

MEDDELELSER OM GRØNLAND

UDGIVNE AF

KOMMISSIONEN FOR VIDENSKABELIGE UNDERSØGELSER I GRØNLAND

Bd. 144 · Nr. 1

DE DANSKE EXPEDITIONER TIL ØSTGRØNLAND 1926-39

UNDER LEDELSE AF LAUGE KOCH

APPENDIX No. 1

CLIMATE AND WEATHER
OVER THE COAST-LAND OF NORTHEAST
GREENLAND AND THE ADJACENT SEA

BY

E. HOVMØLLER

WITH 100 FIGURES IN THE TEXT AND 11 PLATES

KØBENHAVN

C. A. REITZELS FORLAG

BIANCO LUNOS BOGTRYKKERI

1947

CONTENTS

	Page
Introduction	5
I. Description of the climate in the coast-land of Northeast Greenland and over the adjacent sea.....	8
1. The material of observations	8
2. Atmospheric pressure	9
3. Wind conditions	23
4. Temperature	33
5. Humidity of the air, cloudiness, visibility, precipitation	87
II. Examples of typical and extraordinary weather situations	98
III. Explanation of plates 1—11.....	177
Literature	207
Plates	209

INTRODUCTION

Great technical progress in the years after the first world war have rendered possible a considerable increase in arctic exploration. Tasks which previously caused almost insurmountable difficulties may now be solved quickly and elegantly, and new problems can be embarked upon. But in spite of all progress, the scientific results of a polar expedition, now as before, depend to a very great extent on the weather. Unfavourable weather and ice conditions may prevent the ship which is to carry the expedition to its working area, from reaching it in time. As to aircraft, which has been increasingly employed in arctic exploration, its efficiency in these desolate and bleak tracts depends far more on the weather than in other regions. The mapping from the air which in the course of some few years has brought our knowledge of the topography of the arctic countries a great step forwards, is only possible under particularly favourable meteorological conditions. For detailed investigations in a single tract the weather conditions are of decisive importance; even at the present day an unexpected change in the weather may cause great difficulties and dangers.

The aforementioned dependency on the weather can only to a small extent be assumed to be overcome in the course of time as a result of purely technical advances; but it would be of considerable value if it were possible one day to keep the expeditions informed of weather changes, both such as had taken place and such as were expected, so that they would be able to avert catastrophes. This would require, in the first place, an increased knowledge of the special problems associated with arctic weather, and secondly, a much closer network of observing stations than that existing so far.

Meteorological observations from the polar countries may not only become of importance—immediately or at some future time—through their being used for prognostic purposes; they also constitute an indispensable part of the extensive investigations now commenced on the adaptation of animals and plants to the extremely poor life conditions afforded by the arctic countries.

All these facts render it understandable that arctic explorers take an interest in the meteorological and climatical conditions of the polar countries—an interest which for more than a hundred years has manifested itself in the collection, carried on with admirable perseverance and under the most difficult conditions, of observational data which even at the present day constitute an essential part of the basis of our knowledge in this particular field.

To meteorology as such, a knowledge of the climate and weather of arctic regions is of great importance, among other reasons because of the part which these regions play in the general circulation of the atmosphere. For the solution of the fairly simple fundamental problems of meteorology we shall, indeed, rarely need the still rather sparse observation material from the polar countries, often collected under conditions unfavourable for observation; but gradually as the development of this branch of science necessitates a shifting of the searchlight from the simple to the more complicated, the arctic material already available will be more highly needed and every effort will be made to secure fresh particulars.

The initiative towards the present work was taken by Dr. LAUGE KOCH, who as the leader of the scientific expeditions to Northeast Greenland in the years 1929—39 had ample opportunities of gaining experience as to the importance of the weather for arctic exploration. The work was first planned to give an idea of the meteorological conditions during the periods the expedition stayed in Greenland, that is to say, mainly during the summer months; the graphical representations accompanying the present paper (Pls. 1—11) have been executed with this aim in view. Furthermore, it was desirable to procure material for illustration of the connection between the weather and the ice conditions, especially along the east coast of Greenland and around Iceland, in the individual years; for this purpose it was necessary to extend the investigation to comprise the winter half of the year also. The result was a confirmation of the impression received beforehand that in arctic regions the winter is of greater interest in a meteorological respect than the summer: the processes are, physically as well as geographically, of a greater magnitude, the problems stand out more clearly and sharply, and the interaction of the weather conditions of the temperate and of the polar zone is more marked in the winter than in the summer. Such considerations induced the author, with the consent of Dr. KOCH, to lay approximately the same stress upon winter and summer; the plates deal with the summer only, but a series of selected weather maps is added, the greater number of them concerning the winter half-year. Nearly all the examples are derived from the eleven years that the investigation had in view from the outset, which is all the more

