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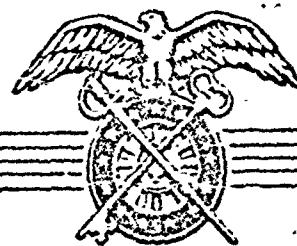
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Major General Andrew T. McNamara
The Quartermaster General
Washington 25, D. C.

Dear General McNamara:

This report, "Climatic Analogs of Fort Greely, Alaska, and Fort Churchill, Canada, in Eurasia", delimits, within the Eurasian continent, the land areas whose climates are similar to those of the two Department of the Army cold weather test sites.

It was determined that relatively large areas have climatic conditions analogous to those of the test sites when only single climatic elements are considered. Simultaneous consideration of several elements, such as summer and winter temperatures and annual precipitation, reduces the size of the areas climatically analogous to the test sites.

The results of this study provide a realistic basis for determining the representativeness of the climate of the test sites. The study will prove useful to test and design personnel in that it delimits areas where items tested in the climates of the test sites can be expected to operate satisfactorily. The report also indicates areas having a more extreme climate than that of the test sites, information that should be considered when designing equipment intended for use in extreme cold environments.

Sincerely yours,

C. G. Calloway
C. G. CALLOWAY
Major General, USA
Commanding

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ENVIRONMENTAL PROTECTION RESEARCH DIVISION

Technical Report
EP-77

CLIMATIC ANALOGS OF FORT GREELY, ALASKA, AND FORT CHURCHILL, CANADA,
IN EURASIA

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Meteorologist

REGIONAL ENVIRONMENTS RESEARCH BRANCH

Project Reference
7-83-01-005A

December 1957

Foreword

This report is one of a series designed to determine the extent of world areas having climates similar to those of the various Department of the Army test sites. The present study compares climatic conditions at Fort Greely, Alaska, and Fort Churchill, Canada with those of the Eurasian arctic and subarctic.

The series of climatic analog studies, prepared at the request of the U.S. Army Waterways Experiment Station, Corps of Engineers, Vicksburg, Mississippi, is part of a program for evaluating the suitability and representativeness of all Department of the Army test sites. They constitute the Quartermaster Corps contribution to the Corps of Engineers project on "Military Evaluation of Geographic Areas."

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Abstract

Climatic conditions at Fort Greely, Alaska, and Fort Churchill, Canada, are compared with the climates of arctic and subarctic regions in Eurasia. The climatic elements are treated in the discussion, and maps are included to present pictorially the distribution of analogous conditions.

The cold region around the "cold pole" of Siberia, in the vicinity of Verkhnyansk, is too cold for analogy to either test site. Mean temperatures for the coldest month are analogous to those of Fort Churchill in a relatively narrow band encircling this region. Coldest month temperatures analogous to those of Fort Greely, the warmer of the two test sites, are found in a second, outer band around the Siberian core region of extreme cold.

Only very limited areas are found where both temperature and windchill conditions are analogous. Areas analogous to Fort Greely are confined principally to northern and eastern Novaya Zemlya and to the coastal areas bordering the southern part of the Kara Sea. Windchill and temperature conditions analogous to those of Fort Churchill during the coldest month are best defined in the northern lowlands between the Ob and Yenisey Rivers and along the Arctic coast from the Yenisey to the Lena River.

Combined summer-winter temperatures and annual precipitation analogy to Fort Greely exists only in the northern part of the Central Russian Tableland and adjoining parts of the West Siberian Lowland. The northern part of the West Siberian Lowland and the Arctic Lowlands to the north receive annual precipitation amounts and have summer-winter temperatures analogous to those at Fort Churchill. Larger areas are indicated where annual precipitation combined with either summer or winter temperatures is analogous to the test sites.

CLIMATIC ANALOGS OF FORT GREELY, ALASKA, AND FORT CHURCHILL, CANADA, IN EURASIA

1. Introduction

This study was prepared in answer to a request from the Office, Chief of Engineers, for a climatic comparison of Fort Greely, Alaska, and Fort Churchill, Canada, Department of the Army cold-weather test sites, with other arctic and subarctic regions. The present study covers Eurasia north of latitude 45°N. (see Figure 1). A subsequent report will cover the arctic and subarctic areas of the Western Hemisphere.

Only those climatic elements that most adequately define stress factors in cold environments have been selected for study. For each selected element a map has been prepared depicting areas having conditions regarded as analogous to those at Fort Greely and Fort Churchill. Information from certain of these maps has been consolidated on a single composite map to show areas of coincidence of analogous elements.

Climatic conditions at Fort Greely and Fort Churchill have been summarized by the Environmental Protection Research Division, in the following publications:

Frequency and Duration of Low Temperature at Fort Churchill,
Manitoba, Canada, Technical Report EP-2(5)

Handbook of Fort Churchill Environment, Technical Report EP-4(8)

Handbook of Big Delta,* Alaska, Environment, Technical Report EP-5(7)

Data from these studies serve as the basis for comparison in this report.

2. Major Physical Features (Fig. 2)

The Eurasia study area consists of the Arctic and subarctic as defined by Washburn (16) and the adjoining areas lying north of 45°N latitude. According to Washburn's criteria, the Arctic consists of those areas north of the 50°F isotherm for the warmest month and where the mean temperature of the coldest month is 32°F or lower; subarctic lands consist of those areas where the mean temperature is higher than 50°F for not more than four months of the year and where the mean temperature of the coldest month is 32°F or lower. In order to include most of the area of the continents having a summer analogy of one or more climatic elements, the study area was extended southward to 45°N latitude. Thus it includes Scandinavia and central Europe, most of the

*Renamed Fort Greely in August, 1955.

USSR and arctic islands off its coast, and a large part of Outer Mongolia and Manchuria.

In Europe, most of the study area lies below 1,000 feet in elevation. The central plains of Europe extend eastward from the Paris Basin as the Baltic Plain, eventually joining the Central Russian Tableland. In the south, the European plains are bordered by the Alps, the highest mountain chain in Europe, with many peaks exceeding 10,000 feet. This system extends from southern France into southeastern Austria. Farther east, the Alps join a smaller mountain system that includes the Transylvanian Alps and the Carpathian Mountains. This system has heights considerably lower than the main ridge of the European Alps.

In the north, the principal highland areas are the Norwegian Highlands which form the "backbone" of the Scandinavian Peninsula. This mountain system is oriented in a southwest-northeast direction, and its highest peaks, located on the west coast, rarely exceed 7,000 feet.

The USSR, a major part of the study area, consists essentially of a large lowland north of the east-west mountain and plateau belt which extends across the continent. European Russia is predominantly a low rolling plain with an average elevation of less than 600 feet and maximum elevations which do not usually exceed 1,500 feet. In the southeast, this plain merges into the Caspian Depression which contains the lowest land areas of the Soviet Union. The Ural Mountains, averaging 1,600 feet in elevation, border the Central Russian Tableland on the east and separate it from the vast flat areas of the West Siberian Lowland. The Urals extend approximately north-south from the Arctic seacoast to the southern steppes. In the north, elevations range from about 2,000 to slightly less than 6,200 feet, the highest peak, Mt. Narodnaia, reaching an elevation of 6,183 feet. The middle Urals are generally lower than those in the north or south, and have been described as little more than hills. It is here that most rail lines and roads cross the mountains. In the southern Urals, elevations increase again, and the highest mountain, Yaran-Tau, has an elevation of 5,375 feet.

East of the Urals, the West Siberian Lowlands extend into eastern Siberia above 70°N latitude. About 90 percent of western Siberia consists of gently sloping plain, stretching from the Urals to the Yenisey River in the east and from the Arctic to the Altai Mountain system in the southeast. The highest portion of the Altai system has average elevations ranging from 11,400 to 15,000 feet. This mountain system is the source of the Ob and Irtysh Rivers, the principal streams of the West Siberian Plain.

From the Yenisey River east to the Pacific Ocean lies a region of plateaus and mountains. The Central Siberian Plateau, lying between the Yenisey and Lena Rivers, occupies the greater portion of eastern Siberia. The average elevation of this plateau is below 1500 feet, but occasional heights of 3,000 feet are found near the center. To the south, the Central Siberian Plateau is bordered by the Sayan-Baykal and the Transbaykal Mountain systems and the Stanovoy Range, which comprise

the major part of the Central Asiatic Mook Mountains. The highest peak, Mt Ku-Sarlyk in the Sayan Mountains, reaches 12,500 feet.

In Northeastern Siberia, the Verkhoyansk Range and the East Siberian Highlands enclose lowlands which open north to the Arctic Ocean. Other mountain ranges extend along Sakhalin Island (north of Japan) and the Kamchatka Peninsula.

The Amur Region, in the extreme southeast of the USSR, lies between the Stanovoy range in the north and the Amur River to the south, and extends to the Duroya range in the east. The area is a plateau, which slopes southward to the Amur River. The Sikhotin-Alin mountains, with some peaks reaching nearly 13,000 feet, extend along the coast south of the Amur River.

3. Climate

The climates in the study area are controlled by the extent and topography of the land masses, the distribution of adjacent cold or warm water currents, the seasonal pressure distribution, and the seasonal and areal variation in solar radiation.

In western Europe, maritime air masses dominate the weather most of the year. The climate is mild, due to maritime exposure and the absence of a north-south mountain barrier which permit relatively warm and moist air masses from the Atlantic Ocean to penetrate far inland. The warm areas to the south are separated from the cooler northern areas by the east-west mountain chains of southern Europe. Inland, the marine influence is less pronounced, and central Europe may be considered a broad transitional zone between the mild maritime climate to the west and the continental type to the east. In Scandinavia, this zone of maritime influence is narrow. The climate of the coast of Norway is mild, due to the proximity of the warm North Atlantic drift (Gulf Stream), but the coastal mountains of Norway serve as a barrier restricting the penetration of warm air inland for any great distance. As a consequence, away from the coast, temperatures fall rapidly, resulting in a much more severe climate in eastern Norway and Sweden.

The climate of eastern Europe and European Russia is dominated in winter by the circulation associated with the semi-permanent high pressure area over the continent, and in summer by a thermal low caused by solar heating. The climate is not as severe as that of Siberia because of the incursion of modified maritime air masses into the area. East of the Yenisey River this westerly oceanic influence is negligible.

The climate of Siberia is influenced by the vast land mass of Eurasia and by the ring of high mountains and plateaus to the south and east that prevent the invasion of moist, warm, moderating air masses. Arctic and polar air masses penetrate deeply into the interior because

there is no east-west terrain barrier to the north. Relatively clear skies and the absence of moist air and strong winds present ideal conditions for radiational cooling. As a consequence, the interior of Siberia has one of the world's most continental climates, characterized by extremely cold winters.

The influence of the Pacific Ocean is confined to a narrow coastal strip south of the mouth of the Amur River and to the extreme northeastern part of Siberia. In winter, the coastal regions bordering the Arctic Ocean are warmer than the interior because of proximity to a large body of water which, even though frozen, is warmer than the interior of the continent.

4. Analysis of Climatic Elements

The climatic elements for which maps have been prepared are those which impose stress on men and equipment in a cold environment, or are significant when comparing climates in the Arctic and subarctic. The series (see end of the report) includes maps of the mean and mean daily minimum temperatures for the coldest month; absolute minimum temperatures; mean and mean-daily maximum temperatures for the warmest month; absolute maximum temperatures; mean annual precipitation; mean snow depth for the month of maximum depth; mean windchill for the coldest month; mean cloudiness for the coldest and warmest months, and mean annual frequency of fog.

On all maps, colored overprints are used to indicate areas closely analogous to Fort Churchill (blue) and Fort Greely (yellow). Semi-analogy is indicated by symbols in the station circles.

All stations utilized in the analysis are shown on the station location map (Fig. 1). On individual maps, only those stations are indicated from which data were utilized in the analysis of that particular map. The distribution of stations varies, depending on the availability of data for the climatic element being analyzed. Since data are sparse or lacking for large portions of the region, the delimitations of analogous conditions in these areas must be regarded as approximate. In the analysis of the maps, mountain areas were considered, but no attempt was made to allow for the more intricate complexities introduced by them. The maps are intended to provide only a generalized picture of analogous and semianalogous areas based on the distribution of the more important climatic elements.

a. Mean Temperature, Coldest Month (Fig. 3)

Fort Greely: -5°F., January

Fort Churchill: -19°F., January

The standard deviation of the monthly mean temperatures was considered in determining the range for mean temperature analogy⁽¹⁾. It was decided to use a range of mean temperatures within which the average

Temperature of a single January could be expected to occur in half the years. For Fort Churchill, which has a standard deviation of 7° for the January mean, a range of plus or minus 4.9° from the long-term January mean results in the desired expectancy of 50 percent. For Fort Greely, which has a standard deviation of about 9° , the range resulting in an expectancy of 50 percent equals plus or minus 6.5° from the long-term mean. It was decided that a 5° range on either side of the long-term mean, as used in previous studies of other environments, would be a sufficiently close approximation of these values.

In the discussion of climate it was shown that there is a gradual change in climate from west to east. This fact is well indicated by the positions of the analogous areas in Figure 3. Perhaps the most striking feature of the map is the large portion of central and eastern Siberia, in which mean temperatures are much lower than those at either test site.

The area analogous to Fort Churchill, the colder of the two test sites, encircles the central cold region in a relatively narrow band. It includes those portions of the Arctic coast having the greatest exposure to the warming effect of the ocean. The area broadens slightly in the west to include most of the West Siberian Lowland lying north of about 62° N. latitude and east of the Ob River. The influence of the Pacific Ocean and Okhotsk Sea does not extend far inland, as is evidenced by the narrowness of the analogous area along the east coast.

The area analogous to Fort Greely lies in another band encircling the area analogous to Fort Churchill and separated from it by a narrow band in which temperatures are semianalogous to those of both test sites. The analogous area includes Franz Josef Land and Novaya Zemlya in the Arctic Ocean, but excludes most of the Arctic coast. The total land area in the study region analogous to Fort Greely is about twice as large as that analogous to Fort Churchill.

b. Mean Daily Minimum Temperature, Coldest Month (Fig. 4)

Fort Greely: -13° F., January

Fort Churchill: -27° F., January

Areas having mean daily minimum temperature with a range of plus or minus 5° from the mean values are considered analogous, and are designated by the colored shading on the map. Areas with analogous mean daily minimum temperatures approximate closely those with analogous mean temperatures of the coldest month (Fig. 3). For the greater part of the region, lowest minimum temperatures occur in January. Near the coasts, temperatures fall less rapidly through fall and early winter, due to retention of heat by the water and conduction through the ice. As a result, lowest mean daily minimum temperatures do not occur until February or even March at coastal locations.

Much of the interior of Siberia experiences temperatures considerably lower than those at either Fort Churchill or Fort Greely. Cold air accumulates over the interior, due to nocturnal (radiational) cooling during long, clear arctic nights. Extremely low temperatures are common in winter, especially in valleys and lowlands.

Many of the arctic coastal stations in the area analogous to Fort Churchill have mean daily minimum temperatures within 2°F of the Fort Churchill value. Temperatures decrease rapidly in the nonanalogous areas with increasing distance from the Arctic Ocean and its moderating influence.

c. Absolute Minimum Temperature (Fig. 5)

Fort Greely: -65°F ., January
Fort Churchill: -57°F ., January

Figure 5 shows the lowest temperatures reported for stations in the study area. Where available, lengths of record are indicated by subscripts to the temperature values. Use of short period records was confined to a minimum when analyzing the data, since lower values for absolute minimum temperatures are likely to occur with a longer record.

The analogous areas, based on a plus or minus 5°F temperature range, surround a large part of interior Siberia which has absolute temperatures much lower than those of either test site. In this region, temperature inversions and air drainage down mountain slopes are common. On cloudless nights that are free of wind, valley temperatures are much lower than those of adjacent mountains. Verkhoyansk and Oymyakon, near the "cold pole" of the Eastern Hemisphere, had the world's lowest official absolute minimum temperature, -90°F ., until the record was broken in the Antarctic in 1957 (-102.1 , South Pole). Other lowland stations in the region have absolute minimum temperatures between -70°F and -84°F .

The area analogous to Fort Churchill extends west over the northern part of the Ural Mountains into European Russia, and a second, smaller analogous area is centered over the interior of northern Finland. Low temperatures in European Russia are usually the result of the extension of a high pressure area over western Siberia. Nighttime radiational cooling often intensifies the actual temperature drop so that extreme low temperatures occur some time after the invasion of a cold air mass.

d. Mean Windchill, Coldest Month (Fig. 6)

Fort Greely: $1,630 \text{ Kg. Cal/m}^2/\text{hr.}$, January
Fort Churchill: $1,820 \text{ Kg. Cal/m}^2/\text{hr.}$, January

Windchill is a measure of the cooling effect of air movement on the human body. In this study, its computation is based on an empirical formula determined by Siple and Passel (38) from experiments

conducted in the Antarctic in 1940. The following formula is used to compute the cooling effect H , of wind speed V (meters per second) and temperature t (Centigrade) in kilogram calories per square meter of exposed skin surface per hour per Centigrade degree of temperature difference between the skin surface and the air:

$$H = (\sqrt{100V} + 10.45 - V) (33 - t)$$

The formula applies best to simultaneous conditions of wind and temperature, and use of average conditions in computing values gives slightly different results (Court (4), Falkowski (9)). However, these values are considered sufficiently representative to afford a qualitative measure of the relative severity of combinations of wind and low temperatures in the study area.

Mean windchill values for the test sites and stations in the study area were taken from the "Windchill Nomogram", prepared in 1943 by scientists of the Office of The Quartermaster General. Part of this nomogram is reproduced as an insert on Figure 6.

Ranges of analogy for the windchill factor were determined by the ranges of temperature and wind speed analogy. The mean wind speed at Fort Greely in January is 17 mph. Wind speeds in the range from 15 to 19 mph were considered analogous. These values for mean wind speed occurring within the range of mean temperature analogy (0° to -10°F) result in windchill values of from 1,500 to 1,760 kilogram calories per square meter per hour (see nomogram insert in Fig. 6). At Fort Churchill, the mean wind speed for the coldest month is 15 mph, and wind speeds from 13 to 17 mph were considered analogous. Close analogy of windchill includes values from 1,690 through 1,950 kilogram calories per square meter per hour. Values plotted beside the station symbols on the windchill map indicate the windchill as numerator and the wind speed as denominator. The mapped areas of analogy are based only on the windchill factor.

Owing to lesser wind speeds, windchill in most of the Siberian interior is less extreme than at Fort Churchill or Fort Greely, even though winter temperatures are much lower. Windchill is greatest on the Arctic coast of Siberia. This area has windchill factors closely analogous to those of Fort Churchill. Windchill factors closely analogous to that of Fort Greely are found in a comparatively large area north of the 62° parallel in Siberia and along a coastal strip bordering the Okhotsk Sea.

c. Mean Cloudiness, Coldest Month. (Fig. 7)

Fort Greely: 5.5 tenths of sky covered, January

Fort Churchill: 4.7 tenths of sky covered, January

Europe has marked cloudiness in the coldest month and a larger mean value than either Fort Greely or Fort Churchill. This cloudiness is associated with low pressure and frontal system activity in

western Europe. Cloudiness decreases eastward due to the blocking effects of the winter anticyclone and to the modification of air masses as they move across the continent. In most of Siberia, cloudiness is at a minimum in winter and more analogous to the test sites, due to the very dry air masses associated with the winter continental anticyclone.

Cloud amounts closely analogous to those at Fort Greely (4.6 to 6.5 tenths) occur in the Alps and the Scandinavian Peninsula in Europe, and in large areas of central and northeastern Siberia. Areas with cloud amounts closely analogous to that of Fort Churchill (3.8 to 5.7 tenths) are smaller and for the most part are in northeast Siberia and in a band extending over the Central Asiatic Block Mountains into central Siberia.

f. Mean Snow Depth, Month of Greatest Depth (Fig. 8)

Fort Greely: 17.0 inches, February

Fort Churchill: 25.1 inches, March

Snow depths plotted on Figure 8 are mean monthly depths for the month of maximum accumulation. The map presents only a generalized picture of the distribution of snow cover, since snow tends to be deposited in an extremely irregular manner. Snow depths are influenced greatly by local climatic conditions, topography, and vegetation. The distribution of snow depths in mountains is especially complicated, depending greatly on height, exposure, and nature of summits and slopes. In areas dominated by strong winds, exposed places are usually blown free of snow, which accumulates in appreciable amounts in depressions and forests. Where winds are not very strong, snow accumulates in a more or less even layer.

In Eurasia, snow depths are greatest on the western slopes of the Central Siberian Plateau and adjacent areas in the eastern part of the West Siberian Lowland in the vicinity of the Yenisey River. Depths decrease away from this central core, but secondary increases are noted on the western slopes of the Ural Mountains and in the far eastern areas of Kamchatka, Sakhalin, and the lower Amur.

Areas with snow depths closely analogous to that of Fort Churchill (20.0 to 30.0 inches) surround the central core area of deeper snow in a rather wide band, and extend over northern European Russia into Finland. Other analogous areas are located in Sakhalin Island, the lower Amur region, and a narrow strip extending from the Okhotsk Sea to the Bering Sea. Snow depths decrease both north and south from these areas and become analogous to those of Fort Greely (12.0 to 22.0 inches). Most of the northern coast, from the Kola Peninsula to the Yenisey River and from the Kolyma River to the Bering Straits, is analogous to Fort Greely, as is a fairly wide belt across middle Asia.

Snow storms occur most frequently in the tundra and steppe

regions. They are particularly violent, often : aching blizzard proportions. In the European portion of the USSR, with the exception of the extreme north, the maximum number of snowstorms occurs in January. February and December have the next greatest number of storms.

C. Mean Temperature, Warmest Month (Fig. 9)

Fort Greely: 50°F, July

Fort Churchill: 51°F, July

There is a significant increase in the amount and intensity of solar radiation received over the continent in summer compared with winter. The surface of the earth, and the air in contact with it, are warmed considerably by long hours of sunlight, particularly in the northern areas. The heating of the huge land mass produces a weak thermal low pressure area which dominates most of the continent of Asia and produces weak north and northwest winds over European Russia.

The temperature distribution over the continent in summer is approximately latitudinal. This distribution varies only on the coasts bordering the Arctic Ocean, on the Scandinavian Peninsula, on Kamchatka Peninsula, on Sakhalin and Kurile Islands where maritime air from the Pacific exerts its influence, and in mountain areas where the varying topography is a controlling influence. Large inland bodies of water, such as Lake Baykal, also have a local effect on temperatures, producing cooler summer weather in their immediate vicinity.

The area having mean temperatures of the warmest month closely analogous to Fort Churchill's (49°F to 59°F) is very narrow, but stretches the entire breadth of the continent from the Atlantic to the Bering Sea. The southern limit of this area in Europe and the USSR follows approximately the 60th parallel of latitude except for a few, more southern extensions, that include practically all of Norway, most of Sweden, Kamchatka, and the coasts bordering the Okhotsk Sea. The area extends northward from this latitude to include all but a relatively narrow strip along the northern coasts where the cold arctic waters exert their influence. Another area of close analogy exists adjacent to and southwest of Lake Baykal, where higher elevations contribute to temperatures that are cooler than are characteristic of that latitude.

Temperatures analogous to those of Fort Greely (51°F to 61°F) lie within an area larger than the area closely analogous to Fort Churchill. A considerable overlap of areas analogous to both test sites occurs in the north. In Europe, the area closely analogous to Fort Greely extends from the Scandinavian Peninsula, almost all of which is analogous, into the Paris Basin. Much of northern European Russia is closely analogous, the area reaching across the northern part of the continent to eastern Siberia, where it again extends southward and includes much of the coast bordering on the Okhotsk Sea. Temperatures analogous to those at Fort Greely are also found near Lake Baykal, overlapping and surrounding the area delimited as closely analogous to Fort Churchill.

h. Mean Daily Maximum Temperature, Warmest Month (Fig. 10)

Fort Greely: 69°F., July
Fort Churchill: 64°F., July

In the USSR, daily maximum temperatures are not generally observed, and the 1300 LST observation is ordinarily considered the afternoon maximum. In summer, however, the 1300 LST observation can be several degrees lower than the maximum temperature. In winter, because of the relatively small diurnal variation, the difference between the 1300 LST observation and the mean daily maximum usually is smaller.

In order to arrive at a more representative value, an approximate mean daily maximum temperature was obtained, for stations lacking this value, by subtracting the mean daily minimum temperature (computed from observed values) from twice the mean temperature at each station for which both values are available. Some error exists in this method, since it assumes the mean to be an average of the means of the extremes, whereas the mean temperatures at these stations are actually an average of three daily observations. The error, however, is considered to be negligible for this type of analysis, and the method allows a more realistic comparison of mean daily maxima.

The areas closely analogous to each test site correspond generally to those of the mean temperature for the warmest month. The influence of the cold arctic seas is exhibited along the entire north coast where temperatures are too cool for close analogy with either test site. Summer heating in the continental interior limits the southern boundary of the area analogous to Fort Greely at about 60°N latitude in most of the USSR. In Europe, however, this southern limit is located at about 50°N latitude, owing to the influence of cooler maritime air from the Atlantic.

