep 54
14. Moscow, Vechernyaya Moskva, 4 Jan 55 (Article by Akkuratov)
15. Izvestiya, 5 Mar 55
16. Moscow, Komsomol'skaya Pravda, 3 Oct 54
17. Moscow, Nauka i Zhizn', No 12, Dec 54
18. Vodnyy Transport, 1 Feb 55
19. Izvestiya, 12 Apr 55
20. Pravda, 18 Mar 55
21. Moscow, Vestnik Akademii Nauk SSSR, No 2, Feb 55 (Article by Gusev)
22. Moscow, Priroda, No 2, Feb 55 (Article by Prof N. N. Zubov)
23. Komsomol'skaya Pravda, 9 Jan 55