natural since the observational data from these years (notably from and including the "Polar Year" 1932—33) are comparatively abundant. Part I gives a general account of the climate within the area especially treated in the present paper, viz. the northeast coast of Greenland from Scoresby Sund to Danmarks Havn and the adjoining area of the sea to a distance of c. 500 km from the shore. The climatological chapters are to some extent based on the several works (notably L. 3, 4, 5, 7, 10, 21 and 27) in which other authors have utilised the available material.

The author is indebted to Dr. LAUCE KOCH, who has taken a great interest in the work in all its stages and has repeatedly thrown sidelights on problems which have relevance to the subject treated; grateful acknowledgements are also due to the Danish Meteorological Institute, Copenhagen, which has kindly placed year-books, weather maps, etc., at the author's disposal.

The figures, with the exception of Figs. 6—8, which were drawn by Mr. DANBO, have been drawn by Mr. W. HOBEL, the plates by Mr. F. H. RÖHLING, both of the Geodetic Institute, Copenhagen, while the translation of the paper into English was done by Miss E. GLEERUP.

I. DESCRIPTION OF THE CLIMATE IN THE COAST-LAND OF NORTHEAST GREENLAND AND OVER THE ADJACENT AREA OF THE SEA

1. The Material of Observations.

In illustration of the climate and weather conditions along the coast of Northeast Greenland, fairly long, though somewhat incomplete, series of observations are at hand from two fixed stations, viz.

Scoresbysund .. 70°29' N, 21°58' W, 17m above sea-level (1924—40) and
Myggbukta 73°30' N, 21°30' W, 2 - — — (1922—40).

Shorter series of observations are at hand i. a. from

Danmarks Havn 76°46' N, 18°45' W, 4m above sea-level (1906—08) and
Sandodden 74°25' N, 20°30' W, 10 - — — (1929—31).

The observations from the two first-mentioned stations have chiefly been published in year-books (L. 18, 20); as to a minor part of them, however, we have to use weather maps and the like, which means that the number of the sources of error is substantially increased—above all, the wireless communication, by means of which the daily observations are transmitted from Northeast Greenland to Europe, is often unreliable. Generally speaking, only such material as has been available from printed matters (based on the original observational lists) has been used in the climatological part of the present work; in the subsequent part, however, which gives a description of individual cases, all available material has been utilised.

A detailed journal of observations (L. 7) is at hand from Danmarks Havn, while the material from Sandodden has been published in the "Meteorologisk Aarbog".

From the sea area adjoining Northeast Greenland a considerable number of ships' log-books are at hand, mainly from the Danish Greenland-ships. However, these log-books comprise only the summer months (practically only July and August); for this reason as well as for other obvious reasons the material is less well suited for a climatological

treatment than the observations from the fixed stations. The subjoined account is therefore—as in earlier publications on the same subject—mainly based on observations from the fixed stations, account being taken, however, of what is known or may be assumed as to the difference between the climates of the shore and the adjacent sea area. In the valuation of these inequalities observations from the isolated island Jan Mayen and two Icelandic stations have been employed, viz.

Jan Mayen	70°59' N,	8°18' W,	23 m above sea-level,
Stykkishólmur	65°05' N,	22°46' W,	11 - — —
Grimsey	66°33' N,	17°58' W,	22 - — —

2. Atmospheric Pressure.

Table I gives the mean pressure (reduced to sea-level) for the period 1922—37 at the stations Jan Mayen, Myggbukta, Scoresbysund, and Stykkishólmur:

Table I. Mean atmospheric pressure for the period 1922—37 in mb. The figures for the hundreds (9 and 10) are omitted, thus 00.4 means 1000.4 mb and 95.3 means 995.3 mb. In the last line the mean pressure at Stykkishólmur for the long period 1846—1925 is given in parenthesis. (1000 mb = 750.1 mm of mercury.)