1. Absolute Maximum Temperature

Fort Greely: 90°F., May
Fort Churchill: 96°F., July

Since maximum temperatures in summer are not considered a critical factor in arctic and subarctic operations, no map was prepared for this element. Examination of data for the study area indicates that, in general, absolute temperatures between 85°F and 100°F can be expected in interior areas (Table VI).

The northern coasts from Norway to the Bering Sea, and the coasts bordering the Pacific Ocean, are influenced by their proximity to cold water and therefore do not experience the extreme temperatures typical of the interior. Maximum temperatures along the Arctic coast from the Kara Sea east to the Bering Strait range from 65°F to 75°F. Inland from the coasts, maximum temperatures increase rapidly. On Kamchatka Peninsula and along the coasts bordering the Okhotsk Sea, maximum

temperatures range from 75°F to 85°F.

J. Mean Cloudiness, Warmest Month (Fig. 11)

Fort Greely: 6.4 tenths of sky covered, July

Fort Churchill: 6.4 tenths of sky covered, July

A large part of the study area is analogous in mean cloudiness to both sites. The Paris Basin and the Baltic Plain, central and northern parts of the Scandinavian Peninsula and Finland, and the northern part of the Central Russian Tableland are closely analogous. In Europe, summer cloudiness is caused by convective clouds which are not so persistent as the stratus and stratocumulus clouds of winter. Mean cloudiness in Europe, therefore, is less in summer than in winter. Siberia has a cloudiness maximum in summer. The Siberian summer maximum is also due to convective type clouds; winter skies are usually clear. Virtually all of Siberia is analogous except for the Arctic coast, Kamchatka Peninsula, and coasts bordering the Bering Sea. In these sections, cloudiness is greater than that of the test sites, but is within the semianalogous range. Mean cloudiness in the Kazakh Upland and the southern part of the West Siberian Lowland is less than at the test sites.

K. Mean Annual Precipitation (Fig. 12)

Fort Greely: 11.4 inches

Fort Churchill: 14.4 inches

In winter, northwest Europe is influenced by comparatively warm, moist maritime air coming from the southwest. Precipitation usually results from either frontal or orographic lifting. Low clouds and drizzle occur frequently. Precipitation amounts are evenly distributed throughout the year, and there is no pronounced dry season. In summer, precipitation is of the convective, air mass type, although weak fronts infrequently contribute by releasing the convective instability over interior regions. Coastal regions exposed to the prevailing on-shore circulation receive greater amounts of precipitation than the interior. Eastern Norway, Sweden, and Finland, sheltered by the Norwegian Mountains to the west, receive less precipitation than western Norway. Mean annual precipitation amounts closely analogous to those at Fort Churchill (11.4 to 17.4 inches) are received in northern interior Sweden, extreme northern Finland, and on the Kola Peninsula. Smaller areas, analogous to Fort Greely (8.4 to 14.4 inches) are found in northern Finland (near Karesuando and Karasjok), and on the east coast of the Kola Peninsula in the vicinity of Murmansk.

Central Europe is under the influence of both maritime air from the Atlantic and continental air from the interior of the vast Eurasian land mass. Precipitation decreases from west to east as the distance from the ocean increases. Summer is the season of maximum precipitation, which is predominantly of the shower type, produced mainly

by continental heating of unstable air. Precipitation in all of central Europe is too great for analogy to either test site.

In most of the USSR the continental-type summer rainfall regime also predominates. A summer maximum of precipitation prevails as the result of convective showers or weak frontal activity. In winter, cold, dry air masses dominate the interior of the continent, and only small amounts of precipitation are received. Annual precipitation is greatest in European Russia and western Siberia, decreasing toward the northern coasts and the southern deserts. In western Siberia, the area analogous to Fort Greely is divided by a central core having greater precipitation. This area is semianalogous to Fort Greely, but, with the exception of the most central part, is closely analogous to Fort Churchill. The Arctic coast bordering the Kara Sea is drier than Fort Churchill but is semianalogous to Fort Greely.

All of the Central Siberian Plateau is analogous to Fort Greely. In the south, precipitation increases slightly in the Central Asiatic Block, and conditions become closely analogous to both test sites.

Northeastern Siberia is a region of little precipitation. Most of the stations within the region receive only 3 to 8 inches per year. On the east coast, low pressure systems produce more precipitation than is received in the interior, and as a result the coast from the Okhotsk Sea north to the Bering Strait is analogous to Fort Greely. Precipitation on Kamchatka Peninsula increases from north to south. A band across the center of the peninsula has precipitation closely analogous to that of Fort Churchill, and the northern portion receives amounts closely analogous to that of Fort Greely.

1. Atmospheric Humidity

At low temperatures the actual amount of water vapor in the atmosphere is extremely small, due to a much reduced moisture capacity of extremely cold air. As a consequence, the cold winter air masses of the Arctic and subarctic are extremely dry. Relative humidities, on the other hand, are usually high. In winter, relative humidities range between 75 and 100 percent throughout most of the study area. In summer, although relative humidities are slightly lower, the actual water vapor present in the atmosphere is greatly increased due to the capacity of the atmosphere to hold more water vapor at higher temperatures and due to the availability of moisture from the many lakes and swamps.

For all practical purposes, humidity and moisture conditions at the test sites may be considered comparable to those in areas of the arctic and subarctic regions wherever mean daily temperature analogy exists.

Mean relative humidities for selected stations are presented

in tabular form in Table XII.

m. Fog (Fig. 12a)

In the Fort Greely area, as in most of the Yukon Valley, fogs are most frequent during the colder months, December through February. At this time of the year, radiation fogs form under a surface temperature inversion, and ice fogs form near cities and camps.

Radiation fogs are caused by a rapid fall in temperature when the air comes in contact with the ground or snow surface cooled through long-wave terrestrial radiation. Such fogs are common in the principal interior river valleys in Siberia and North America, and, as at Fort Greely, are usually shallow and of low density. At Fairbanks, Alaska, the months from December through February average between 4 and 5 days with light to dense fog.

During winter, burning of fuels in towns and camps supplies an abundance of condensation nuclei upon which sublimation of moisture in the form of ice crystals takes place. This results in the formation of ice fog. Langmuir and Schaefer (19) point out, however, that most sources of smoke are also sources of moisture, and that the fog might be due entirely to the additional moisture which accompanies the smoke. Horizontal visibilities during periods of ice fog may be reduced considerably in the fog layers, which vary from 50 to 500 feet in thickness. They occur in most interior areas subject to extremely low temperatures, and may occur even at coastal stations when under the influence of weather conditions favorable for fog formation. This type of fog is rare with temperatures above -20°F and with wind speeds in excess of 3 mph. V. J. Oliver and M. B. Oliver (27) have found that ice fog is not very likely to occur with temperatures between -20°F and -40°F but at temperatures colder than -40°F , ice fog will probably occur, and with temperatures colder than -50°F , ice fog is inevitable.

Ice fog frequencies at the test sites and in the study area reach their maximum during the cold months because of the requirement for extremely low temperatures for its formation. At Fort Churchill, ice fog occurs most frequently (108 hours) in February. Statistics available for Fort Greely for an 8-year period of record indicate that ice fog is most prevalent during December, January, and February, which have an average total of 115 hours of this type of fog.

Fort Churchill experiences its foggiest period from June through August; about 2 to 4 days during each month have dense fog. These fogs, which do not extend more than 20 miles inland, result from relatively warm moist air moving over the cold water of Hudson Bay. Over a large portion of the Siberian coast from the Kara Sea to Chukchi Sea, similar fogs may be expected up to 90 or more days each year.

Figure 12a shows the mean number of days with fog at stations in the study area. Data plotted at each station indicate the mean annual number of days and the average occurrence in the coldest, warmest,

and foggiest months. Areas with 10 or less and 60 or more days per year with fog are delimited by color. These areas should be regarded as only approximate, since the reported data are not based on standardized definitions of fog and differing methods of observing and reporting fog are used. For these reasons, and because fog in many cases is governed strongly by local influences, no attempt was made to delimit areas with fog conditions analogous to those of the test sites.

5. Analysis of Composite Maps

a. Composite Analogous Areas, Coldest Month (Fig. 13)

Temperature and windchill are two factors contributing to great environmental stress in the study area in the winter. In constructing this map, areas where analogous mean temperatures and mean daily minimum temperatures coincided were first outlined to indicate analogous coldest month temperature conditions. Areas with analogous mean minimum temperature in the coldest month are, in general, similar to those indicated for the mean temperature, coldest month, and therefore the composite of the two elements does not differ greatly from either one. Areas where analogous windchill conditions overlapped analogous temperature conditions were then delineated. Areas with analogous snow depth during the month of greatest depth were superimposed on the areas previously delimited, since depth of snow adds to climatic stress, especially in the use of certain items of equipment and in the movement of soldiers. Although in most cases the months of deepest snow and lowest temperature are not identical, it was felt, nevertheless, that the addition of snow depth data on this map provides essential information.

Areas where both temperature and windchill conditions are analogous to those of Fort Greely are extremely limited. These areas are confined principally to northern and eastern Novaya Zemlya and to the areas bordering the southern part of the Kara Sea in the vicinity of Amerma, Kara Guba, and Mare Sale; another small area is found in north-eastern Chukchi peninsula.

Windchill and temperature conditions analogous to those of Fort Churchill are found in the northern lowlands between the Ob and Yenisey Rivers, and in an area extending northeastward along the Arctic coast to the Lena River. A smaller area occurs in northeastern Siberia in the vicinity of Mys Billingsa.

b. Composite Analogous Areas, Fort Greely (Fig. 14)

This and the following composite map (Fig. 15) each synthesize for a single test site, analogous areas of annual temperature and precipitation, the parameters regarded as most important in determining total environmental analogy. Areas of winter temperature analogy are those previously delimited in Figure 13. The procedure outlined for obtaining these areas was also used in determining summer

temperature analogy; that is, areas of analogous mean temperatures for the warmest month were combined with areas of analogous mean maximum temperature for the warmest month, and coincident areas delimited. Areas which did not show analogy on both mean and mean extreme maps for the season were excluded from the composite map. Areas of summer temperature analogy are indicated in yellow and those of winter temperature analogy in blue. The overlap of the warmest and coldest month areas is a composite area where temperature conditions are analogous in both of the extreme seasons. Areas where mean annual precipitation is analogous to that of Fort Greely were then superimposed and delimited where they overlapped areas of temperature analogy.

Three areas of analogous winter-summer temperature conditions are depicted. The first is located in the northeastern Central Russian Tableland and the northwestern sector of the West Siberian Lowland, extending southeast from the northern limit of forests to about 60° N latitude. Another area of analogous temperatures is located in northern and central Kamchatka Peninsula and in the area around the Gulf of Shelikhova. The third area extends over northern Sakhalin Island and a small area east of the Amur River.

When areas of analogous precipitation are superimposed, only the northeastern part of the central Russian Tableland- West Siberian Lowland region and the northwestern portion of the Kamchatka Peninsula remain analogous.

Larger analogous areas occur when annual precipitation is considered with either summer or winter temperature. Summer temperatures and annual precipitation in the northern portion of the West Siberian Lowland and the Central Siberian Plateau are analogous to those of Fort Greely, and smaller areas appear between the East Siberian Highlands and the Koryak Mountains, and in the extreme eastern part of the Aldan Plateau. Winter temperature and annual precipitation analogy is found in the southern part of the West Siberian Lowland, over the western Central Asiatic Block Mountains, in the Lake Baykal region, on the Chuckchi Peninsula, and in a coastal strip bordering the Bering Sea.

c. Composite Analogous Areas, Fort Churchill (Fig. 15)

This map was prepared to show areas of composite analogy to Fort Churchill, for the same elements as were used in the preceding map of composite Fort Greely analogy.

Combined winter-summer temperature analogy to Fort Churchill exists in the northern West Siberian Lowland and in the Arctic Lowlands to the north. Central Siberia is too cold for analogy in winter, although a summer temperature analogy occurs in the northern portion. Additional areas of winter-summer temperature analogy are located in the lower elevations of the east slopes of the East Siberian Highlands and the Verkhoyansk Range.

The principal areas of summer temperature and annual precipitation analogy are located in northern European Russia, extending across the Kola Peninsula into the Swedish Uplands and on Kamchatka Peninsula. Winter temperatures and annual precipitation are analogous in a discontinuous strip along the Nizhnyaya Tunguska River through the Central Siberian Plateau and extend into the Mongolian Plateau in the East.

Composite winter-summer temperature and annual precipitation analogy is confined to two rather small areas in the West Siberian Lowland and a third in the extreme eastern part of the Aldan Plateau. Thus the principal area of triple analogy for Fort Churchill lies east of the Ob, while for Fort Greely the principal area lies west of the Ob.

6. Tables of Monthly Climate Averages for Selected Stations

Tables I through XIII list the monthly values of climatic elements for 27 stations in Eurasia. These stations were selected as representative of climatic conditions of various parts of the study area. Station names are listed in Table I, with geographic coordinates and elevation above mean sea level. No stations are included for the Central Siberian Plateau, due to scarcity and unreliability of available data. In each table, mean values for Fort Greely and Fort Churchill are also shown for comparison. The elements for which tables are prepared are those used in the map series, and tables of absolute maximum temperature, relative humidity, and frequency of fog have been added. Regions represented by the stations can be determined from the map of Major Physical Features (Fig. 2).

These tables supplement the seasonal maps by giving a picture of the climatic regime throughout the year.

TABLE I: LOCATION AND ELEVATION OF STATIONS

Station	Elevation (Feet)	Latitude (°) (')		Longitude (°) (')	
Arkhangelsk, USSR	20	64	28 N	40	31 E
Barnaul, USSR	535	53	20 N	83	17 E
Berezovo, USSR	138	63	56 N	65	04 E
Borno, Norway	16	65	28 N	12	12 E
Borzya, USSR	2243	50	24 N	116	29 E
Budapest, Hungary	426	47	31 N	19	01 E
Dikson O., USSR	66	73	30 N	80	23 E
PORT CHURCHILL, CANADA	115	58	47 N	94	17 W
PORT GREELY, ALASKA	1274	64	00 N	145	14 W
Gizhiga, USSR	33	62	02 N	160	40 E
Helsinki, Finland	39	60	10 N	24	57 E
Igarka, USSR	115	67	32 N	86	50 E
Irkutsk, USSR	1532	52	16 N	104	19 E
Katochkin Shar, USSR	61	73	16 N	56	24 E
Moskva, USSR	528	55	47 N	37	38 E
Mys Chelyuskin, USSR	20	77	43 N	104	17 E
Nikolaevsk, USSR	108	53	08 N	140	45 E
Okhotsk, USSR	20	59	21 N	143	17 E
Paris, France	164	48	48 N	2	30 E
Petropavlovsk, USSR	286	52	53 N	158	43 E
Rostov, USSR	157	47	13 N	39	1 E
Sararovo, USSR	314	60	58 N	69	04 E
Sredne Kolymsk, USSR	98	67	10 N	157	10 E
Tiksi, USSR	23	71	35 N	128	55 E
Uralsk, USSR	124	51	12 N	51	22 E
Verkhoyansk, USSR	400	67	33 N	123	24 E
Vilyusk, USSR	394	63	45 N	121	35 E
Wrangelya O., USSR	10	70	58 N	181	27 E
Warszawa, Poland	361	52	12 N	21	00 E

Table II: MEAN TEMPERATURE (°F)

Station	Yrs. Rec.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Arkhangelsk	35	8	10	17	30	41	53	60	55	46	34	21	12	32
Barnaul	33	-1	2	15	34	52	64	68	63	52	36	17	5	34
Berezevo	M	-2	-2	9	24	37	52	61	56	44	27	8	-3	25
Borno	60	32	31	32	38	44	50	55	54	50	42	36	32	41
Borzya	15	-12	-11	6	32	48	62	67	62	50	30	5	-12	27
Budapest	30	31	34	43	52	62	68	71	69	61	52	41	35	52
Dikson O.	M	-14	-12	-11	0	17	32	40	41	35	20	1	-10	12
PORT CHURCHILL	19	-12	-17	-6	14	30	43	54	52	42	27	6	-11	18
FORT GREELY	9	-5	2	12	28	46	56	59	54	44	27	5	-4	27
Gizhiga	16	-11	-9	1	15	33	49	56	52	44	27	3	-8	23
Helsinki	92	-21	20	25	34	46	57	62	60	51	42	32	25	40
Igarka	7	-20	-13	-4	10	27	46	59	55	41	19	-5	-17	17
Irkutsk	35	-6	-1	14	33	46	58	65	59	46	32	13	-1	30
Matochkin Shar	17	6	2	-2	10	24	34	42	43	36	27	19	9	43
Moskva	35	13	16	23	38	53	60	64	60	50	39	27	18	38
Mys Chelyuskin	11	-14	-13	-12	-5	15	30	35	32	27	13	-6	-15	7
Nikolaevsk	63	-10	-4	9	27	39	53	62	61	49	29	15	-3	28
Okhotsk	32	-10	-7	6	21	35	44	54	55	46	27	5	-7	22
Paris	20	38	39	44	50	56	62	66	63	60	52	43	40	51
Petrovsk	16	14	15	22	30	36	44	51	54	49	40	27	19	33
Rostov	30	21	25	34	48	62	69	75	73	62	50	36	28	49
Samarovo	M	-4	1	14	31	44	60	66	60	48	31	12	0	30
Sredne Kolyansk	13	-10	-33	-17	5	30	55	66	50	37	12	-18	-34	9
Tiksi	7	M	-20	M	M	M	M	48	M	M	M	M	M	M
Ural'sk	20	4	10	18	39	59	68	74	69	56	42	23	11	39
Verkhoyansk	38	-58	-48	-24	9	36	56	60	52	36	6	-34	-51	3
Vilyusk	25	-38	-24	-4	18	40	59	65	58	42	17	-15	-35	15
Vrangelya O.	9	-11	-14	-10	1	17	33	37	36	28	16	1	-5	11
Warsawa	25	26	28	35	46	57	63	65	64	57	47	36	29	46

M - Missing

Values for coldest and warmest month are underlined

M - Missing
Values for coldest and warmest month are underlined

Table III: MEAN DAILY MINIMUM TEMPERATURE (°F)

Station	Yrs. Rec.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Arkhangelsk	18	<u>1</u>	0	8	23	35	44	51	48	40	30	16	4	25
Barnaul	18	<u>-12</u>	-7	2	23	40	51	55	52	41	28	10	-4	23
Berezevo	M	<u>-13</u>	-11	-2	15	29	45	53	48	38	21	0	-12	17
Borno	20	<u>27</u>	28	29	34	40	45	51	51	45	37	32	28	37
Borzya	9	<u>-32</u>	-24	-7	17	34	48	56	52	35	17	-8	-25	13
Budapest	30	<u>28</u>	28	36	43	51	56	60	58	52	44	36	31	44
Dikson O.	M	<u>-20</u>	-19	-18	-8	12	29	36	37	32	16	-6	-17	6
PORT CHURCHILL	19	<u>-27</u>	-25	-16	4	22	34	43	43	34	20	-2	-19	9
PORT GREELY	9	<u>-13</u>	-7	1	18	36	46	49	44	36	20	-2	-13	19
Qishiga	5	<u>-19</u>	-14	-7	6	25	38	44	43	32	15	-7	-18	12
Heligoland	20	<u>17</u>	12	22	31	41	49	57	54	47	36	30	22	35
Igarika	7	<u>-10</u>	-22	-15	-2	19	38	50	47	35	22	-13	-27	7
Irkutsk	18	<u>-17</u>	-14	-1	21	33	44	50	48	35	22	2	-11	18
Matotchkin Shar	16	<u>-4</u>	-4	-11	1	17	30	37	37	32	22	9	-2	14
Moskva	25	<u>6</u>	8	16	42	42	50	54	51	42	33	22	12	33
Nys Chelyuskin	7	<u>-2</u>	-21	-26	-14	9	27	32	31	26	8	-9	-19	8
Nikolaevsk	22	<u>-13</u>	-15	-7	18	32	45	54	53	44	29	0	-10	20
Okhotsk	7	<u>-13</u>	-17	-7	8	26	37	48	47	38	21	0	-12	14
Paris	20	<u>12</u>	33	36	40	46	52	55	54	50	44	37	35	43
Petrovavlovsk	12	<u>9</u>	10	15	25	32	39	47	48	43	34	22	14	28
Rostov	30	<u>13</u>	19	28	40	52	60	64	61	52	41	31	23	40
Samarovo	9	<u>-14</u>	-7	0	19	47	47	56	51	41	24	5	-10	22
Sredne Kolymak	9	<u>-19</u>	-10	-29	-11	18	43	48	41	30	5	-23	-40	-1
Tiksi	7	<u>-24</u>	-26	-28	-9	14	32	41	41	32	7	-17	-26	3
Uralak	17	<u>-4</u>	1	11	30	46	55	59	55	45	33	17	3	29
Verkhoyansk	14	<u>-6</u>	-56	-39	-12	22	43	47	39	27	-4	-40	-58	-8
Vilyuek	11	<u>-13</u>	-32	-18	-12	28	46	52	46	34	10	-22	-43	5
Vrangelya O.	10	<u>-18</u>	-21	-18	-6	11	28	32	32	25	12	-5	-12	5
Warsawa	25	<u>21</u>	23	28	38	48	53	56	55	48	41	32	25	39

Values for coldest month are underlined
M - Missing

Table IV: MEAN DAILY MAXIMUM TEMPERATURE (°F)

Station	Yrs. Rec.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Arkhangelsk	18 - 35	15	20	26	37	46	62	68	62	52	38	26	20	39
Barnaul	18 - 33	10	13	28	45	64	77	81	74	63	45	24	2	45
Berezevo	M	-1	7	20	33	45	60	70	64	51	33	15	6	34
Borno	20	32	33	36	42	48	53	60	59	52	44	37	33	44
Borzya	9 - 15	-6	2	5	47	62	76	79	72	65	43	16	1	41
Budapest	30	37	40	52	62	72	77	82	81	73	62	48	39	60
Div'ison O.	14	-4	-3	-5	6	22	35	46	46	39	24	9	-1	18
FORT CHURCHILL	19	-11	-8	4	24	38	52	64	62	49	34	13	-3	26
FORT GREELY	9	3	11	23	38	56	66	69	63	52	34	13	4	36
Gizhiga	5	-3	-4	9	24	41	60	68	61	50	29	13	2	29
Helsinki	20	26	26	32	43	55	63	71	65	57	45	37	31	46
Igarka	7	-10	-4	8	22	25	54	68	63	47	24	3	-7	24
Irkutsk	18 - 35	5	12	29	45	59	72	76	70	58	42	24	9	42
Matochkin Shar	17	12	8	4	15	28	25	48	48	39	31	24	15	26
Moskva	25 - 35	20	24	30	46	64	70	74	69	58	45	32	24	43
Mys Chelyuskin	7 - 11	-5	-5	-12	4	21	33	38	33	28	18	-3	-11	12
Nikolaevsk	22 - 53	-1	7	20	36	46	61	70	69	54	29	22	4	36
Okhotsk	7 - 32	-5	3	5	34	44	51	60	62	54	33	10	-2	30
Paris	20	44	46	52	60	67	72	76	75	69	60	49	44	59
Petropavlovsk	12 - 16	19	20	29	35	33	49	55	60	55	46	32	24	38
Kostov	M	27	31	40	56	72	78	86	85	72	59	41	33	58
Samarovo	M	6	9	14	43	41	73	76	69	55	38	19	10	38
Sredne Kolymsk	9	-31	-26	-5	21	42	67	66	59	44	19	-13	-28	19
Tiksi	7	M	-14	M	M	M	M	55	M	M	M	M	M	M
Ural'sk	17	12	19	25	48	72	81	87	83	68	51	29	19	49
Verkhoyansk	14	-50	-40	-9	30	50	69	73	65	45	16	-28	-44	14
Vilyusk	11	-31	-16	10	34	57	72	78	70	50	24	-8	-27	25
Vrangelya C.	10	-4	-7	-2	8	23	38	42	40	31	20	7	2	17
Warszawa	25	31	33	42	54	66	73	74	73	66	53	40	33	53

Values for warmest month are underlined
M - Missing

Table V: ABSOLUTE MINIMUM TEMPERATURE (°F)

Station	Yrs. Rec.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arkhangelsk	35	-49	-41	-35	-18	8	26	34	33	20	-5	-22	-45
Barnaul	33	-55	-55	-42	-19	4	29	37	32	21	-30	-49	-51
Berezevo	M	-57	-52	-49	-20	-2	25	32	22	11	-13	-41	-52
Borno	55	3	2	8	14	25	33	38	36	30	19	12	0
Borzya	9	-55	-56	-37	-16	11	25	36	34	12	-19	-40	-61
Budapest	30	2	-10	8	24	33	37	48	45	34	15	11	-2
Nikson O.	15	-52	-55	-46	-35	-14	7	27	26	11	-15	-39	-49
FORT CHURCHILL	19	-57	-52	-52	-26	-14	13	22	25	15	-17	-53	-47
FORT GREELY	9	-65	-60	-39	-37	-1	32	35	22	9	-15	-42	-62
Gzhiga	12	-59	-52	-52	-23	-3	28	55	25	8	-21	-39	-50
Helalinki	44	-23	-21	-16	12	25	34	42	32	28	14	-5	-18
Igarka	7	-70	-71	-63	-47	-16	15	33	31	15	-21	-61	-76
Irkutsk	30	-58	-48	-34	-24	6	24	33	27	14	-23	-39	-51
Katoclidn Shar	16	-38	-39	-41	-28	-10	13	25	27	7	-12	-23	-41
Koskva	37	-42	-40	-26	1	19	28	38	33	23	-1	-9	-40
Mys Chelyuskin	6	-54	-48	-42	-37	-15	11	26	24	2	-16	-41	-46
Nikolaevsk	22	-50	-51	-34	-13	12	25	38	36	1	1	-29	-40
Okhotak	19	-40	-50	-34	-30	3	27	36	34	16	-6	-26	-33
Paris	172	-2	-4	10	24	29	36	40	41	33	22	5	-14
Petropavlovsk	23	-29	-25	-12	4	14	29	35	35	30	18	5	-13
Rostov	24	-19	-15	-6	18	30	36	47	40	25	14	1	-11
Samarovo	9	-49	-41	-39	-14	5	29	34	30	20	-21	-42	-52
Sredne Kolymsk	9	-71	-72	-61	-42	-16	22	33	24	9	-30	-53	-73
Tiksi	7	-54	-57	-47	-30	-14	18	29	27	18	-27	-49	-50
Uralak	25	-42	-30	-24	-10	23	32	41	32	20	6	-31	-39
Verkhoyansk	33	-90	-84	-77	-66	-30	19	28	18	2	-48	-72	-84
Vilyusk	11	-76	-68	-58	-34	-9	28	32	21	-3	-32	-60	-72
Vranrellya O.	10	-43	-43	-50	-27	-13	14	23	24	6	-10	-28	-34
Werszawa	44	-22	-28	-11	22	30	35	43	41	29	15	0	-5

Absolute values for period of record are underlined

" - Missing

-Also reported as corrected to -70°

Table VI: HIGHEST REPORTED TEMPERATURE (°F)

Station	Yrs. Rec.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arkhangelsk	95	41	39	54	67	83	90	<u>94</u>	89	77	65	50	39
Barinual	37	40	40	52	79	90	94	<u>96</u>	95	87	75	54	40
Berezevo	10	30	32	46	58	77	84	<u>86</u>	84	76	64	39	36
Borno	55	48	50	55	70	76	84	<u>87</u>	81	74	66	55	51
Borzya	11	20	28	50	74	87	94	<u>99</u>	94	81	73	40	31
Budapest	30	59	64	78	87	90	<u>103</u>	<u>101</u>	<u>101</u>	95	80	73	56
Dikson O.	M	31	30	27	33	45	67	<u>73</u>	69	55	40	32	31
FORT CHURCHILL	19	39	31	41	62	87	83	<u>86</u>	87	84	62	45	34
FORT GREELY	9	46	51	51	62	90	86	<u>85</u>	82	73	62	50	48
Gichiga	12	34	35	38	40	65	77	<u>82</u>	80	67	53	38	32
Helsinki	39	47	43	53	67	77	84	<u>83</u>	84	74	59	49	46
Irkutsk	7	28	27	32	49	61	89	<u>83</u>	82	68	50	33	32
Irkutsk	30	36	41	52	85	88	<u>95</u>	<u>98</u>	92	84	73	56	36
Matorshkin Shar	17	41	42	37	41	55	56	<u>66</u>	68	54	53	42	43
Moskva	105	43	43	64	78	95	93	<u>97</u>	<u>100</u>	89	72	57	46
Mys Chelyuskin	7	28	24	27	26	36	48	<u>67</u>	63	56	34	33	29
Nikolaevsk	22	M	M	M	M	M	M	<u>88</u>	M	M	M	M	M
Okhotsk	32	27	30	37	43	59	73	<u>77</u>	78	74	57	36	32
Paris	172	60	69	79	85	92	96	<u>101</u>	99	96	83	71	64
Petrovsk	26	40	44	44	53	65	74	<u>84</u>	81	73	64	45	43
Rostov	30	55	54	55	80	82	89	<u>99</u>	<u>102</u>	100	95	89	69
Samarovo	9	32	33	44	61	82	88	<u>92</u>	87	81	63	38	35
Sredne Kolymsk	13	8	17	30	42	74	94	<u>92</u>	85	67	51	24	9
Tiksi	7	25	13	22	36	74	75	<u>91</u>	81	68	45	25	18
Ural'sk	25	36	35	60	79	92	<u>101</u>	<u>104</u>	98	96	81	56	39
Verkhoyansk	33	2	14	38	52	71	94	<u>93</u>	88	74	48	33	32
Vilyusk	25	21	30	41	60	78	93	<u>96</u>	93	78	64	34	22
Vrangelya O.	9	33	27	28	33	49	63	<u>65</u>	61	46	38	35	29
Warsawa	44	51	54	69	78	93	96	<u>96</u>	98	88	77	60	57

Absolute values for period of record are underlined

M - Missing

Absolute values for period of record are underlined
M - Missing

Table VII: MEAN WIND SPEED (Miles per hour)

Station	Yrs. Rec.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Arkhangel'sk	10	<u>11.9</u>	9.5	10.6	9.0	10.2	10.4	8.7	9.5	10.7	11.3	12.4	9.7	10.3
Barnaul	13	<u>7.6</u>	7.0	6.0	7.0	8.0	7.0	6.0	5.0	6.0	8.0	8.0	6.0	7.0
Berezevo	M	<u>7.2</u>	7.6	8.5	8.5	9.2	9.6	8.3	8.5	7.8	8.7	8.3	7.6	8.3
Borno	26	<u>15.7</u>	<u>14.2</u>	14.9	12.7	13.4	14.2	12.7	11.9	13.4	13.4	14.2	14.2	13.8
Borzya	11	<u>3.9</u>	<u>4.5</u>	6.6	9.8	10.0	8.7	7.5	7.3	7.3	7.6	6.2	4.2	7.0
Budapest	30	<u>4.1</u>	3.9	4.1	4.4	4.1	4.4	4.6	4.2	3.6	3.0	3.4	3.2	3.9
Dikson O.	M	<u>19.0</u>	19.0	17.0	15.9	15.4	14.7	14.5	15.0	15.7	17.4	16.3	19.1	16.5
FORT CHURCHILL	19	<u>14.2</u>	14.6	14.2	14.3	13.4	12.2	11.5	13.0	16.3	17.1	16.9	14.9	14.4
FORT GREENLY	9	<u>17.0</u>	17.0	10.0	9.0	10.0	9.0	3.0	10.0	10.0	13.0	15.0	14.0	11.8
Gizhiga	M	<u>12.0</u>	11.0	11.0	10.0	9.0	9.0	9.0	8.0	7.0	9.0	10.0	12.0	10.0
Helsinki	16	<u>10.2</u>	<u>9.1</u>	9.4	8.1	8.4	8.3	7.6	7.9	9.1	9.9	9.9	10.1	9.0
Igarka	7	<u>8.0</u>	9.0	10.0	10.0	11.0	10.0	8.0	9.0	10.0	10.0	9.0	7.0	9.0
Irkutsk	10	<u>6.4</u>	6.5	6.8	9.3	9.0	14.4	6.1	5.7	6.3	7.2	6.7	6.2	7.6
Matochidn Shar	17	<u>17.0</u>	15.0	18.0	16.0	16.0	17.0	15.0	12.0	14.0	15.0	17.0	14.0	16.0
Moskva	10	<u>8.1</u>	8.1	8.3	7.5	7.5	7.0	6.9	7.2	8.0	7.8	9.0	8.4	7.8
Mys Chelyuskin	M	<u>19.0</u>	12.0	13.0	12.0	12.0	14.0	15.0	12.0	14.0	14.0	10.0	11.0	12.0
Nikolaevsk	16	<u>8.1</u>	6.4	7.4	7.1	7.8	8.9	8.1	6.8	6.9	7.5	8.4	8.8	7.7
Okhotsk	13	<u>9.8</u>	9.2	8.1	8.7	8.9	9.2	8.9	8.3	8.7	11.0	11.9	10.7	9.4
Paris						Not available								
Petrovsk	16	<u>19.8</u>	18.0	19.0	14.3	11.3	9.6	9.4	8.1	11.4	14.4	16.6	19.1	14.2
Rostov	11	<u>14.0</u>	12.0	11.0	12.0	10.0	9.0	9.0	9.0	9.0	10.0	11.0	11.0	11.0
Samarovo	M	<u>8.5</u>	8.0	6.7	8.5	9.2	8.3	7.4	7.4	8.7	8.5	8.5	8.3	8.3
Sredne Kolyansk	M	<u>3.6</u>	3.1	4.3	4.9	4.5	6.3	6.3	6.0	5.8	4.3	3.6	3.8	4.7
Tikel	M	<u>17.0</u>	<u>12.5</u>	6.7	6.0	9.6	9.2	8.9	10.5	11.6	11.2	10.1	8.1	10.1
Ural'sk	6	<u>14.0</u>	<u>12.0</u>	15.0	15.0	15.0	13.0	12.0	12.0	14.0	14.0	14.0	15.0	13.8
Verkhoyansk	16	<u>1.4</u>	1.6	2.2	4.0	5.7	6.8	5.6	4.6	3.5	2.7	1.8	1.2	3.4
Vilyusk	11	<u>4.2</u>	4.1	5.2	6.3	6.6	6.2	5.3	5.4	5.2	5.6	4.8	3.9	5.2
Vrangelya O.	9	<u>15.0</u>	<u>13.2</u>	9.2	10.3	9.2	7.6	9.6	10.1	13.4	13.9	15.0	13.6	11.7
Warszawa						Not available								

Values for coldest month are underlined
M - Missing

Table VIII: MEAN WINDCHILL* (Kg. Cal./m²/hr.)

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Arkhangelsk	<u>1200</u>	1225	1144	903	759	578	462	548	698	882	1103	1195	900
Barnaul	<u>1220</u>	1215	1022	796	563	380	313	366	527	792	1063	1156	784
Berezevo	<u>1390</u>	1335	1211	991	800	593	434	520	677	947	1226	1349	956
Borno	<u>990</u>	<u>924</u>	977	852	756	671	581	586	660	788	898	963	810
Borzya	<u>1348</u>	1319	1184	894	653	452	349	408	574	877	1156	1263	873
Budapest	<u>700</u>	695	591	481	359	286	263	274	371	453	579	648	475
Dikson O.	<u>1790</u>	1785	1729	1524	1224	977	846	829	940	1205	1507	1732	1341
FORT CHURCHILL	<u>1820</u>	1790	1595	1270	985	760	575	625	825	1090	1450	1695	1207
FORT GREELY	<u>1630</u>	1520	1200	930	680	515	455	560	710	1030	1430	1555	1018
Oizhiga	<u>1590</u>	1543	1389	1150	858	623	520	363	699	1020	1330	1558	1070
Heleinki	<u>1040</u>	1030	976	820	649	492	420	449	594	743	894	999	759
Irkutsk	<u>1592</u>	1535	1436	1225	990	683	476	535	759	1090	1417	1504	1104
Matochkin Shar	<u>1310</u>	1282	1074	858	667	541	380	434	607	824	1087	1236	824
Moskva	<u>1442</u>	1471	1610	1357	1124	969	813	758	898	1059	1222	1336	1172
Mys Chelyuskin	<u>1120</u>	1077	677	763	549	436	380	436	592	749	947	1049	731
Nikolaevsk	<u>1770</u>	1636	1770	1511	1197	995	928	931	1044	1271	1466	1635	1346
Okhotsk	<u>1450</u>	1276	1143	893	749	564	420	422	588	892	1092	1388	906
Paris	<u>1530</u>	1446	1220	1035	829	697	550	520	657	990	1354	1512	1029
Petrozavle'sk	<u>1360</u>	1305	1198	995	851	713	594	533	652	883	1087	1237	946
Rostov	<u>1150</u>	1040	882	680	442	329	241	270	432	623	851	974	660
Samarovo	<u>1380</u>	1292	1138	888	697	449	352	436	638	888	1167	1306	886
Sredne Kolym'sk	<u>1625</u>	1429	1324	1113	791	505	477	554	728	969	1336	1531	1032
Tiksi	<u>M</u>	<u>1780</u>	<u>M</u>	<u>M</u>	<u>M</u>	<u>M</u>	<u>638</u>	<u>M</u>	<u>M</u>	<u>M</u>	<u>M</u>	<u>M</u>	<u>M</u>
Urealsk	<u>1370</u>	<u>1276</u>	1207	862	533	373	273	351	574	801	1109	1174	825
Verkhoyansk	<u>1400</u>	1471	1217	1006	741	491	436	507	676	981	1323	1320	964
Vilyusk	<u>1600</u>	1409	1230	982	613	434	340	430	636	1032	1370	1543	968
Vrangelya O.	<u>1675</u>	1670	1491	1361	1094	835	819	834	1011	1222	1487	1563	1255
Warszawa													

Values for coldest month are underlined
 *Computed from values in Tables I, II, & VII
 M = missing

TABLE IX: MEAN CLOUDINESS (in tenths of sky covered)

TABLE IX: MEAN CLOUDINESS (in tenths of sky covered)

Station	Yrs. Rec.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Arkhangelsk	20	8.1	7.9	7.0	7.0	7.3	6.7	7.1	7.7	8.1	8.3	8.6	8.1	7.7
Barnaul	11	<u>6.7</u>	5.7	5.1	5.1	5.8	5.8	<u>5.3</u>	5.6	5.9	6.7	7.1	6.8	6.0
Bereznovo	14	7.2	7.1	6.8	6.5	6.6	6.8	7.0	7.0	7.5	7.1	7.1	6.9	7.0
Berno	11	2.3	1.9	2.6	4.4	5.0	5.5	<u>5.7</u>	5.6	4.3	4.2	3.2	2.9	1.0
Borova	50	<u>6.7</u>	6.1	5.5	5.4	5.0	4.8	<u>5.1</u>	3.9	4.0	5.5	6.6	7.1	5.4
Budapest	"	<u>6.2</u>	6.6	6.0	6.9	8.2	9.7	<u>7.7</u>	8.6	8.8	8.5	7.6	6.1	7.5
Dikson O.	8 - 10	<u>4.7</u>	4.5	4.8	5.9	7.7	7.2	<u>6.4</u>	<u>6.3</u>	8.0	8.3	7.5	5.1	6.1
FORT CIRCILL	9	<u>5.5</u>	5.5	6.1	5.6	6.2	5.8	<u>6.1</u>	7.0	6.8	6.6	5.9	5.6	6.1
FORT GRIMLY	14	<u>5.5</u>	5.3	5.3	6.4	6.8	7.3	<u>7.6</u>	7.2	6.7	7.0	6.4	5.6	6.1
Gzhelga	36	<u>5.0</u>	7.5	6.7	6.4	5.9	5.5	<u>5.3</u>	6.2	6.3	7.4	8.1	8.3	6.9
Helinki	1	<u>5.8</u>	<u>5.3</u>	6.8	5.8	6.7	7.5	<u>6.8</u>	7.1	8.0	8.5	7.6	7.1	6.9
Isarka	20	<u>5.2</u>	4.6	5.0	5.8	6.5	6.6	<u>6.8</u>	6.3	6.0	6.1	6.5	6.7	6.0
Irkutsk	17	<u>6.9</u>	6.9	6.5	6.8	8.0	7.5	<u>7.0</u>	7.3	8.2	8.3	8.0	7.2	6.9
Katochkin Shar	10	7.4	7.4	7.5	5.9	5.3	5.6	<u>5.3</u>	<u>5.6</u>	6.9	7.1	8.7	8.5	6.9
Ibaskva	"	<u>5.9</u>	6.6	4.2	7.0	9.2	8.7	<u>9.0</u>	8.9	6.4	8.0	8.7	3.6	6.9
Iys Chelyuskdn	18	4.3	4.5	5.2	6.3	7.3	6.9	<u>7.3</u>	6.9	5.9	6.3	5.5	3.2	6.0
Nikolaevsk	15	<u>3.7</u>	3.7	4.5	5.7	7.3	7.7	<u>7.3</u>	7.2	5.5	4.9	4.2	3.9	5.5
Okhotsk	10	<u>7.5</u>	6.5	6.0	6.4	6.1	5.7	<u>5.8</u>	5.6	5.6	4.9	4.2	3.1	6.4
Paris	16	<u>5.7</u>	5.6	6.0	6.6	7.0	7.9	<u>7.4</u>	7.1	6.0	5.5	5.6	5.7	6.3
Petrovavlovsk	10	<u>6.0</u>	5.1	5.6	6.0	6.6	6.4	<u>6.6</u>	6.7	3.5	7.4	6.7	6.1	6.4
Rostov	"	<u>4.0</u>	4.2	3.2	3.4	5.1	5.7	<u>6.2</u>	7.2	7.0	6.8	5.4	4.3	5.3
Sararovo	9	6.7	5.7	6.5	5.1	4.6	5.0	<u>4.4</u>	4.3	5.0	6.4	7.1	7.2	4.6
Sredne Kolymsk	7	<u>3.4</u>	3.1	3.3	4.8	6.1	6.6	<u>6.6</u>	6.6	6.6	6.4	4.6	3.9	4.1
Tikal	25	<u>6.0</u>	6.3	5.6	6.5	7.2	7.1	<u>6.7</u>	6.9	7.5	7.9	7.0	6.3	6.9
Verkhansk	9	<u>5.5</u>	5.8	5.0	5.4	7.9	7.4	<u>7.1</u>	7.9	8.1	7.4	6.7	6.4	6.7
Vilyusk	"	<u>7.6</u>	<u>7.4</u>	6.8	6.5	5.9	5.9	<u>6.1</u>	5.8	5.8	6.7	8.0	9.2	6.7
Vrangelya G.														
Yaroslavl														

values for coldest and warmest months are underlined
! = missing

Table XI: Mean Snow Depth (inches)

Station	Yrs. Rec.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arkhangelsk	25	17.3	23.6	<u>25.2</u>	11.5	0.6	0.0	0.0	0.0	0.0	0.9	4.4	10.6
Barnaul	18	9.2	<u>11.4</u>	<u>17.2</u>	2.4	0.0	0.0	0.0	0.0	0.0	0.5	2.7	6.3
Berezevo	M	17.4	<u>20.6</u>	<u>22.4</u>	17.2	3.0	0.0	0.0	0.0	0.0	1.3	7.2	13.6
Borno					Not available								
Bortava	2	1.9	<u>2.5</u>	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	1.9
Budapest					Not available								
Dikson O.	M	11.0	9.8	10.6	<u>11.8</u>	10.2	4.0	0.0	0.0	0.3	5.7	7.9	10.2
PORT CHURCHILL	7-10	16.0	20.9	<u>25.1</u>	20.4	10.6	4.0	0.0	0.0	0.0	0.7	4.4	10.2
PORT GREELY	5	10.7	<u>17.0</u>	<u>14.9</u>	11.6	9.6	2.0	0.0	0.0	0.0	4.2	7.0	10.5
Gizhiga	M	13.8	<u>19.7</u>	<u>24.6</u>	<u>27.0</u>	12.6	0.0	0.0	0.0	0.0	0.6	3.2	8.0
Helsinki	20	9.0	15.0	<u>18.0</u>	6.0	0.4	0.0	0.0	0.0	0.0	0.3	1.0	5.0
Izarka					Not available								
Irkutsk	18	6.7	<u>8.4</u>	7.2	0.4	0.2	0.0	0.0	0.0	0.0	0.5	2.5	4.7
Vatochkin Shar					Not available								
Moskva	54	8.2	12.0	<u>12.1</u>	2.8	0.0	0.0	0.0	0.0	0.0	0.2	1.2	4.4
Mys Chelyuskin	8	7.5	7.5	<u>8.1</u>	8.1	8.1	4.8	0.4	0.0	0.8	3.2	5.1	7.1
Vikolayevsk	16	21.1	26.1	<u>26.3</u>	20.5	3.6	0.0	0.0	0.0	0.0	0.6	5.8	16.0
Okhotsk					Not available								
Paris	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Petrozavlovsk	33	26.7	39.1	<u>41.9</u>	21.7	0.0	0.0	0.0	0.0	0.0	0.0	3.4	8.4
Rostov	19	3.3	<u>3.3</u>	<u>1.7</u>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.3
Saratov	M	15.3	19.0	<u>21.4</u>	15.0	0.3	0.0	0.0	0.0	0.3	1.2	7.1	12.2
Sredne Kolymsk	9	15.0	17.4	<u>13.5</u>	16.4	8.0	0.0	0.0	0.0	0.0	3.9	8.9	11.9
Tiksi					Not available								
Ural'sk					Not available								
Varkhovansk	16	3.0	9.5	<u>10.6</u>	10.1	3.4	0.0	0.0	0.0	0.0	2.9	3.9	7.5
Vil'vusk	14	13.9	15.5	<u>16.6</u>	14.7	4.1	0.0	0.0	0.0	0.1	2.0	7.1	11.0
Vranzelya O.					Not available								
Varskawa					Not available								

Values for month of greatest depth are underlined

M = missing

Table XI: MEAN PRECIPITATION (Inches)

Station	Yrs. Rec.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Arkhangelsk	45	0.89	0.78	0.90	0.78	1.43	2.01	2.37	2.53	2.24	1.78	1.27	1.05	18.33
Barnaul	75	0.75	0.51	0.55	0.59	1.26	1.73	2.13	1.77	1.14	1.26	1.06	1.02	13.77
Berezevo	8	0.50	0.30	0.40	0.60	1.50	2.20	2.50	2.00	1.50	0.90	0.60	0.50	13.50
Borno	50	3.54	2.99	2.48	2.17	2.48	2.48	2.95	3.27	5.12	4.65	4.68	3.23	40.04
Bortya	15	0.08	0.04	0.04	0.16	0.67	1.10	3.07	2.99	0.58	0.12	0.08	0.08	9.09
Budapest	35	1.46	1.22	1.77	2.28	2.91	2.91	2.09	1.97	2.01	2.60	2.09	1.87	25.20
Dikson O.	11	0.29	0.18	0.15	0.29	0.26	0.66	0.95	1.46	1.14	0.46	0.40	0.24	6.48
FORT CHURCHILL	19	0.41	0.36	0.63	0.69	0.65	1.51	2.81	2.54	1.97	1.50	0.78	0.56	14.00
FORT GREELY	9	0.40	0.20	0.30	0.30	0.60	2.10	3.20	2.10	1.20	0.40	0.30	0.30	11.00
Gizhiga	16	0.30	0.30	0.40	0.30	0.40	0.70	1.70	1.80	1.20	1.00	0.60	0.40	9.20
Helsinki	71	1.77	1.46	1.38	1.42	1.77	1.81	2.24	2.91	2.52	2.60	2.43	2.01	24.17
Izarka	7	0.95	0.67	0.75	0.67	0.95	2.00	1.97	1.97	2.05	1.38	1.22	1.02	15.00
Irkutsk	35	0.39	0.28	0.28	0.24	1.50	2.17	3.46	3.11	1.59	0.75	0.67	0.63	15.17
Katochkin Shar	16	0.40	0.30	0.20	0.30	0.30	0.60	2.30	1.30	1.50	0.60	0.60	0.40	7.00
Moskva	18	1.57	1.44	1.43	1.44	1.91	2.48	3.12	2.76	2.36	2.52	1.78	1.65	24.16
Nys Chelyuskin	7	0.20	0.10	0.00	0.10	0.10	0.50	1.00	0.90	0.30	0.30	0.20	0.10	3.00
Nikolaevsk	53	0.59	0.47	0.67	1.15	1.30	1.54	2.05	3.07	2.76	1.70	1.26	0.79	17.00
Okhotsk	23	0.08	0.08	0.16	0.35	0.79	1.69	2.32	2.44	2.01	0.95	0.16	0.12	11.14
Paris	38	1.54	1.22	1.61	1.65	2.09	2.32	2.20	2.16	1.97	2.12	1.81	1.73	22.00
Petrozavleusk	33	3.00	2.00	2.70	2.30	1.80	2.10	3.10	3.40	3.10	3.60	2.60	2.60	32.00
Restov	26	1.38	1.42	1.30	1.34	1.69	2.44	2.20	1.22	1.22	1.30	1.50	1.54	18.55
Samarovo	10	0.30	0.60	0.70	0.50	2.00	2.30	2.40	3.00	2.20	1.60	1.00	1.00	18.00
Sredne Kelyusk	13	0.30	0.40	0.20	0.20	0.20	0.90	1.30	1.20	0.80	0.50	0.50	0.40	6.00
Tiksi	7	0.10	0.10	0.10	0.10	0.10	1.20	1.30	1.10	0.80	0.20	0.20	0.10	5.35
Uralak	26	0.70	0.60	0.60	0.60	1.40	1.50	1.20	1.20	1.30	1.20	1.10	0.90	12.30
Verkhoyansk	31	0.20	0.10	0.10	0.20	0.30	0.90	1.00	1.00	0.50	0.30	0.30	0.20	5.05
Vilyusk	24	0.34	0.30	0.28	0.27	0.39	1.23	1.38	1.60	1.07	0.65	0.53	0.39	8.93
Vrangelya O.	9	0.43	0.24	0.29	0.24	0.31	0.53	0.89	0.85	0.64	0.50	0.27	0.23	5.16
Wassawa	M	1.50	1.50	1.40	1.40	1.30	1.30	1.50	1.30	1.10	1.20	1.40	1.50	16.10

M - Missing

TABLE XII: MEAN RELATIVE HUMIDITY (%)

Station	Yrs. Rec.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Arkhangelsk	25	88	87	83	76	73	69	74	86	85	87	90	89	82
Barnaul	10	81	80	75	70	58	63	68	71	75	76	82	82	73
Berezevo	8	85	82	73	71	68	72	73	80	81	85	84	85	78
Borno	18	74	73	73	68	68	74	76	75	76	75	76	74	74
Bortzya	3	80	82	74	58	48	53	67	67	65	62	78	80	68
Budapest							Not available		90	89	88	88	86	88
Dikson O.	19	89	88	85	88	80	91	90	72	85	86	93	94	85
FORT CHURCHILL	10	91	90	90	89	85	78	72	76	76	79	73	71	69
FAIRBANKS, ALASKA*	15	69	68	66	61	58	62	70	81	77	82	77	78	80
Gizhiga	1 - 3	74	86	79	81	81	81	19	81	77	82	88	89	81
Helisinki	26	87	87	82	78	71	72	73	80	83	86			
Irkutsk					Not available									
Katochkin Sbar	M	82	77	70	59	56	61	72	76	75	75	82	86	72
Moskva	16	81	82	82	81	79	79	78	81	83	83	83	83	81
Nys Chelyuskin	10	84	82	78	59	59	68	68	73	80	80	84	85	75
Nikolaevsk	7	86	85	82	84	86	90	90	94	90	87	84	82	87
Okhotsk	9	81	79	77	78	80	80	81	83	80	76	76	82	79
Paris	22	68	65	68	67	83	89	87	86	76	64	62	64	74
Petroavlovsk	10	84	79	72	66	65	65	64	67	72	79	85	85	74
Rostov	35	78	77	77	67	81	85	88	87	84	76	74	88	80
Samarovo	M	86	87	84	68	62	65	59	55	63	73	84	85	72
Sredne Kelyusk	17	79	79	71	68	68	67	71	77	81	84	84	82	76
Tiksi	6	78	78	76	71	70	65	68	78	78	83	84	76	80
Uralak	3	78	82	76	80	82	82	82	34	82	82	73	91	75
Verkhoyansk	M	88	88	87	75	56	60	59	60	66	79	87	74	67
Vilyusk	9	72	71	67	60	55	53	59	69	75	77	76	79	72
Vrangelya O.	12	81	80	72	62	60	60	61	69	74	80	83	74	85
Warsawa	8	86	84	84	84	85	89	75	92	88	86	84	87	

*Substitute Station. Port Greely data not available.