	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
J.M...	00.4	04.8	11.5	13.9	16.6	13.2	10.6	10.8	08.3	05.6	03.6	03.0	08.6
Mb. ..	07.3	10.3	18.5	20.7	20.8	15.4	12.3	13.2	13.1	13.2	10.4	08.4	13.7
Sc. ...	04.0	07.9	15.4	19.0	19.0	13.3	10.6	11.9	11.7	11.1	08.6	07.1	11.7
Sty. ...	95.3	01.5	08.4	11.4	14.0	11.1	07.2	06.8	05.6	04.3	00.8	99.0	05.6
(Sty. . .)	97.2	00.9	06.1	10.0	13.5	11.3	10.1	09.7	06.7	05.1	04.4	98.7	04.9

Fig. 1 a is a graphic representation of the annual variation of the pressure, while Fig. 1 b shows the annual variation of the differences between two and two of the stations.

Fig. 2 a—d show the geographic distribution of the pressure at the four seasons of the year. The area shown on the maps is here larger than that otherwise comprised by the present climatological investigation; this is due to a desire to show the relation between the pressure distribution over the Greenland Sea and the pressure distribution over the Norwegian Sea, the Icelandic area, and the continent of Greenland. In this connection it should be mentioned that no calculation of the mean pressure for the period 1922—37 for other stations than those stated above has been made; the most recent normal values available (according

to L. 4 and 27) have been used instead. That the means have been calculated for somewhat different periods, cannot in this case be assumed to play any decisive role for the general picture; the curves have been smoothed, so that no irregularities appear at the transitions between the areas as to which the normals have been formed for different periods.

For the principles according to which the isobars have been drawn across the interior of Greenland, the reader is referred to the account on pp. 15—16.

The following main points may be deduced from the table, the curves, and the maps:

The mean pressure for the year is low, c. 1006 mb, near West Iceland, somewhat higher, c. 1009 mb, near Jan Mayen, and much higher, c. 1012—14 mb, near Scoresbysund and Myggbukta.

The same distribution of the mean pressure as is found for the whole year is found in broad features for the individual months, the order of succession of the four stations, arranged according to increasing pressure, being the same all the year round, viz. Stykkishólmur, Jan Mayen, Scoresbysund, Myggbukta. The only exception is that in June and July the pressure at Jan Mayen is just as high as at Scoresbysund.

At all the four stations the annual variation of the pressure is of the so-called polar type, with a maximum in May and a minimum in January. The difference between the highest and the lowest monthly mean pressure is considerable (Stykkishólmur: May 1014, January 995 mb; Myggbukta: May 1021, January 1007 mb).

In regard, also, to the details of the annual variation the four stations agree to a fairly great extent. Thus there is a very steep rise from January to March and an abrupt fall from May to July. A certain difference is traceable in the months of August—October, the mean pressure during this period remaining almost constant near the northeast coast of Greenland, but decreasing somewhat near Stykkishólmur and even more near Jan Mayen.

However, the series of years employed is too short to enable us to establish, on this basis, the "reality" of the aforementioned details. The good agreement between the curves is in itself no proof that the irregularities found in the annual variation are "real" (characteristic of the climate of the regions in question); since the series of years employed is the same for all four stations, "casual" variations in the monthly mean pressure may recur in several of the curves without these curves revealing the casual character of the variations. However, the curve which shows the eighty-year monthly means for Stykkishólmur gives us a possibility of estimating whether the irregularities are real; it would