M - Missing

TABLE XIII: MEAN NUMBER OF DAYS WITH FOG

TABLE XIII: MEAN NUMBER OF DAYS WITH FOG

Station	Yrs. Rec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Archangel'sk	10	3	3	3	2	1	*	2	2	2	4	3	3	27
Barnaul	10	6	10	8	4	1	1	2	5	6	6	6	8	63
Berezevo	8	2	1	1	1	1	*	*	1	2	2	1	2	12
Borno	44	*	*	1	1	.2	3	3	2	1	1	*	*	14
Boriya	9	1	1	1	*	0	*	0	*	0	1	*	1	5
Budapest						Not available								
Dikson O.	23	4	4	5	7	7	15	20	16	11	5	3	2	99
FORT CHURCHILL	10	1	1	*	1	.1	4	2	2	1	*	*	0	13
FAIRBANKS, ALASKA**	27	5	4	*	*	*	6	1	1	1	2	2	1	20
Gizhiga	44	1	*	*	1	2	2	7	7	3	1	8	1	29
Helsinki	36	9	4	9	8	1	2	2	2	7	10	2	6	77
Igarka	N	5	2	2	0	1	2	4	3	4	5	2	1	38
Irkutsk	N	9	3	2	1	1	2	4	6	6	5	2	8	65
Katochidn Shar	16	4	2	2	3	3	7	8	10	10	5	10	15	60
Moskva	20	4	6	2	2	3	*	*	1	2	4	3	3	22
Nys Chelyuskin	3	*	*	11	10	9	24	24	25	15	8	8	*	35
Nikolaevsk	N	4	4	1	2	3	1	1	2	3	1	*	0	44
Okhotsk	5	0	0	1	2	7	13	11	7	3	1	6	11	71
Paris	15	12	9	6	3	3	15	17	13	7	2	1	7	71
Petrovsk	15	*	*	1	4	11	*	*	*	1	4	6	7	33
Rostov	10	5	4	4	1	0	*	0	0	1	1	0	0	2
Saratovo	5	5	0	0	0	6	15	10	3	2	1	1	2	18
Sredne Kolym'sk	8	3	4	5	1	0	0	1	5	5	4	1	2	69
Tiksi	3	1	2	2	1	0	0	0	0	*	1	2	2	11
Ural'sk	10	1	2	1	*	*	15	10	5	5	1	2	2	21
Verkhayanak	9	3	2	1	*	1	*	1	5	4	1	2	2	21
Vilyuik	10	4	2	1	*	1	*	1	1	1	1	2	1	16
Vrangelya O.	10	4	4	4	7	10	15	17	16	8	4	4	5	96
Yaroslavl						Not available								

*Less than 0.5 days

**Substitute station. Fort Greely data not available

7. Limitations of Analyses and Definitions of Terms

a. Limitations

The procedures outlined in the discussions of individual elements have certain limitations which affect reliability of the analyses. These are listed below.

(1) Climatic data are lacking for large parts of the study area. This is especially true for the Central Siberian Plateau.

(2) Many arctic stations have extremely short climatic records, and periods of record are variable over most of the study area. Adjustment of records to a standardized period was not practicable.

(3) In some cases data were not given or observed at times or in a form similar to those for Fort Churchill and Fort Greely.

(4) Descriptions of most station sites were not available, making it impossible to ascertain the extent of the area for which data of each station can be considered representative.

b. Definitions

The climatic elements presented in the report are defined below.

Mean Temperature - In Europe and the U S S R the arithmetic mean of three daily temperature observations, usually at 0700, 1300, and 2100 hours, for all days of the month concerned; at Fort Churchill and Fort Greely the arithmetic mean of maximum and minimum temperatures for all days of the month concerned.

Mean Daily Minimum Temperature - The arithmetic mean of minimum temperatures on all days of the month concerned.

Mean Daily Maximum Temperature - For Fort Churchill and Fort Greely, the arithmetic mean of maximum temperatures for all days of the month concerned; for stations in the study area, when the mean 1300 hour temperature was reported as the mean daily maximum, an estimated mean daily maximum was computed. This was done by subtracting the mean daily minimum temperature from twice the mean temperature reported for this station.

Absolute Minimum Temperature - The lowest temperature ever observed at the station.

Highest Reported Temperature - For Fort Churchill and Port Greely, the absolute maximum temperature. For stations in the study area, the highest temperature reported. In many cases this is the highest temperature observed at 1300 hours.

Mean Wind Speed - The arithmetic mean of all observations for the month concerned, in miles per hour.

Mean Cloudiness - The arithmetic mean of all observations of cloud cover in tenths of total sky covered for the month concerned.

Mean Snow Depth - The arithmetic mean of snow accumulation measurements (usually taken at beginning and end of month or at three 10-day intervals during each month) in inches.

Mean Annual Precipitation - The arithmetic mean of total precipitation amounts for all years of record, in inches.

Mean Relative Humidity - The arithmetic mean of all daily relative humidity observations for all days of the month concerned. Relative humidity is the ratio of the quantity of water vapor actually present to the greatest amount possible at a given temperature, in percent.

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9. Maps

Figure 1: Station Locations

Figure 2: Major Physical Features

Figure 3: Mean Temperature, Coldest Month

Figure 4: Mean Daily Minimum Temperature, Coldest Month

Figure 5: Absolute Minimum Temperature

Figure 6: Mean Windchill, Coldest Month

Figure 7: Mean Cloudiness, Coldest Month

Figure 8: Mean Snow Depth, Month of Greatest Depth

Figure 9: Mean Temperature, Warmest Month

Figure 10: Mean Daily Maximum Temperature, Warmest Month

Figure 11: Mean Cloudiness, Warmest Month

Figure 12: Mean Annual Precipitation

Figure 12a: Mean Number of Days with Fog

Figure 13: Composite Analogous Areas, Coldest Month

Figure 14: Composite Analogous Areas, Fort Greely

Figure 15: Composite Analogous Areas, Fort Churchill

MAP ERRATA

Figure 3

Temperature value for Syzran, USSR is 8°F .
Temperature value for Svyatoy Nos, USSR is 17°F .
Change temperature value at Irbit, USSR from -1° to 1° .
Temperature value for Chaiskoe Pole, USSR, is -7°F .
Change value at Verkhoyansk, USSR, from 58° to -58°F .
Change value at Kiyuchi, USSR, from 18° to 19°F .

Figure 4

Temperature value for Maryn, USSR is -18°F .
Temperature value for Mys Vankarem, USSR is -20°F .

Figure 5

Temperature for Povonets, USSR is -37°F .

Figure 6

Wind speed value for Roros, Norway is 5 mph.

Figure 7

Change station circle at Khabarovsk, USSR from ① to ②.

Figure 8

Delete station circle for Pinsk, USSR.

Figure 10

Delete station circle for Tiksi, USSR.

Figure 11

Add pattern to indicate analogy on the coast in the vicinity of Petropavlovsk (Kamchatka).

Figure 12

Change precipitation value at Paris, France from 26.6 to 22.6 inches.

Figure 12a

Change coldest month subscript at Pecs, Hungary from A (August) to JA (January).

Warmest month subscript for Kalmar, Sweden is J (July).

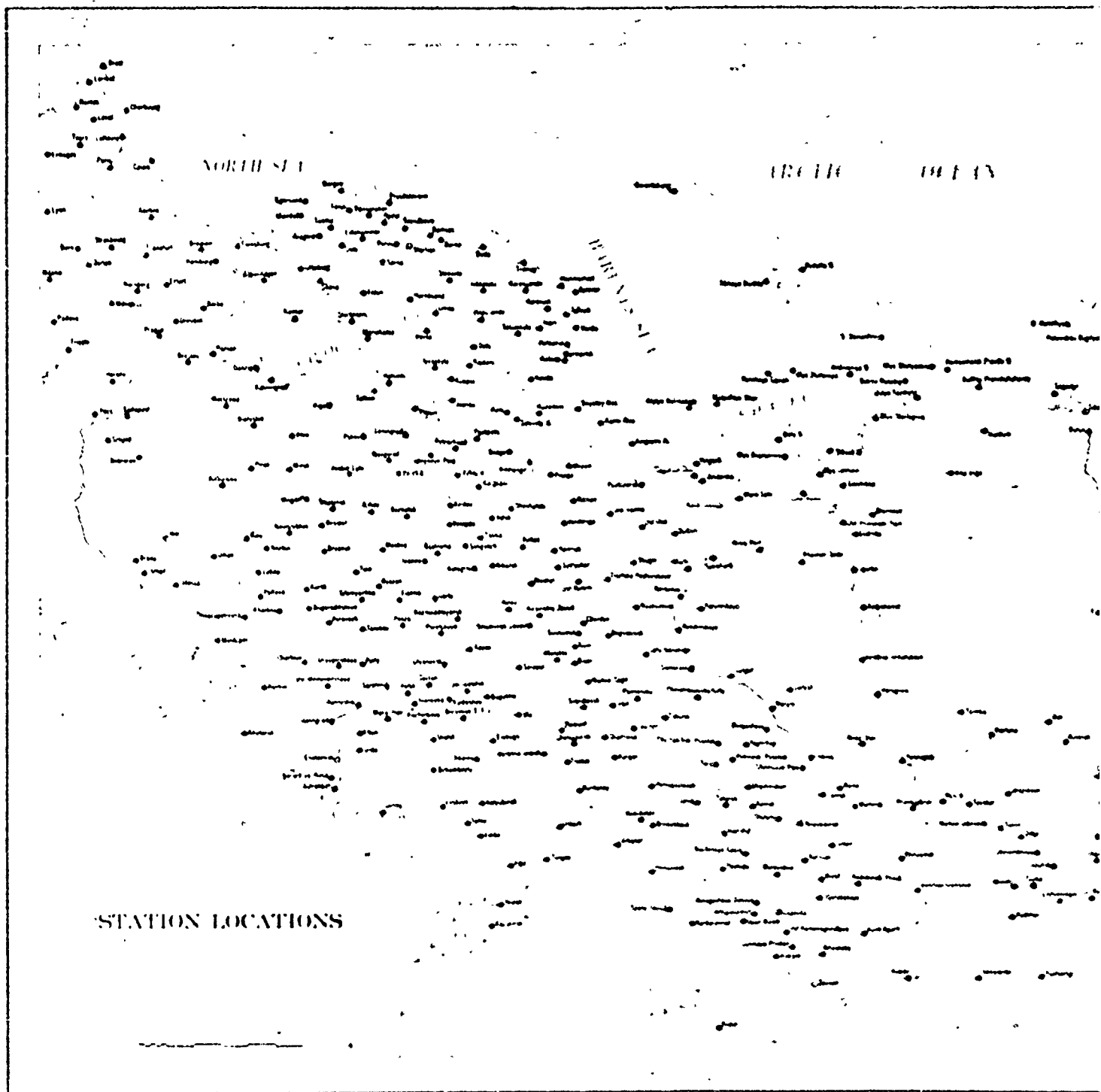
Change warmest month subscript at Vassa, Finland from F (February) to J (July).

Change data for the mean, foggiest month, at Berezevo, USSR from 25-0,D,JA to 2-S,0,D,JA.

Change coldest month subscript at Malye Karmakaly, USSR from A (August) to JA (January).

Change month subscript from M (May) to MA (March) at Mys Shelag'skiy, USSR, and all stations west of the 120° E meridian at which an M appears.

CLIMATIC ANALOGS OF FORT OPELIA AND FORT CHURCH



PORT LUTLEY AND PORT CHENAILL - EURASIA

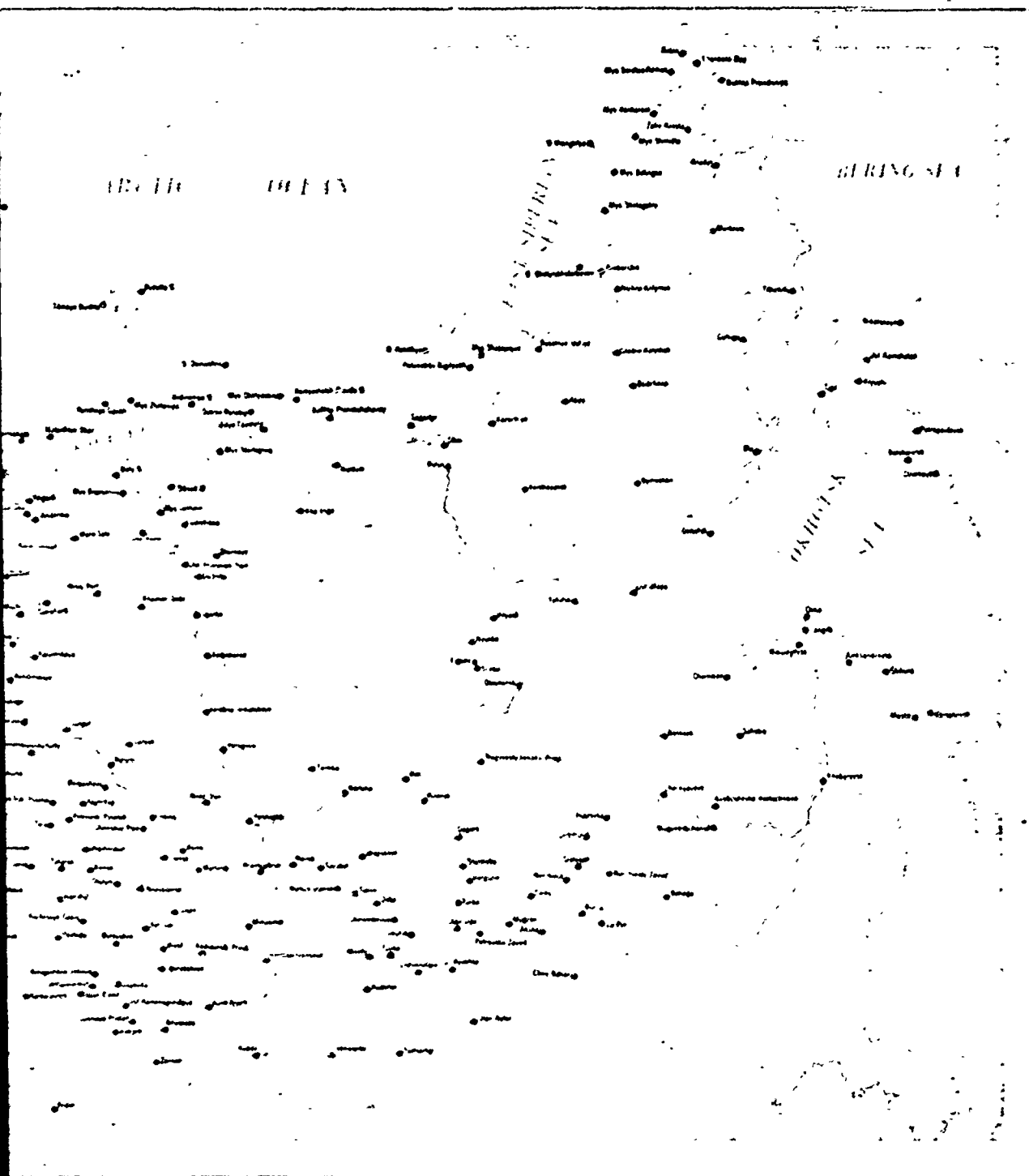
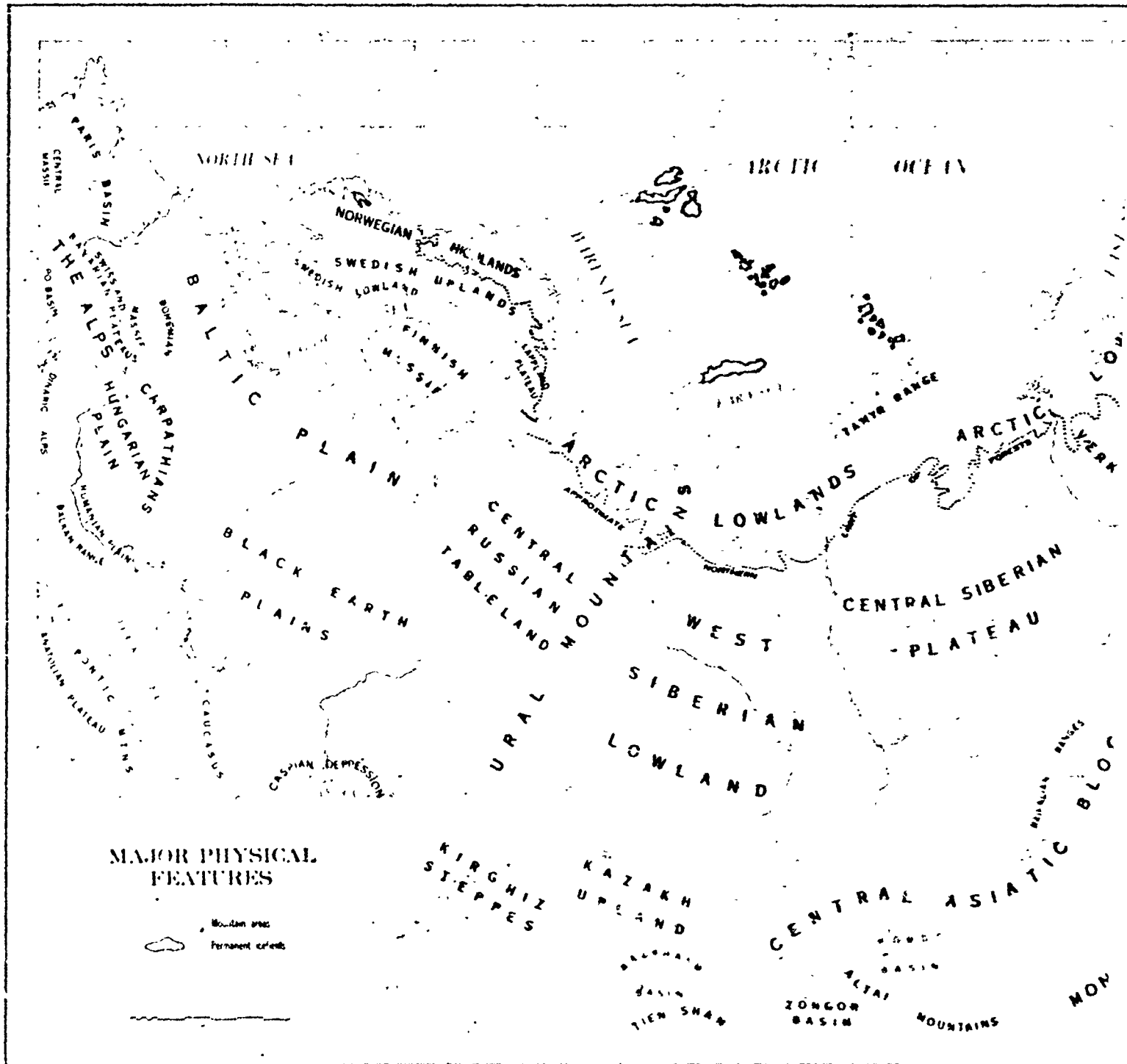
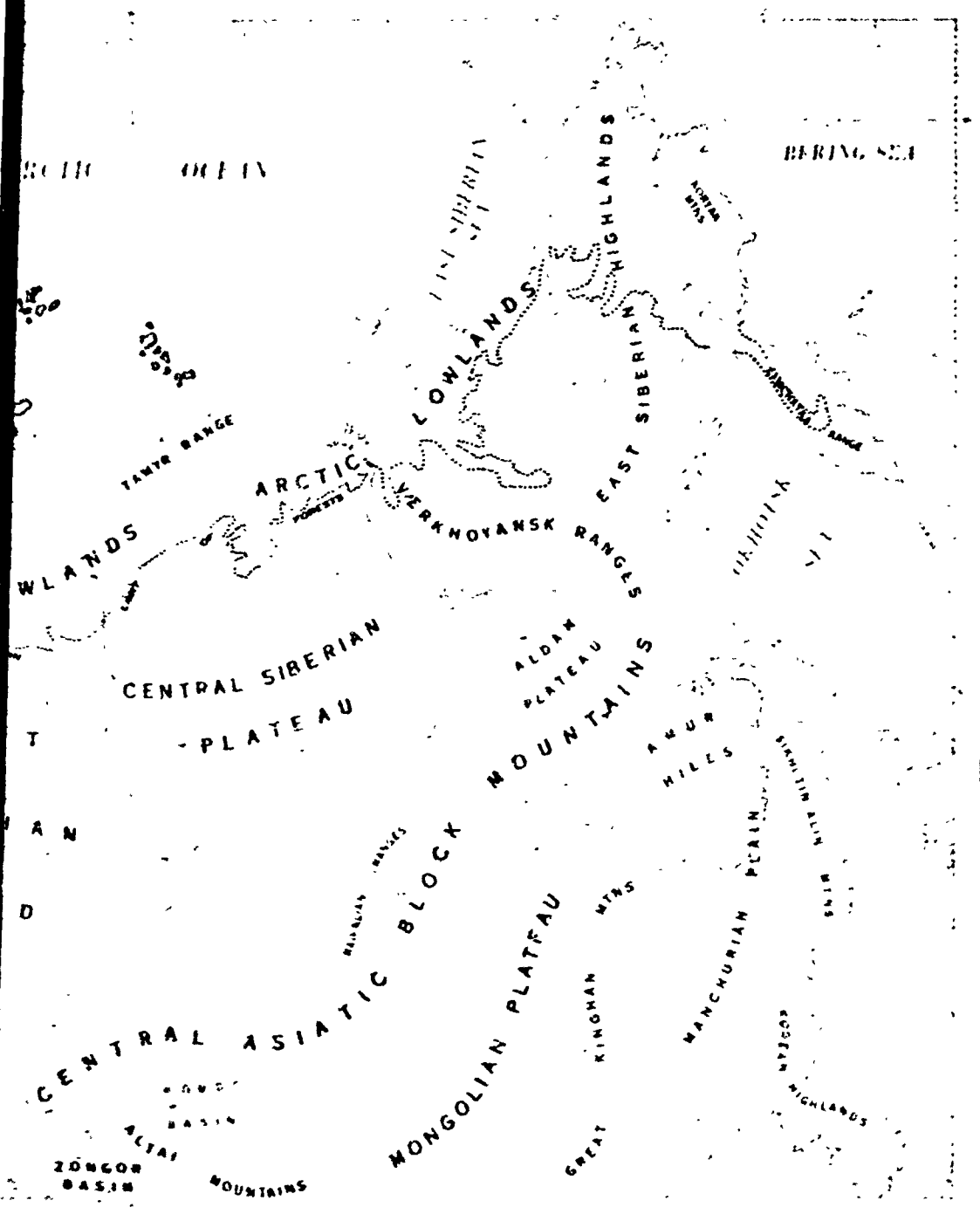


Figure 1

CLIMATIC ANALOGS OF FORT GREELY AND FORT CHURCHILL.



111 AND FORT CHURCHILL - EUKATA



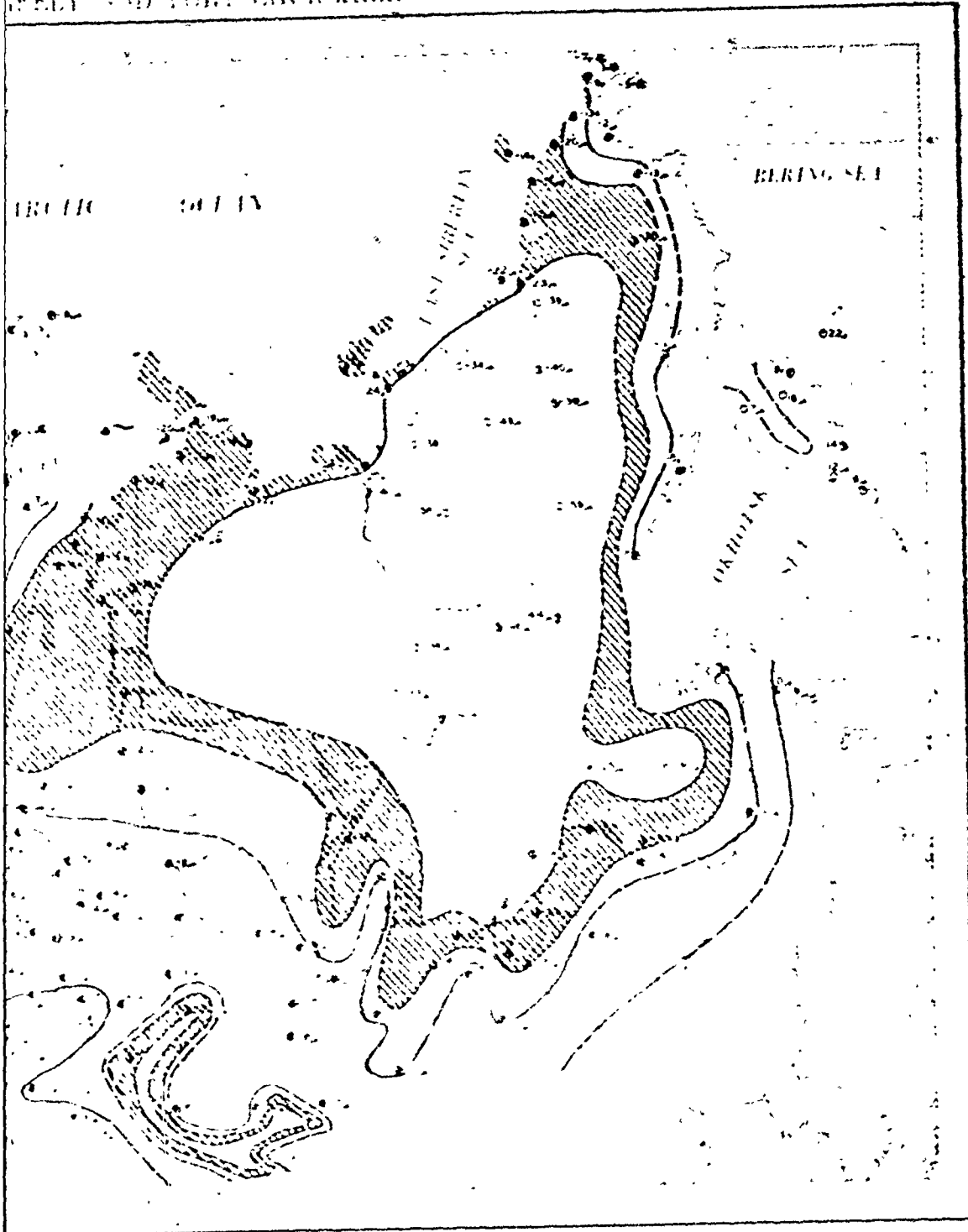
MEAN TEMPERATURE
COLDEST MONTH

FORT GREENE - 5 F FORT CHURCHILL - 19 F

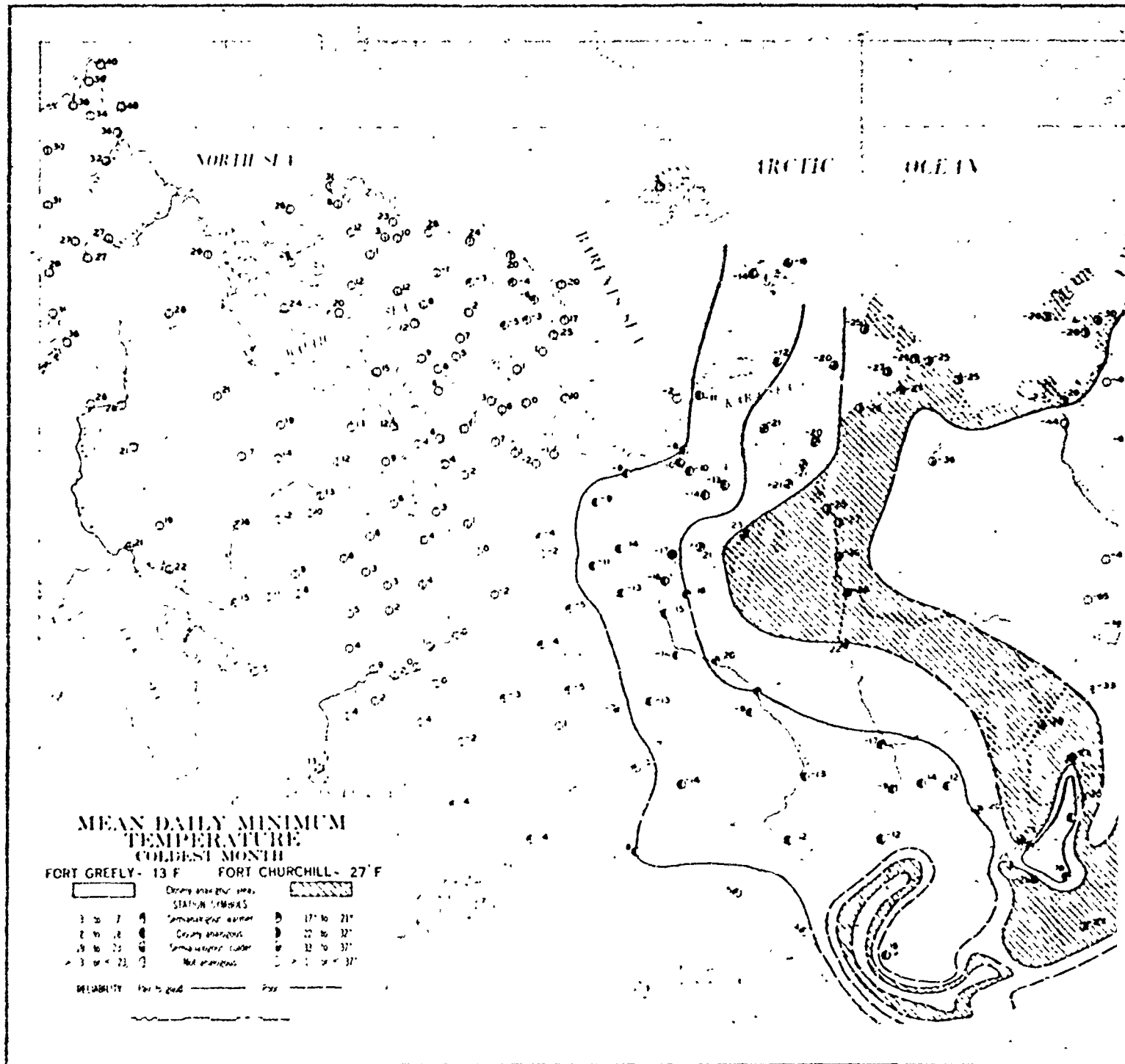
Legend:

- MEAN TEMPERATURE
- COLDEST MONTH
- ISOHERMS

REELY AND FORT CHURCHILL - ELBASTA



CLIMATE ANALOGS OF FORT GREELEY AND FORT CHURCHILL -



1

GREELY AND FORT CHURCHILL - EURASIA

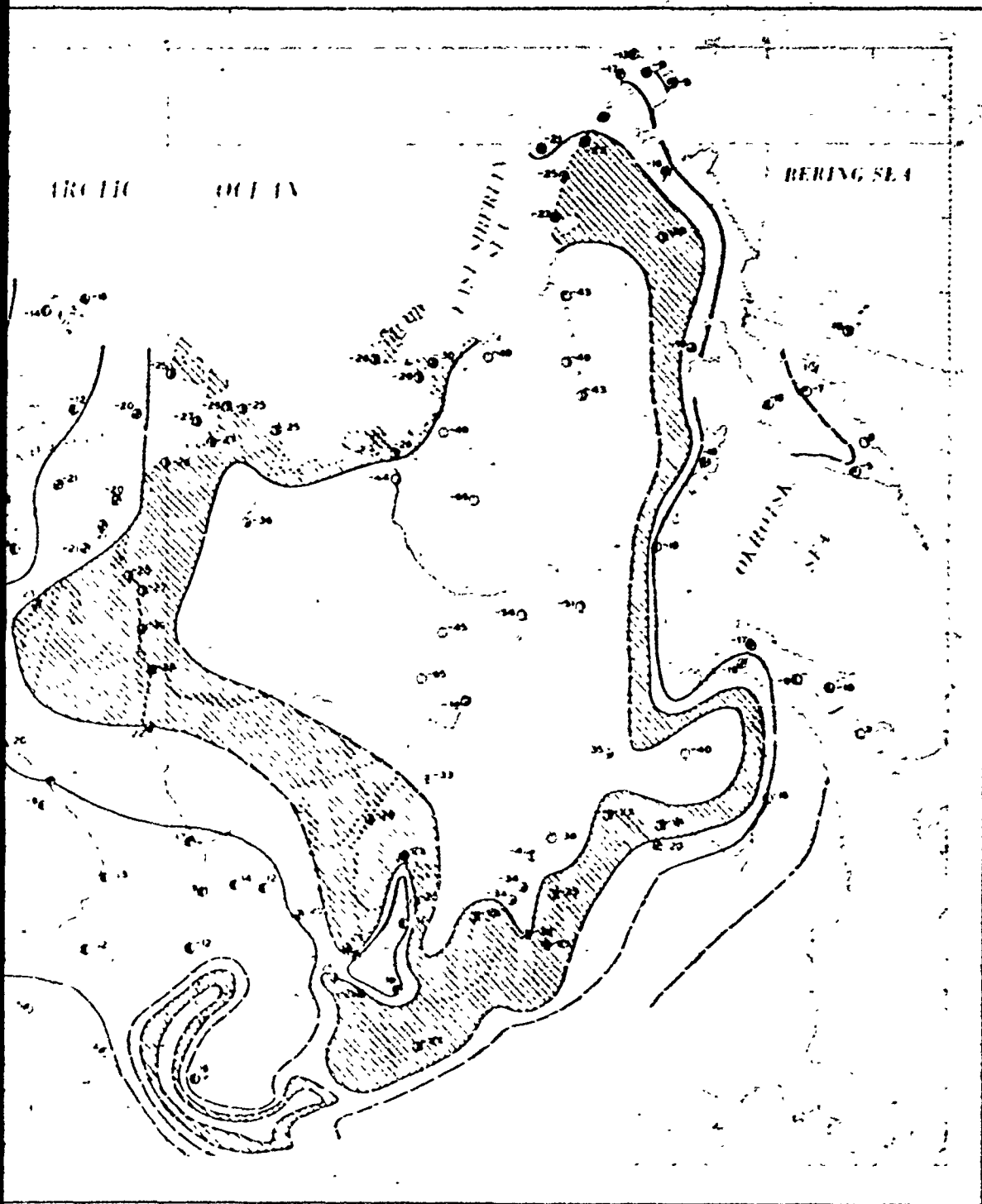
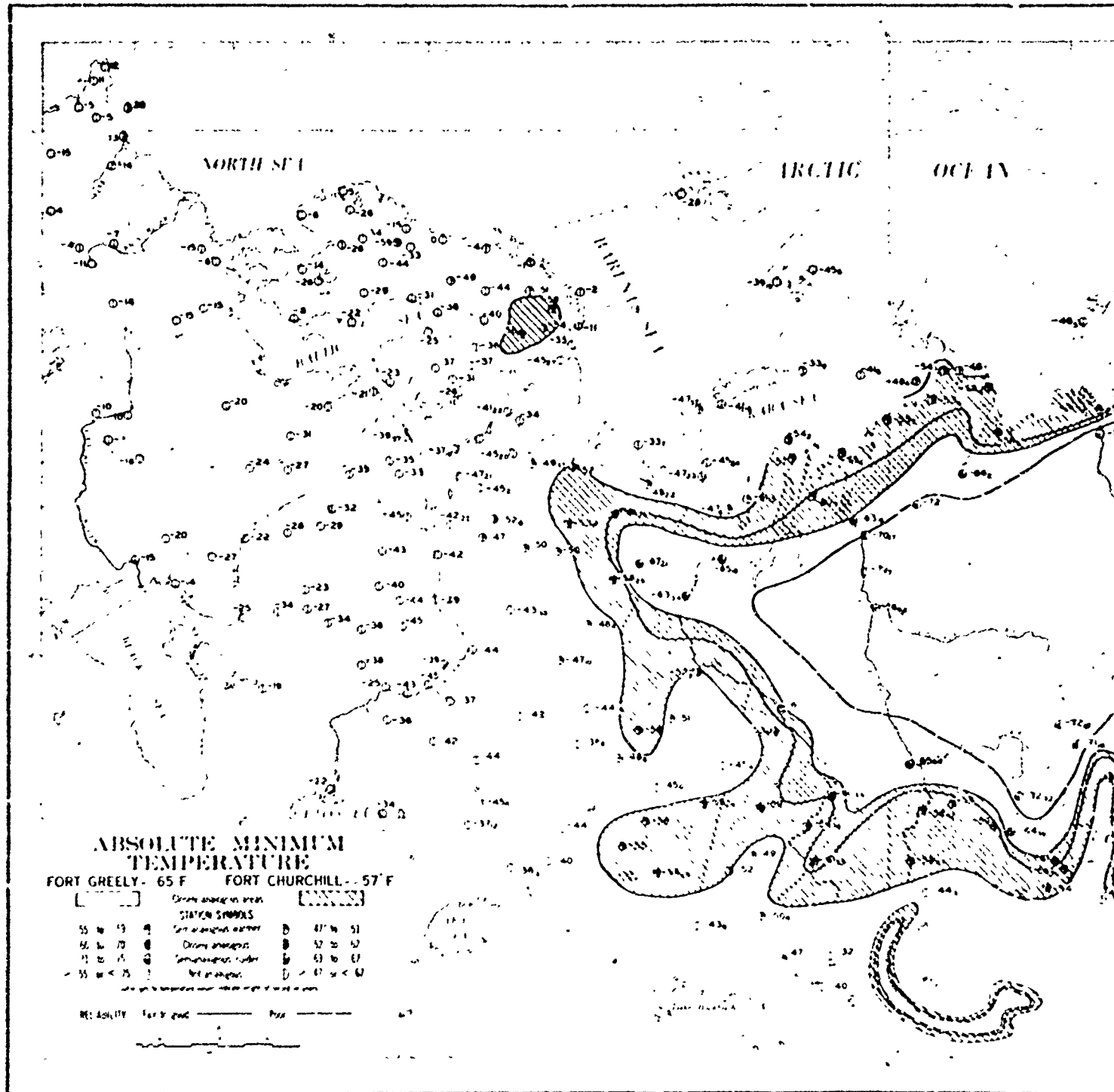


Figure 4

CLIMATIC ANALOGS OF FORT GREELY AND FORT CHURCHILL



MAPS OF FORT GREELY AND FORT CHARLIE - EURASIA

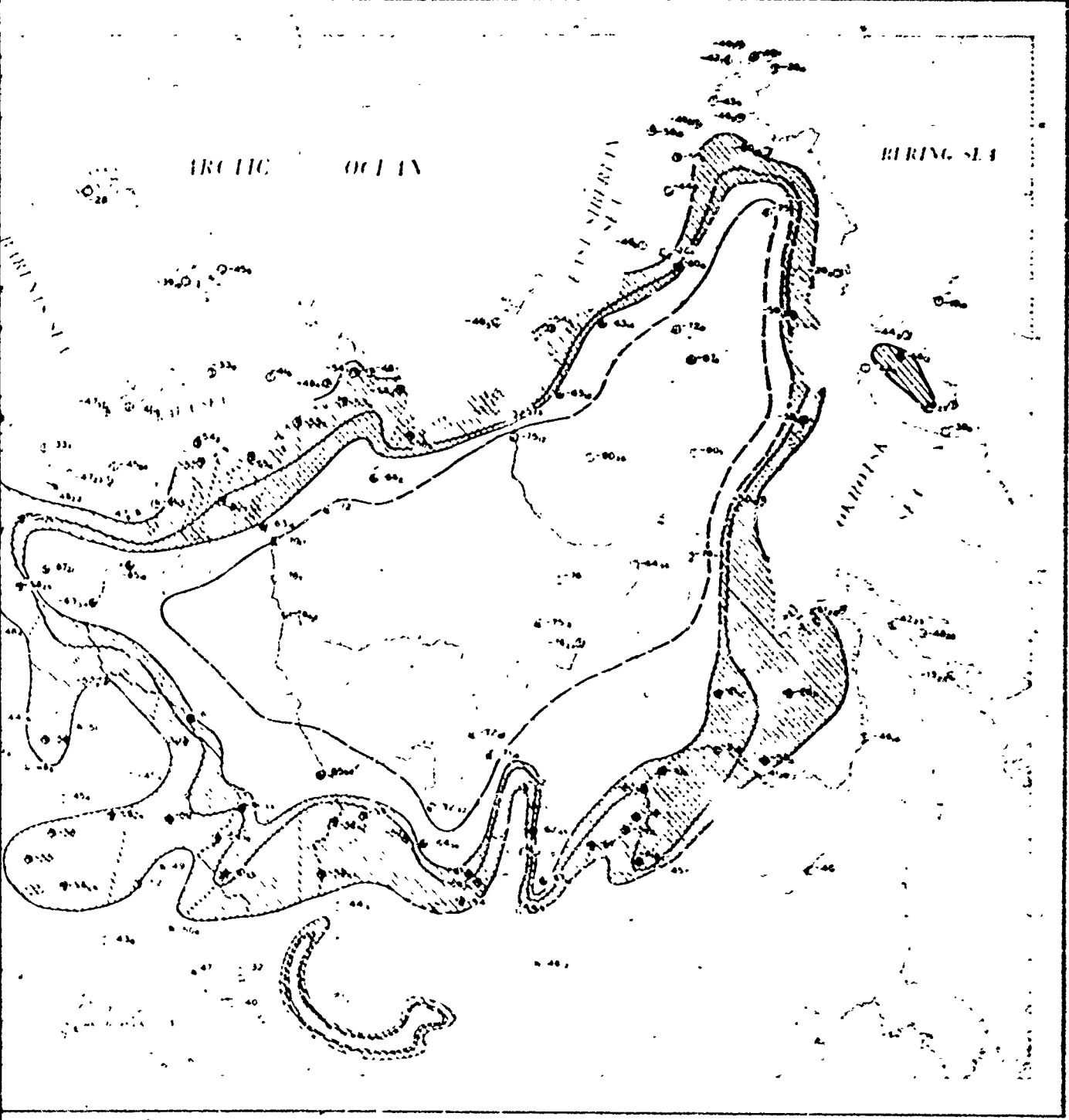
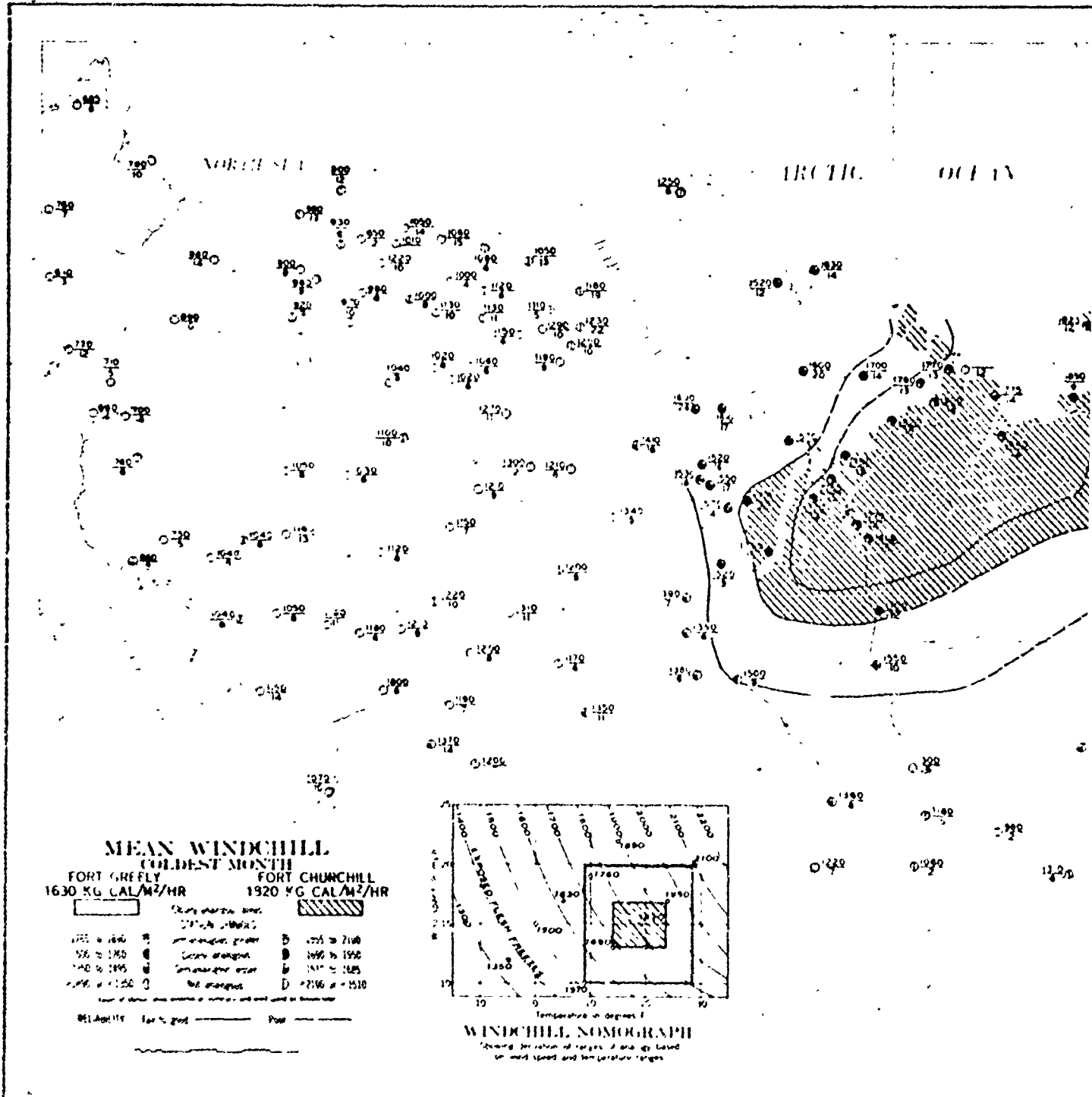


Figure 5

CLIMATE ANALYSIS OF FORT GREELY AND FORT CHURCHILL



GRITLY AND FORT CHARLIE - EURASIA

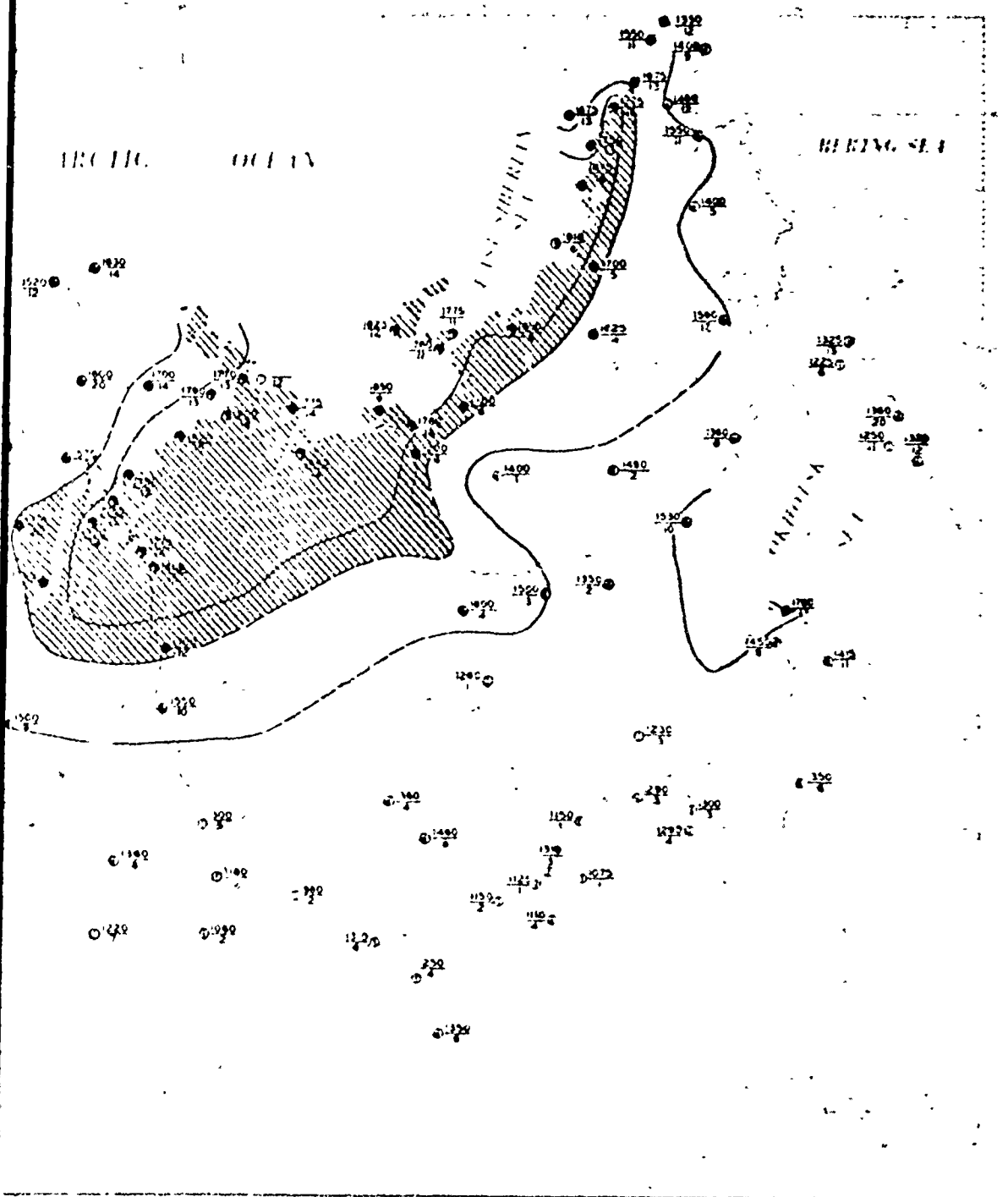


Figure 6

MEAN CLOUDINESS
COLDEST MONTH

FORT GREELY
55 TENTHS

FORT CHURCHILL
47 TENTHS

Station snowiness

Temperature ranges

46 to 55
56 to 65
66 to 75
76 to 85
86 to 95
96 to 105
106 to 115
116 to 125
126 to 135
136 to 145
146 to 155
156 to 165
166 to 175
176 to 185
186 to 195
196 to 205
206 to 215
216 to 225
226 to 235
236 to 245
246 to 255
256 to 265
266 to 275
276 to 285
286 to 295
296 to 305
306 to 315
316 to 325
326 to 335
336 to 345
346 to 355
356 to 365
366 to 375
376 to 385
386 to 395
396 to 405
406 to 415
416 to 425
426 to 435
436 to 445
446 to 455
456 to 465
466 to 475
476 to 485
486 to 495
496 to 505
506 to 515
516 to 525
526 to 535
536 to 545
546 to 555
556 to 565
566 to 575
576 to 585
586 to 595
596 to 605
606 to 615
616 to 625
626 to 635
636 to 645
646 to 655
656 to 665
666 to 675
676 to 685
686 to 695
696 to 705
706 to 715
716 to 725
726 to 735
736 to 745
746 to 755
756 to 765
766 to 775
776 to 785
786 to 795
796 to 805
806 to 815
816 to 825
826 to 835
836 to 845
846 to 855
856 to 865
866 to 875
876 to 885
886 to 895
896 to 905
906 to 915
916 to 925
926 to 935
936 to 945
946 to 955
956 to 965
966 to 975
976 to 985
986 to 995
996 to 1005
1006 to 1015
1016 to 1025
1026 to 1035
1036 to 1045
1046 to 1055
1056 to 1065
1066 to 1075
1076 to 1085
1086 to 1095
1096 to 1105
1106 to 1115
1116 to 1125
1126 to 1135
1136 to 1145
1146 to 1155
1156 to 1165
1166 to 1175
1176 to 1185
1186 to 1195
1196 to 1205
1206 to 1215
1216 to 1225
1226 to 1235
1236 to 1245
1246 to 1255
1256 to 1265
1266 to 1275
1276 to 1285
1286 to 1295
1296 to 1305
1306 to 1315
1316 to 1325
1326 to 1335
1336 to 1345
1346 to 1355
1356 to 1365
1366 to 1375
1376 to 1385
1386 to 1395
1396 to 1405
1406 to 1415
1416 to 1425
1426 to 1435
1436 to 1445
1446 to 1455
1456 to 1465
1466 to 1475
1476 to 1485
1486 to 1495
1496 to 1505
1506 to 1515
1516 to 1525
1526 to 1535
1536 to 1545
1546 to 1555
1556 to 1565
1566 to 1575
1576 to 1585
1586 to 1595
1596 to 1605
1606 to 1615
1616 to 1625
1626 to 1635
1636 to 1645
1646 to 1655
1656 to 1665
1666 to 1675
1676 to 1685
1686 to 1695
1696 to 1705
1706 to 1715
1716 to 1725
1726 to 1735
1736 to 1745
1746 to 1755
1756 to 1765
1766 to 1775
1776 to 1785
1786 to 1795
1796 to 1805
1806 to 1815
1816 to 1825
1826 to 1835
1836 to 1845
1846 to 1855
1856 to 1865
1866 to 1875
1876 to 1885
1886 to 1895
1896 to 1905
1906 to 1915
1916 to 1925
1926 to 1935
1936 to 1945
1946 to 1955
1956 to 1965
1966 to 1975
1976 to 1985
1986 to 1995
1996 to 2005
2006 to 2015
2016 to 2025
2026 to 2035
2036 to 2045
2046 to 2055
2056 to 2065
2066 to 2075
2076 to 2085
2086 to 2095
2096 to 2105
2106 to 2115
2116 to 2125
2126 to 2135
2136 to 2145
2146 to 2155
2156 to 2165
2166 to 2175
2176 to 2185
2186 to 2195
2196 to 2205
2206 to 2215
2216 to 2225
2226 to 2235
2236 to 2245
2246 to 2255
2256 to 2265
2266 to 2275
2276 to 2285
2286 to 2295
2296 to 2305
2306 to 2315
2316 to 2325
2326 to 2335
2336 to 2345
2346 to 2355
2356 to 2365
2366 to 2375
2376 to 2385
2386 to 2395
2396 to 2405
2406 to 2415
2416 to 2425
2426 to 2435
2436 to 2445
2446 to 2455
2456 to 2465
2466 to 2475
2476 to 2485
2486 to 2495
2496 to 2505
2506 to 2515
2516 to 2525
2526 to 2535
2536 to 2545
2546 to 2555
2556 to 2565
2566 to 2575
2576 to 2585
2586 to 2595
2596 to 2605
2606 to 2615
2616 to 2625
2626 to 2635
2636 to 2645
2646 to 2655
2656 to 2665
2666 to 2675
2676 to 2685
2686 to 2695
2696 to 2705
2706 to 2715
2716 to 2725
2726 to 2735
2736 to 2745
2746 to 2755
2756 to 2765
2766 to 2775
2776 to 2785
2786 to 2795
2796 to 2805
2806 to 2815
2816 to 2825
2826 to 2835
2836 to 2845
2846 to 2855
2856 to 2865
2866 to 2875
2876 to 2885
2886 to 2895
2896 to 2905
2906 to 2915
2916 to 2925
2926 to 2935
2936 to 2945
2946 to 2955
2956 to 2965
2966 to 2975
2976 to 2985
2986 to 2995
2996 to 3005
3006 to 3015
3016 to 3025
3026 to 3035
3036 to 3045
3046 to 3055
3056 to 3065
3066 to 3075
3076 to 3085
3086 to 3095
3096 to 3105
3106 to 3115
3116 to 3125
3126 to 3135
3136 to 3145
3146 to 3155
3156 to 3165
3166 to 3175
3176 to 3185
3186 to 3195
3196 to 3205
3206 to 3215
3216 to 3225
3226 to 3235
3236 to 3245
3246 to 3255
3256 to 3265
3266 to 3275
3276 to 3285
3286 to 3295
3296 to 3305
3306 to 3315
3316 to 3325
3326 to 3335
3336 to 3345
3346 to 3355
3356 to 3365
3366 to 3375
3376 to 3385
3386 to 3395
3396 to 3405
3406 to 3415
3416 to 3425
3426 to 3435
3436 to 3445
3446 to 3455
3456 to 3465
3466 to 3475
3476 to 3485
3486 to

PORT GREENLY AND FORT CHARBELL - EURASIA

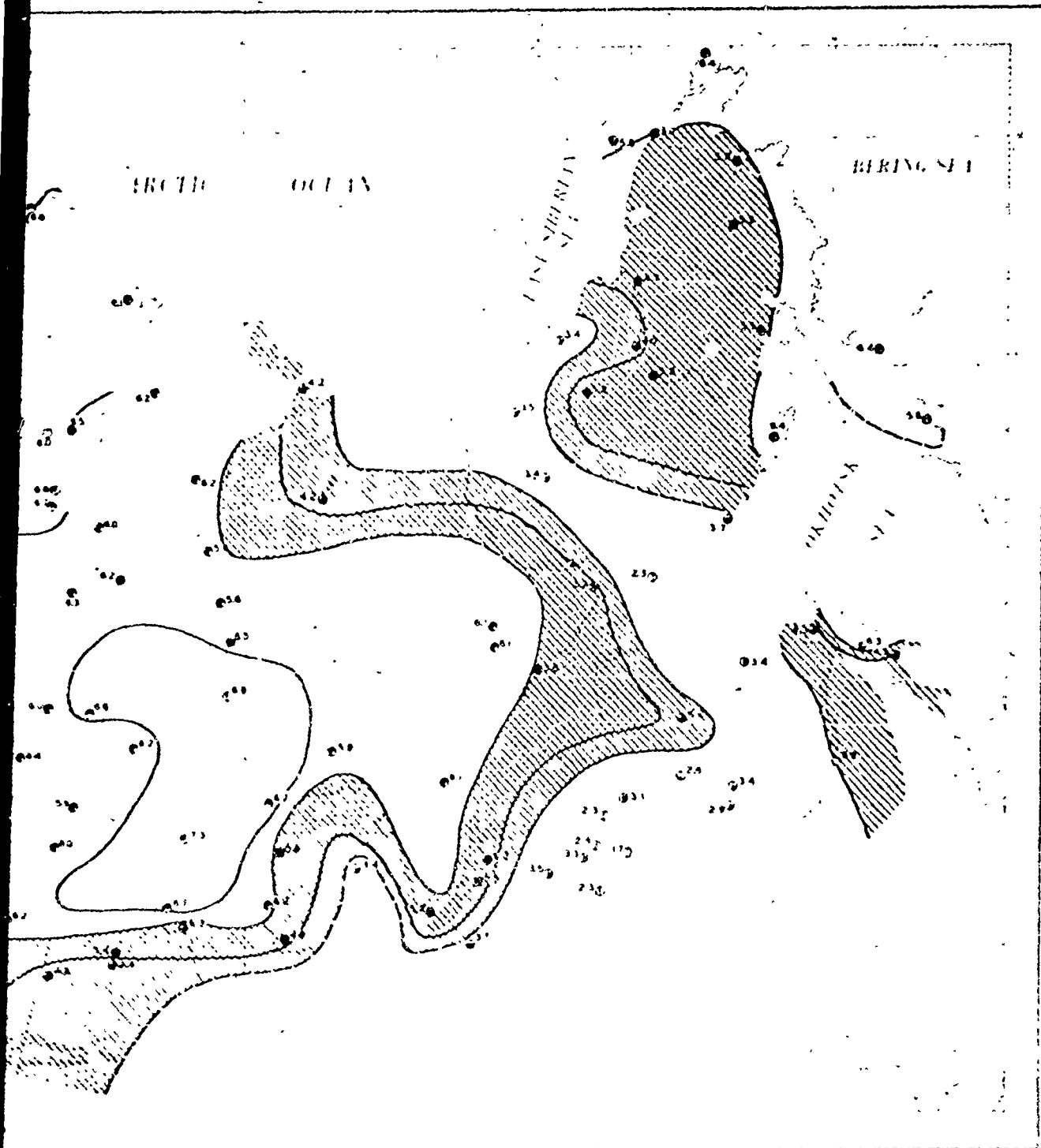
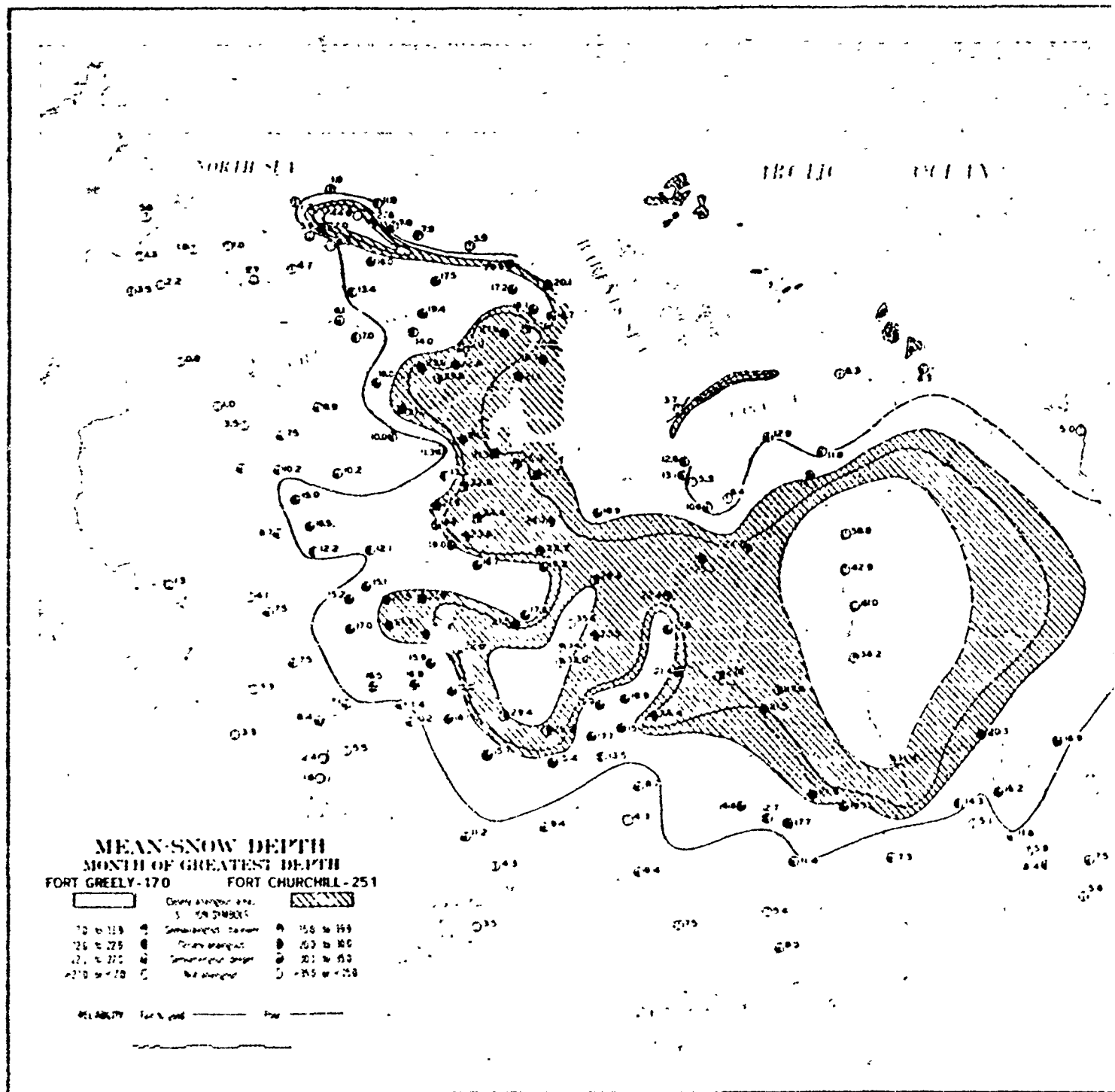


Figure 2

CLIMATE ANALOGS OF FORT GREELY AND FORT CHURCHILL



OF PORTERFIELD AND FORT CHURCHILL - EURASIA

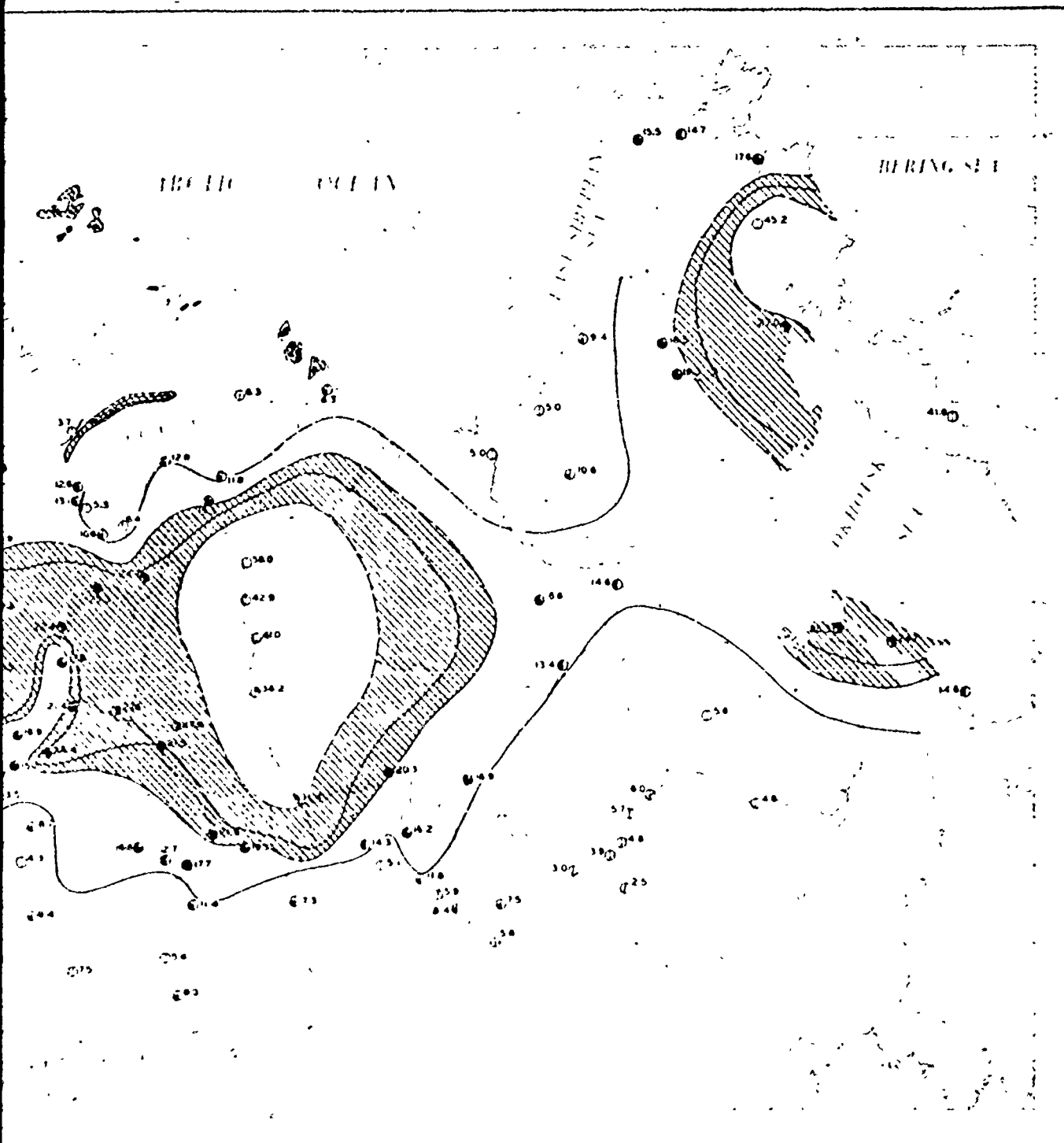
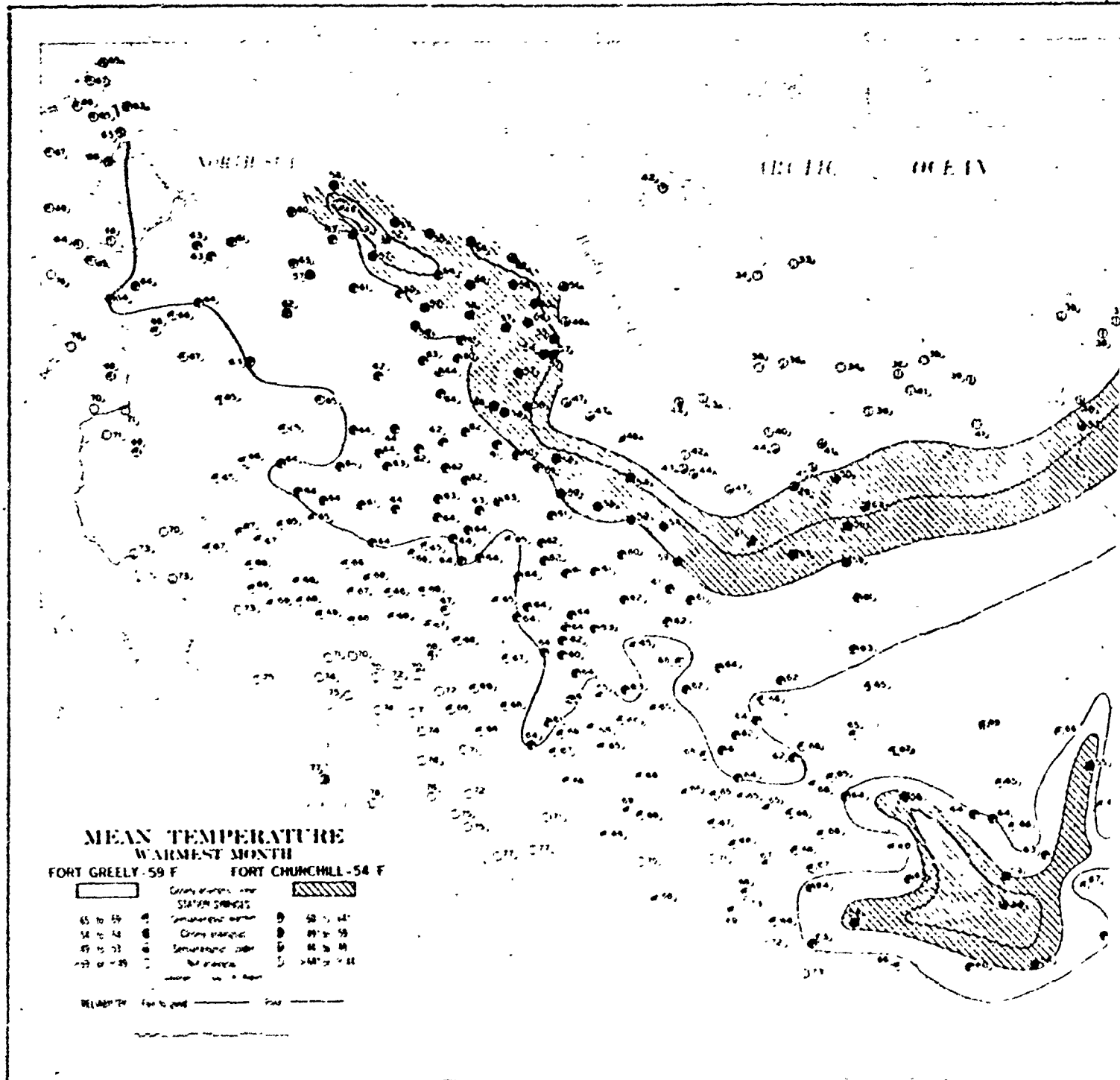
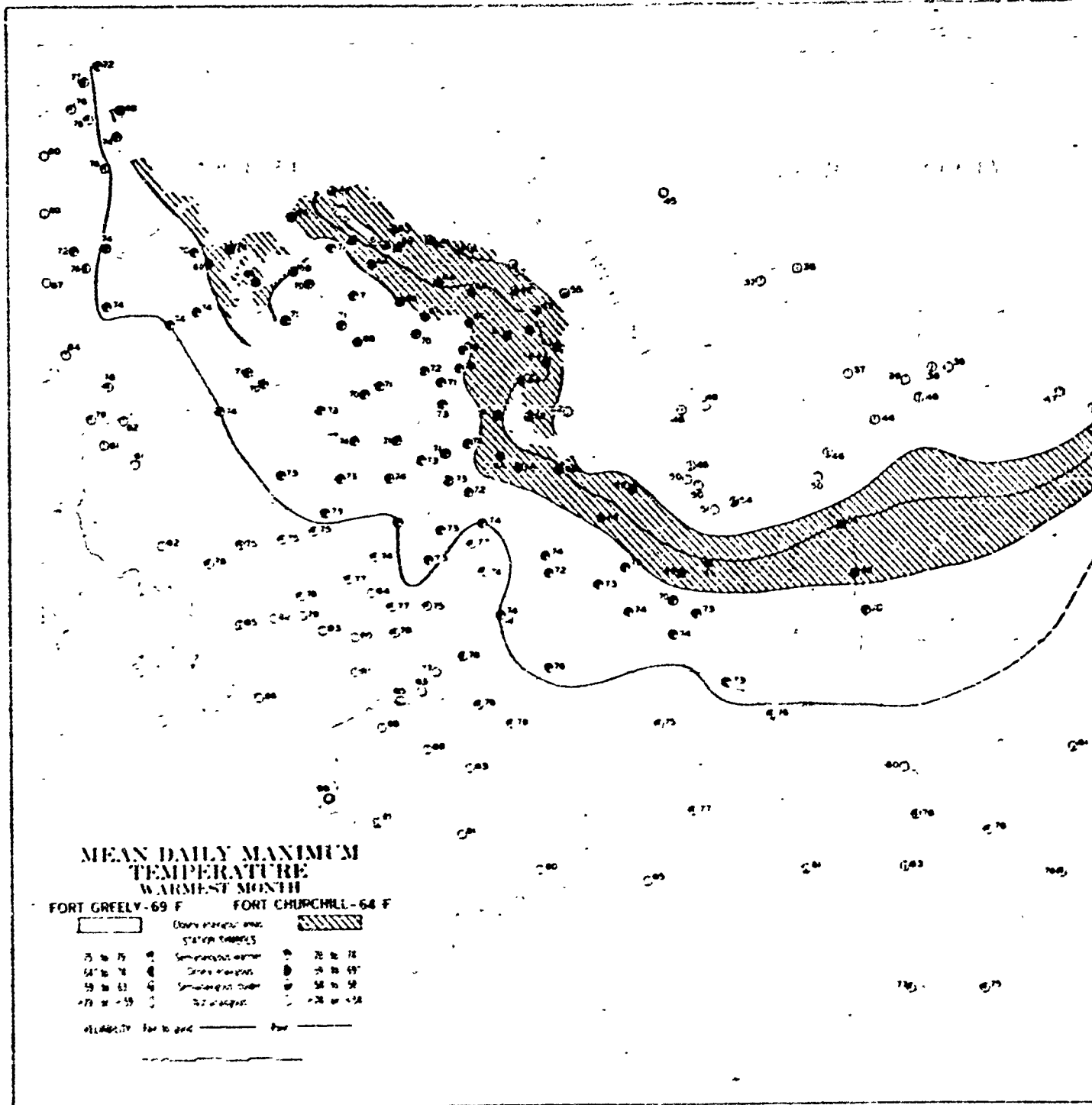


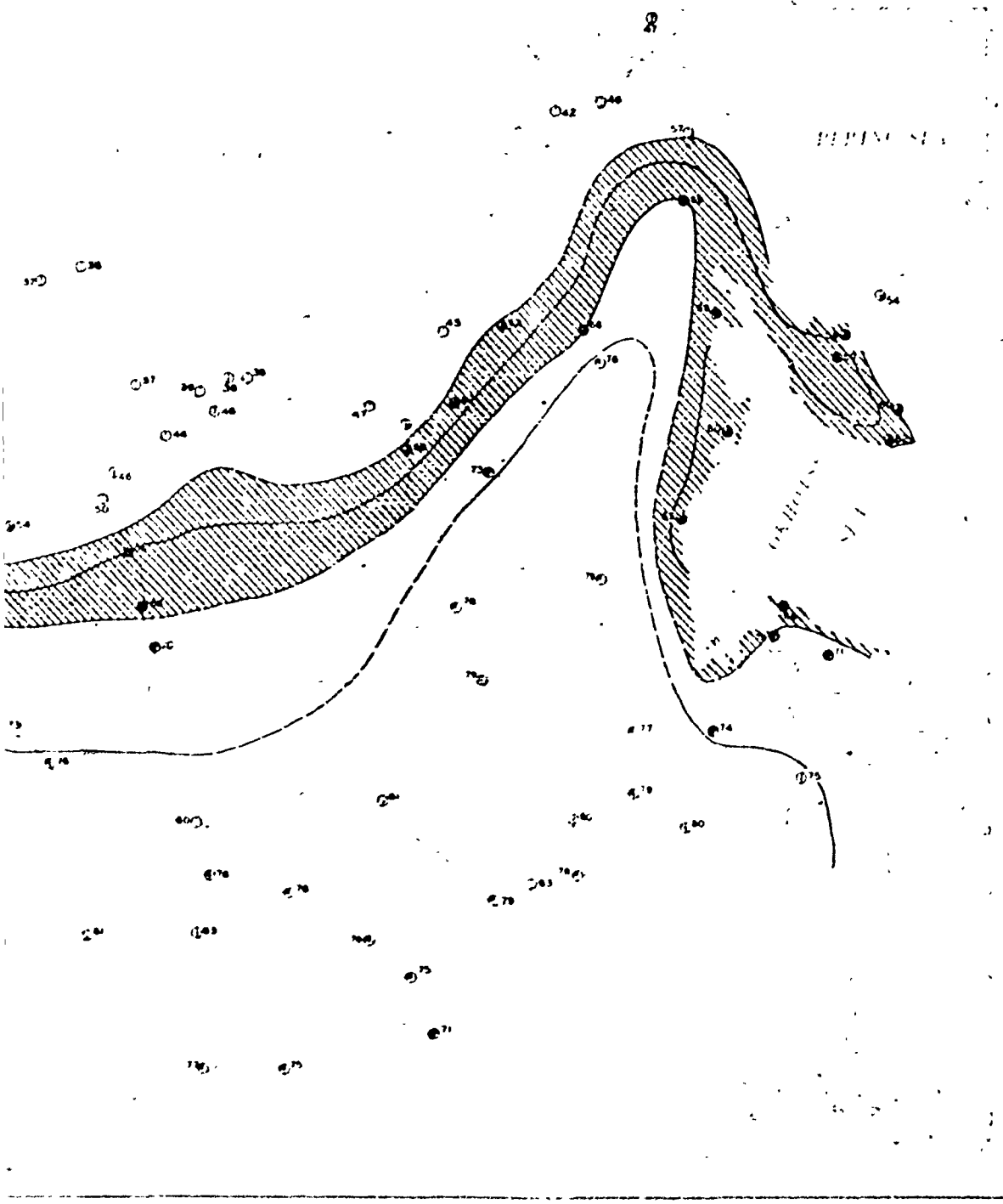
Figure 8

CLIMATIC ANALYSIS OF FORT GREELY AND FORT CHURCHILL



[illegible]



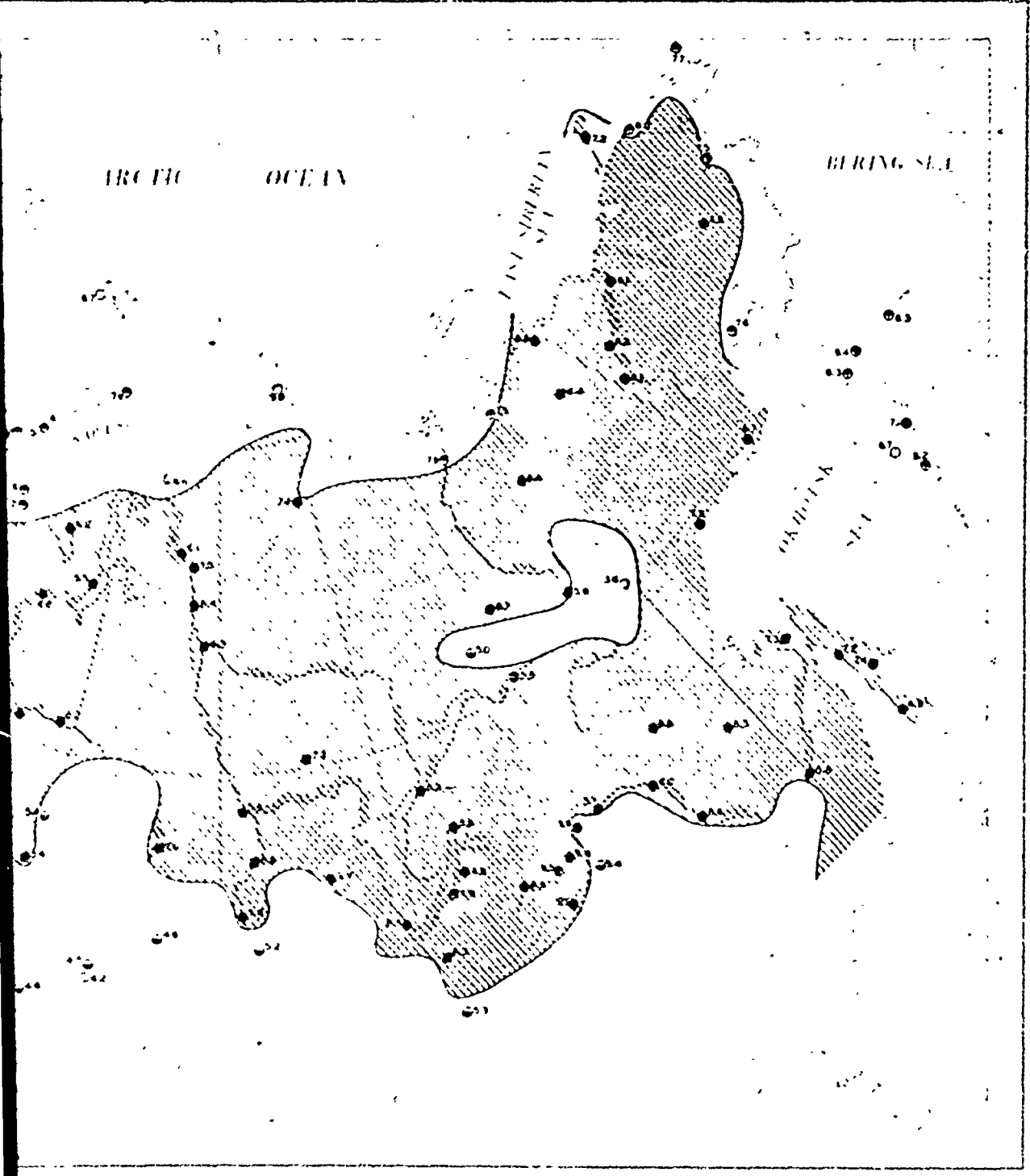


**MEAN CLOUDINESS
WARMEST MONTH
FORT GREELY AND FORT CHURCHILL - 6.4 TENTHS**

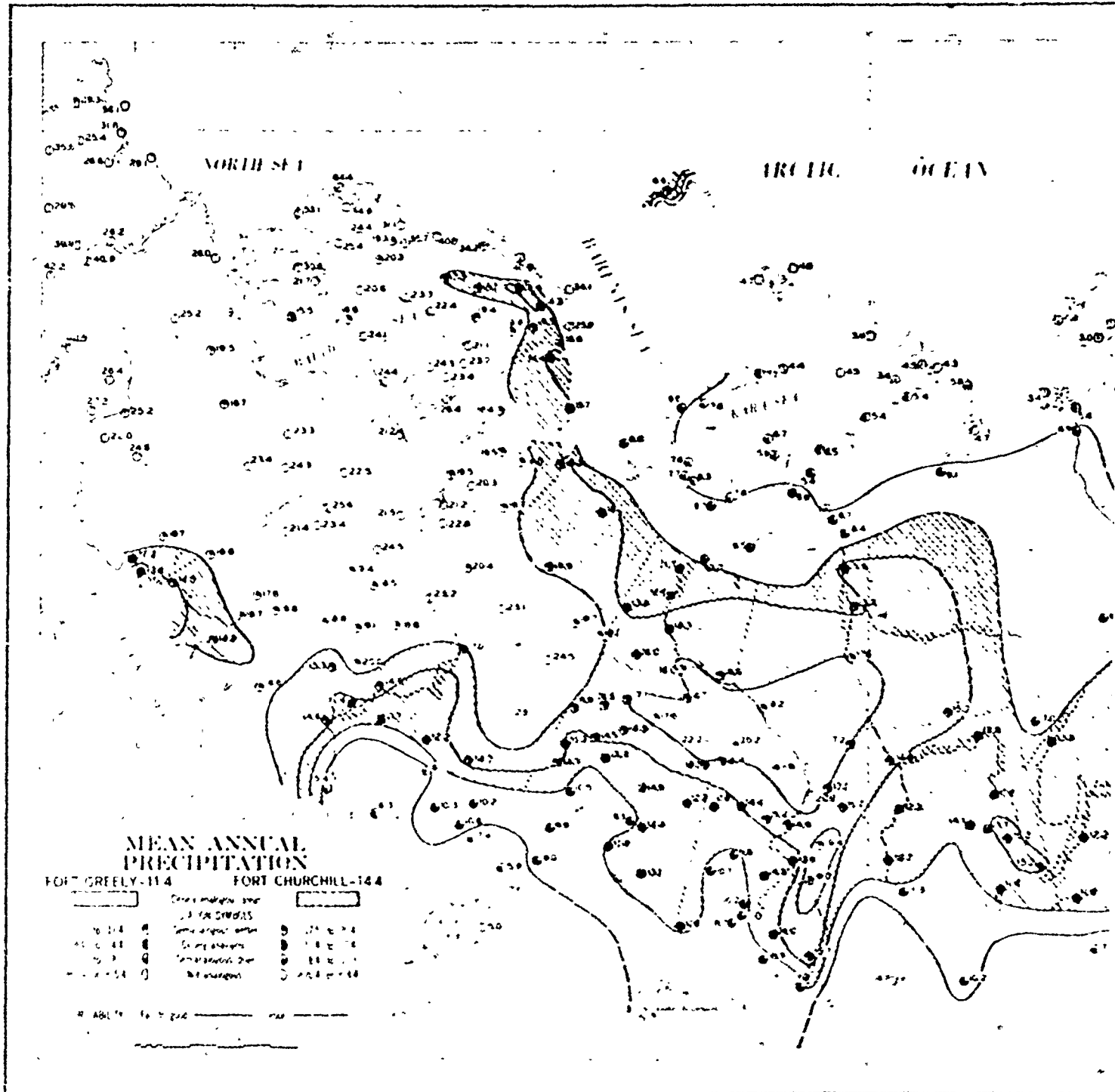
Cloudiness ranges: 5.0 to 6.4, 6.5 to 7.9, 8.0 to 9.4, 9.5 to 10.0

Scale: 0 to 100 miles

FORT GREENLY AND FORT CHURCHILL - MEXIA



CLIMATIC ANALOGUES OF FORT GREELY AND FORT CHURCHILL



WELFARE AND FORT CHURCHILL - EURASIA

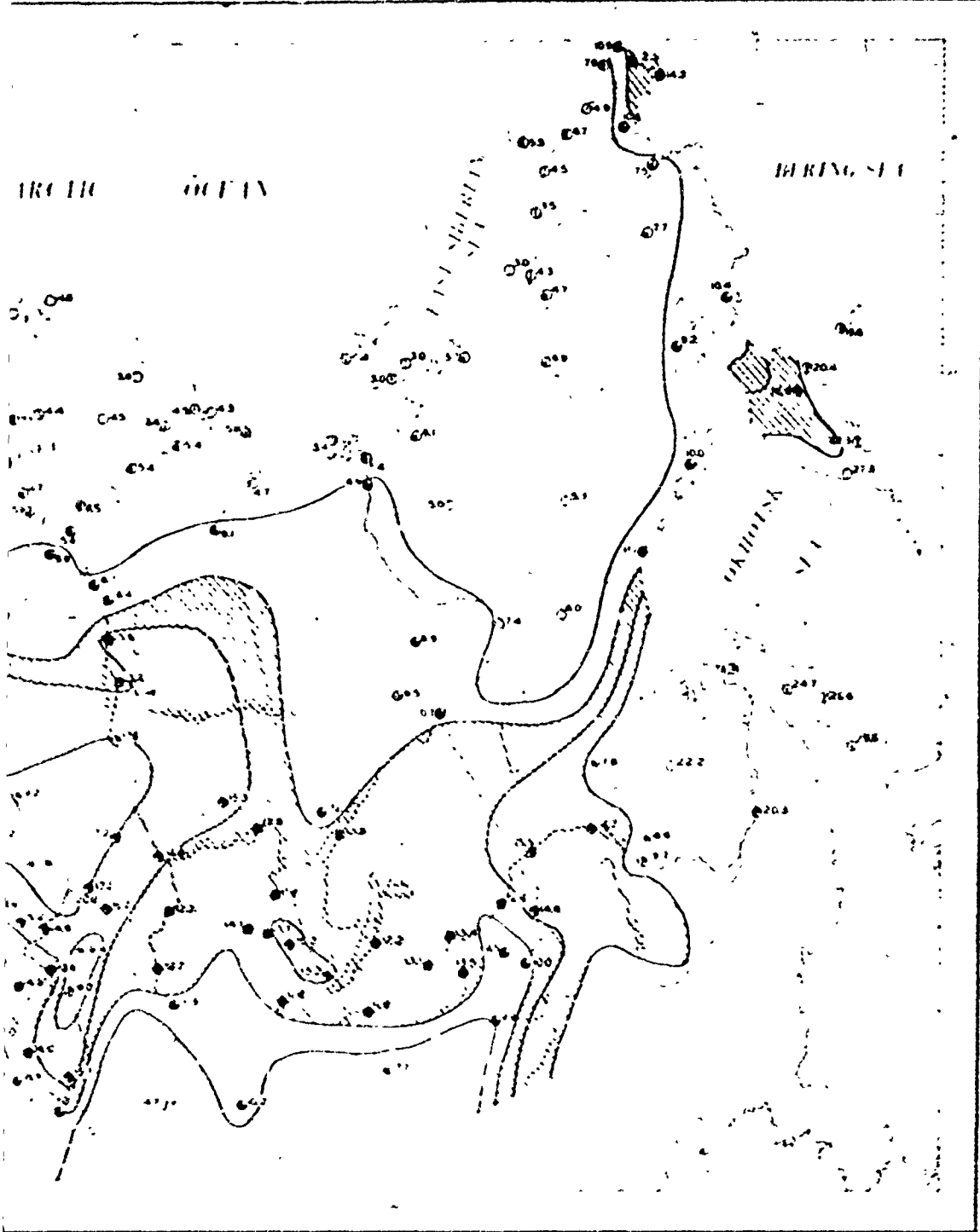
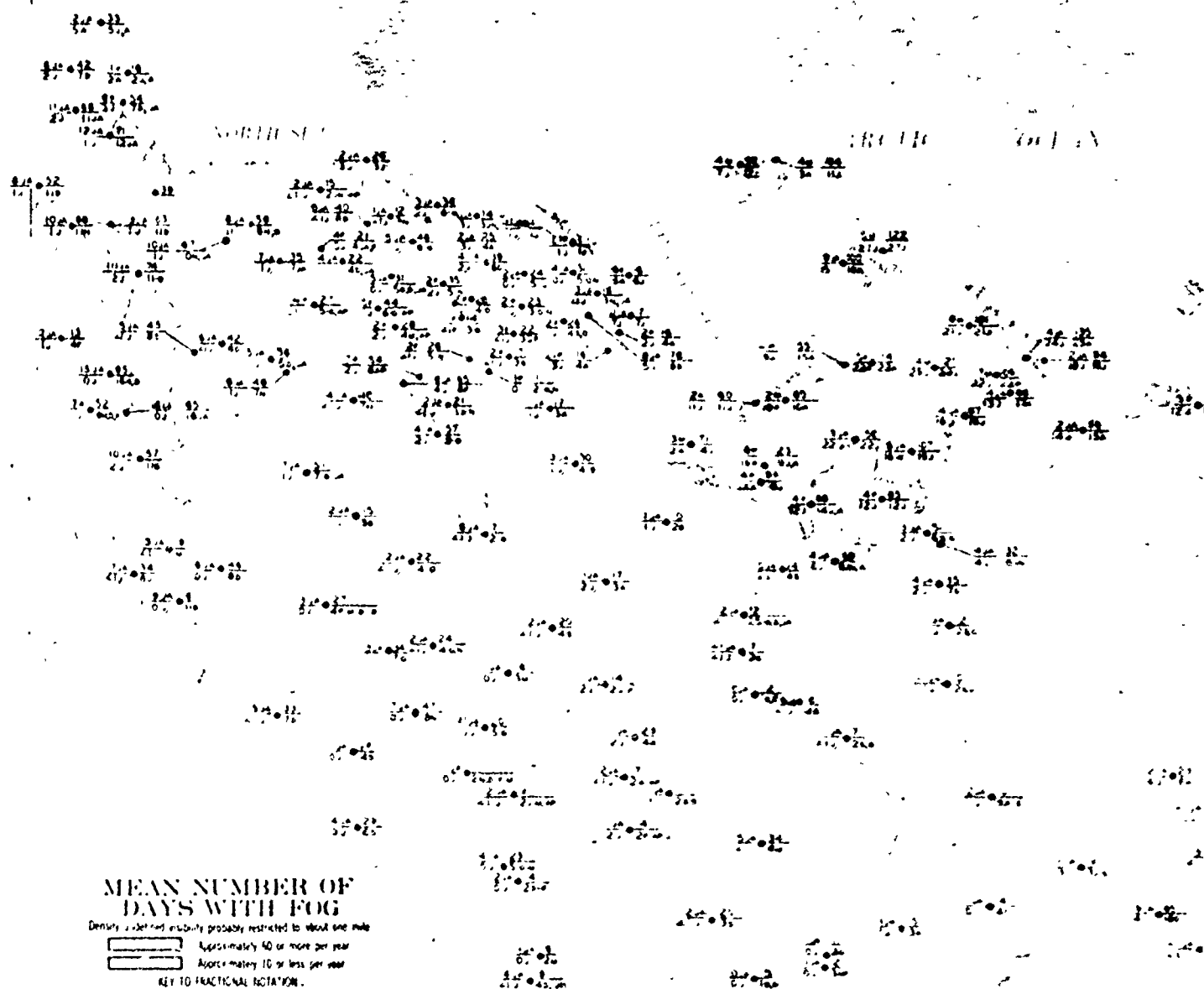


Figure 12

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MEAN NUMBER OF DAYS WITH FOG

Density is defined as unitary probability restricted to about one rule

☐ Approximately 40 or more per year
☐ Approximately 10 or less per year

KEY TO FRACTIONAL NOTATION.

Mean coldest month Mean annual
Mean warmest month Mean foggiest month

11th: $\frac{1}{1} \cdot \frac{1}{2} = \frac{1}{2}$ 12th: $\frac{1}{2} \cdot \frac{1}{3} = \frac{1}{6}$

[illegible]

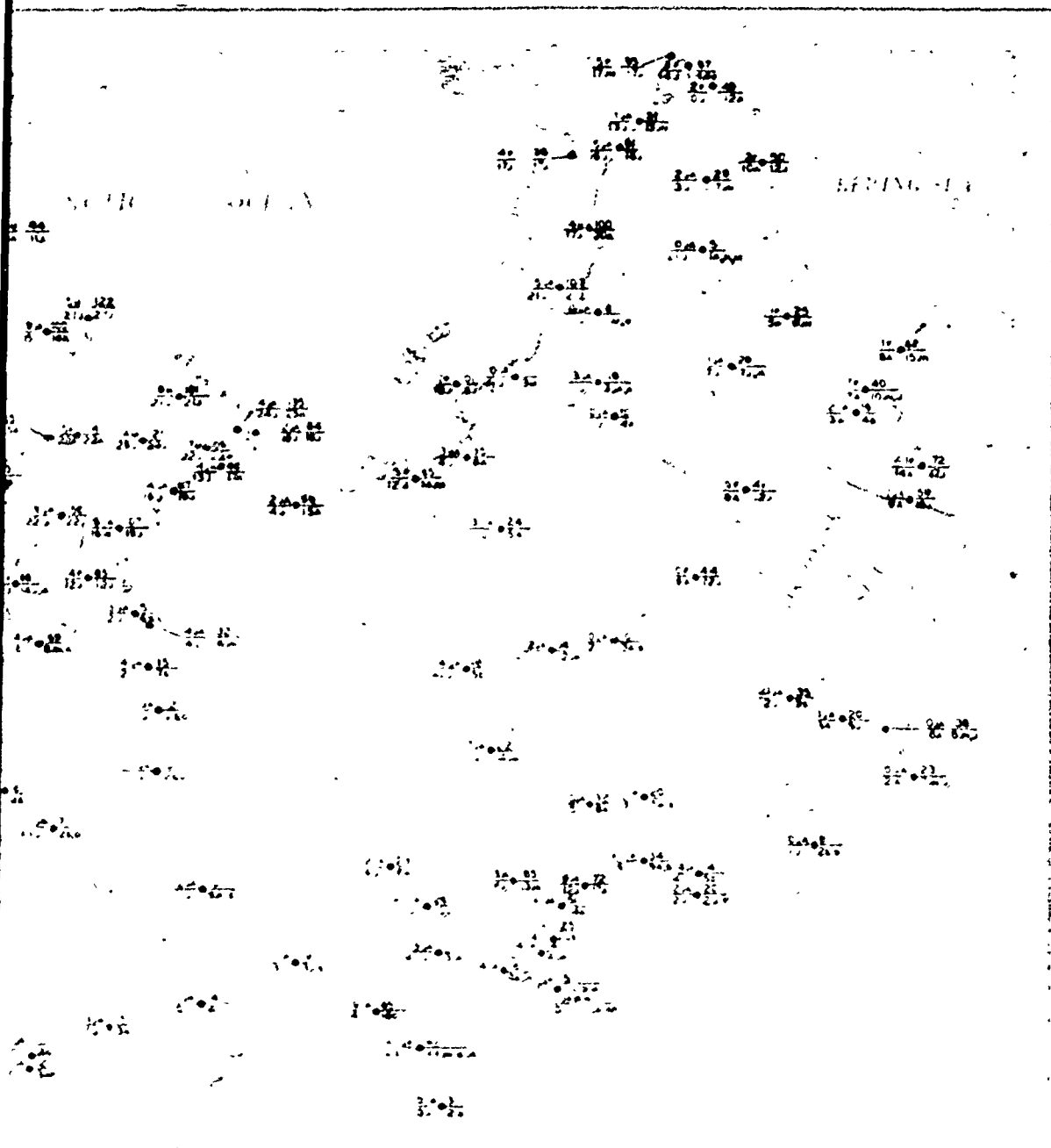
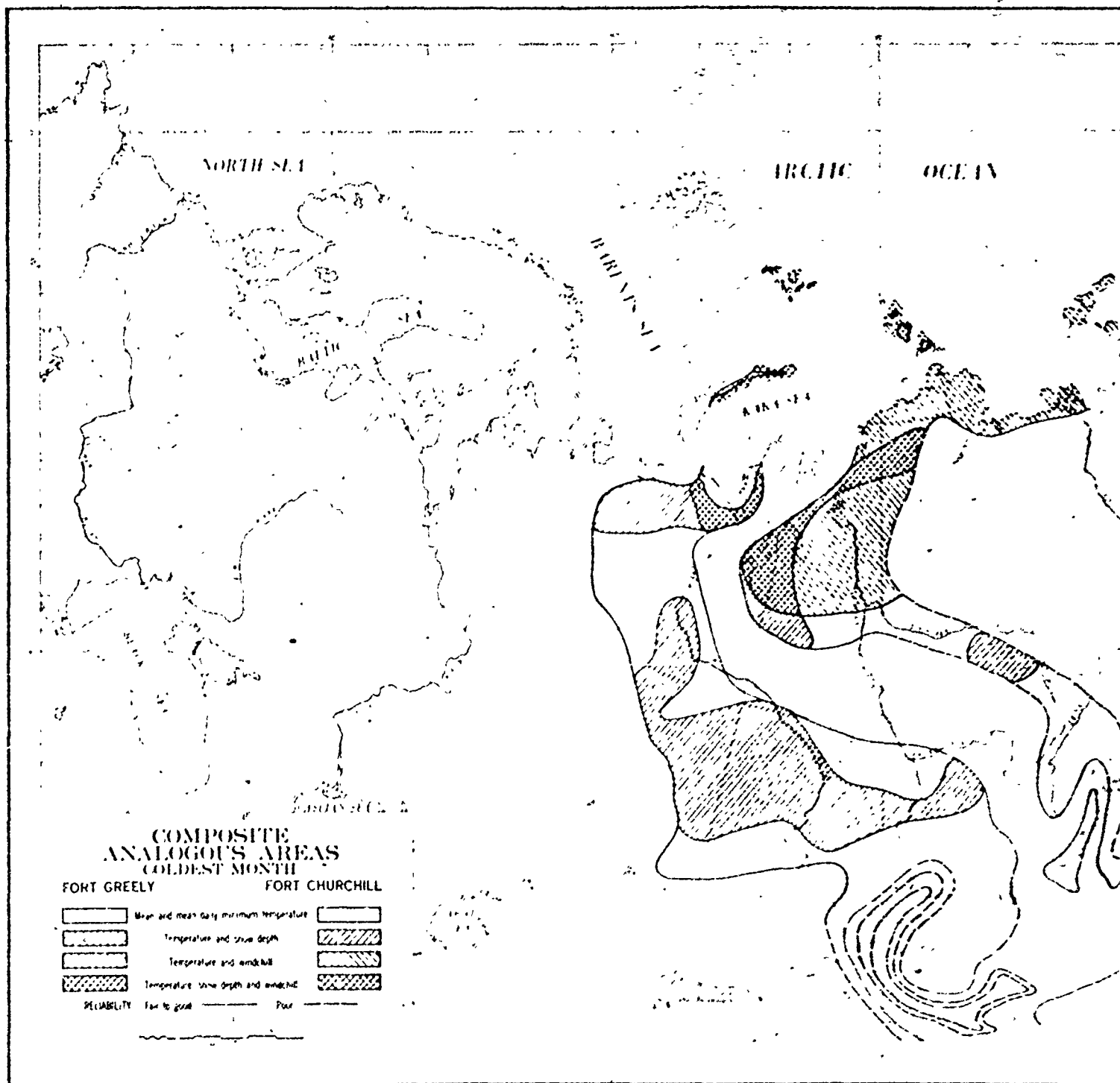


Figure 12A

CLIMATIC ANALOGUES OF FORT GREELY AND FORT CHURCHILL



GREENLY AND FORT CHURCHILL - EURASIA

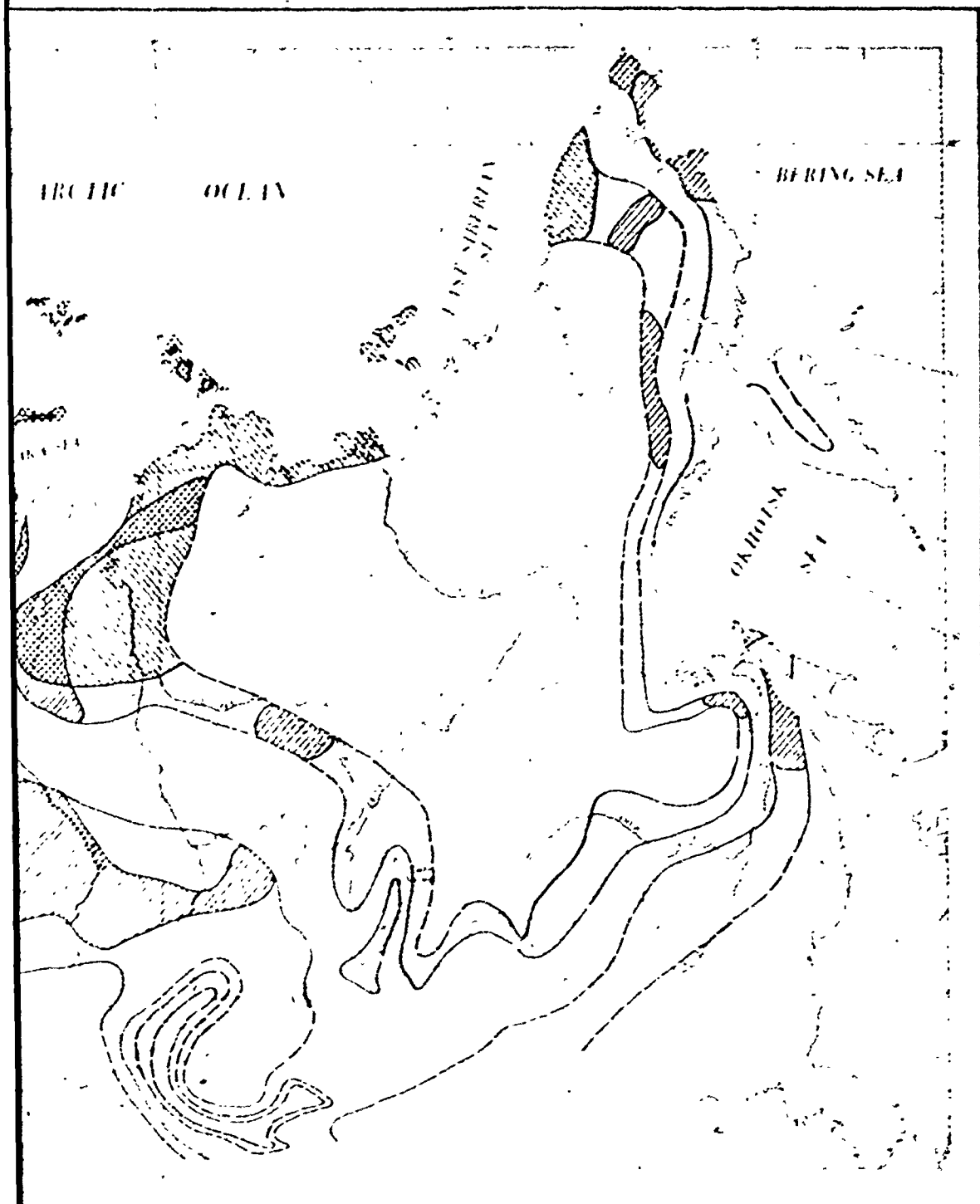
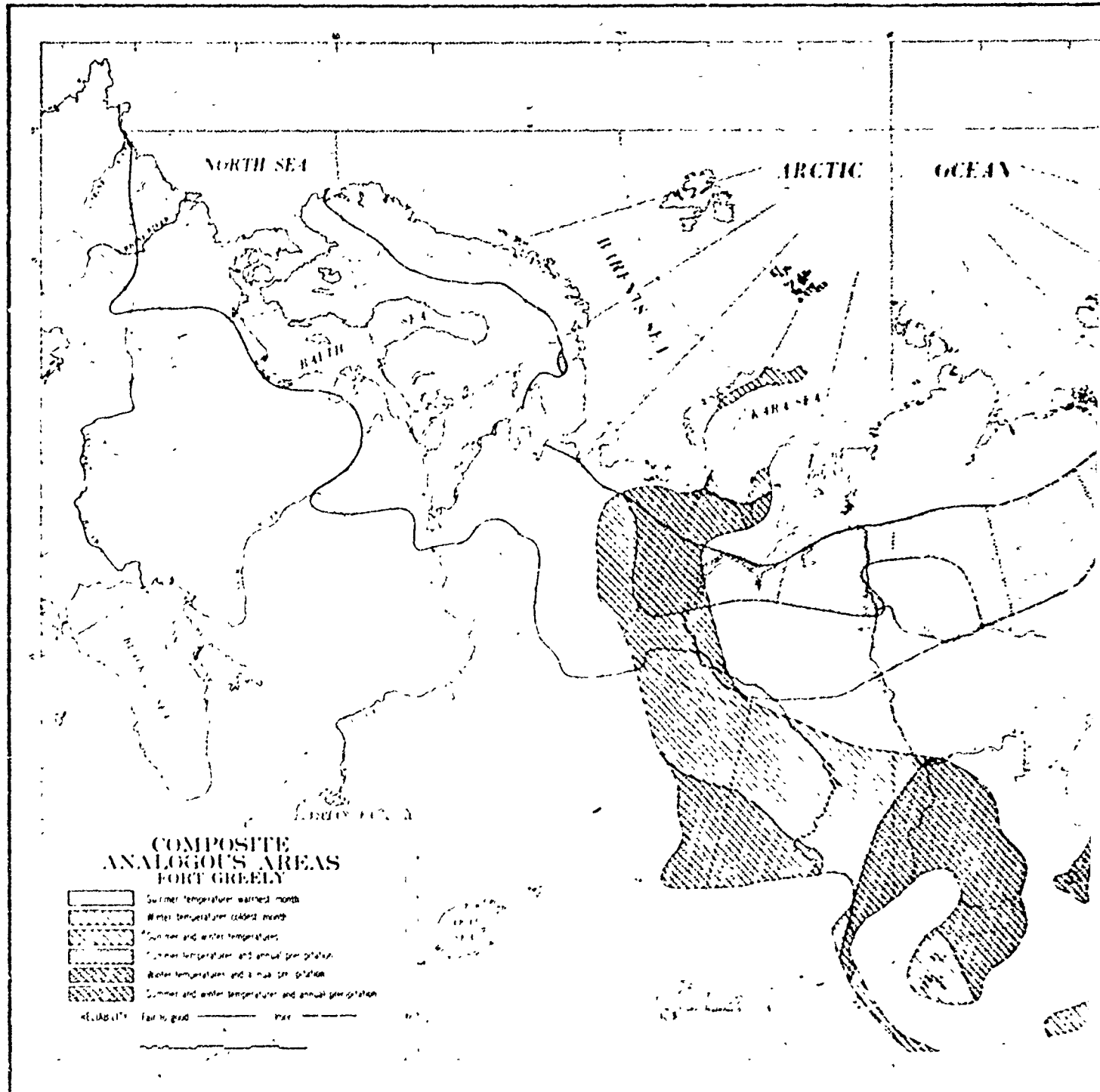


Figure 13

CLIMATIC ANALOGS OF FORT GREELY AND FORT CHURCH



FORT GREELY AND FORT CHURCHILL - EURASIA

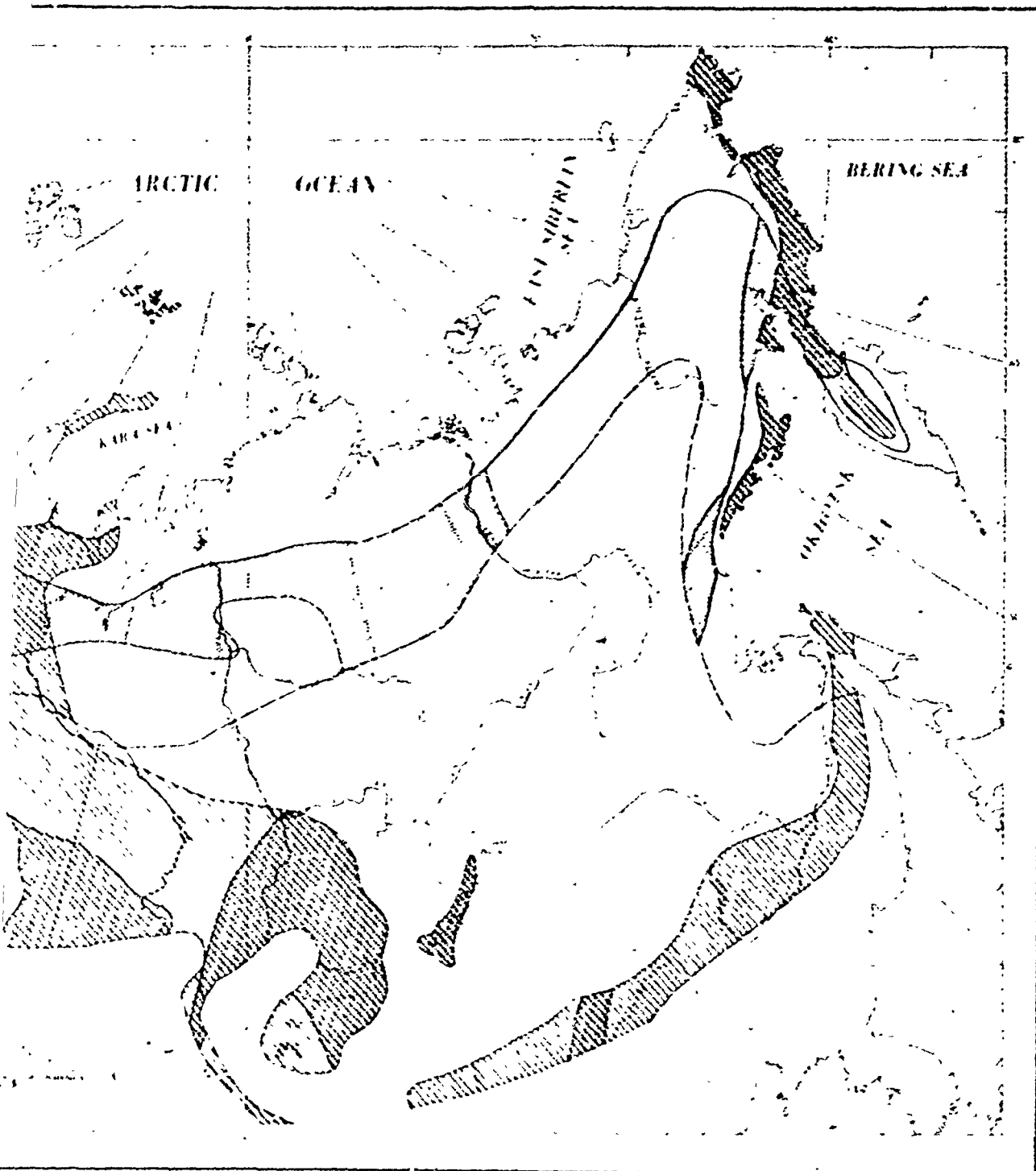
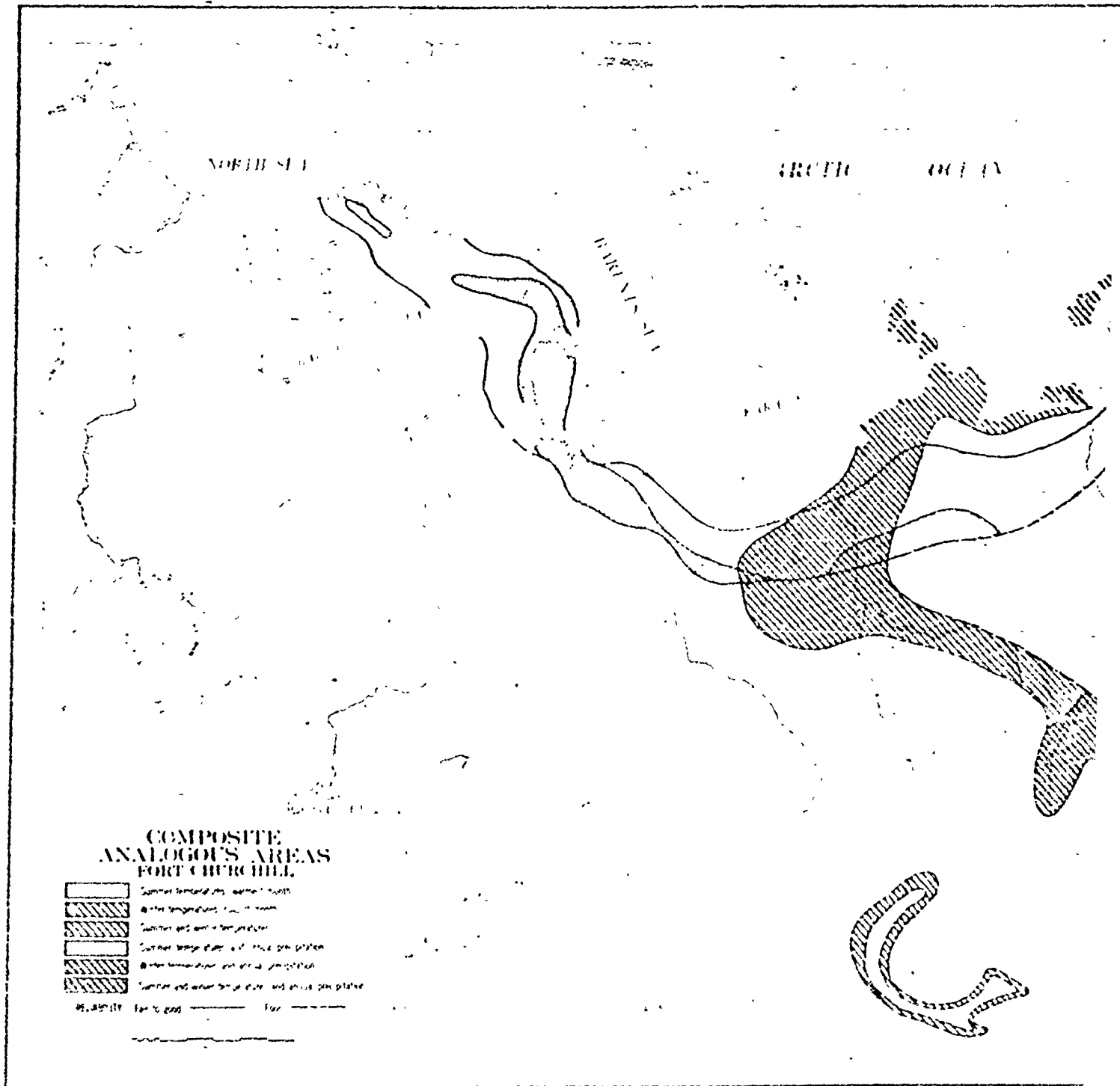


Figure 14

CLIMATIC ANALOGS OF FORT GREENE AND FORT - CHURCHILL



CRETACEOUS AND PALEOGENE - MOUNTAIN

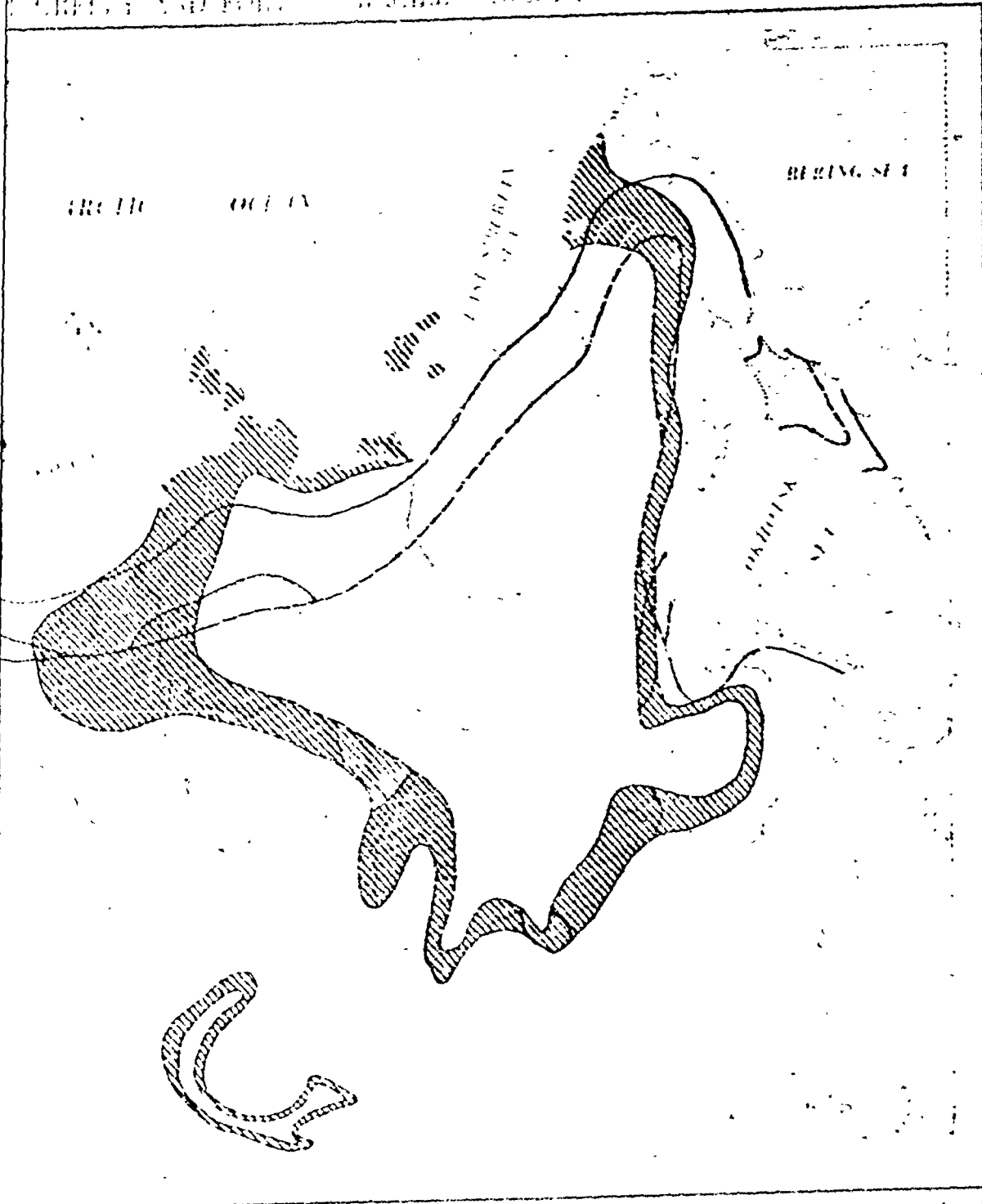


Figure 20