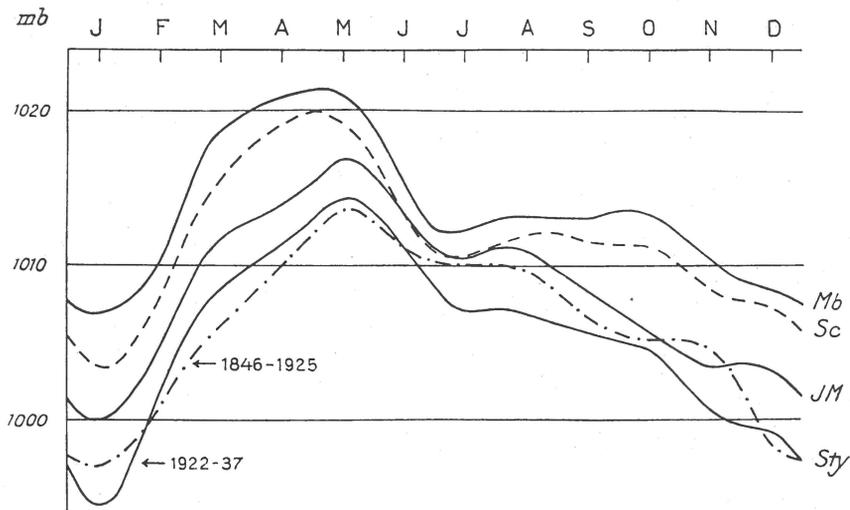


Fig. 1a. Annual variation of the mean pressure according to observations 1922—1937 at Myggbukta, Scoresbysund, Jan Mayen, and Stykkishólmur; at the last-mentioned station also according to observations from the period 1846—1925.

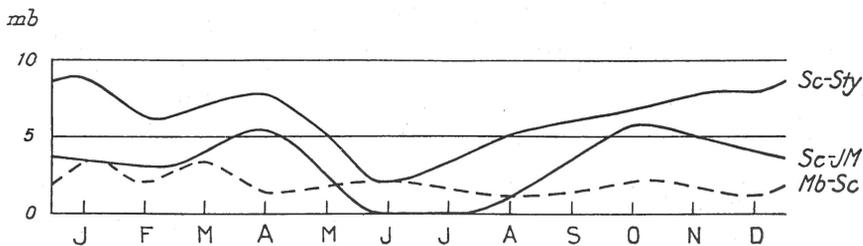


Fig. 1 b. Annual variation of the difference in mean pressure between two and two of the stations Myggbukta, Scoresbysund, Jan Mayen, and Stykkishólmur (1922—37).

rather seem to indicate that a fairly considerable smoothing of the other curves would have been justifiable. (Each of the curves shown in the figure has been constructed from a block diagram, showing the twelve monthly means, by a smoothing which is performed in such a way that the smoothed curve, if it is used as the basis for a computation of the monthly means, gives the original twelve values.)

The differences in the pressure are greater in the winter than in the summer; in other words, the difference between the winter depression and the high pressure in May is greatest where the mean pressure is lowest, that is to say, near Iceland.

The maps (Fig. 2 a—d) showing the geographical distribution of the mean pressure at the different seasons agree in all essential features: the pressure is highest over Northeast Greenland; from a depression southwest of Iceland a trough extends across the Norwegian Sea towards Bear

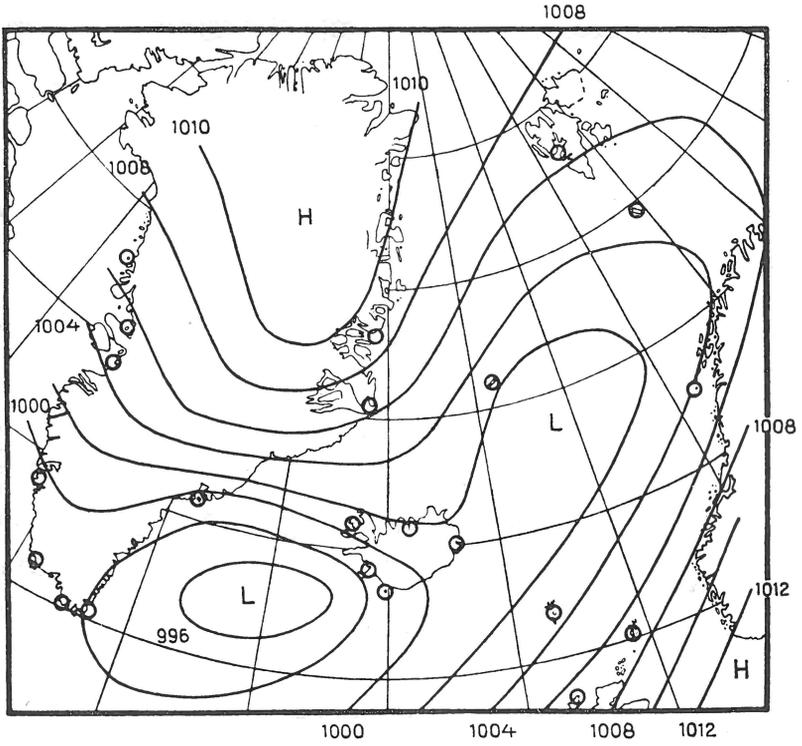


Fig. 2 a: Winter.

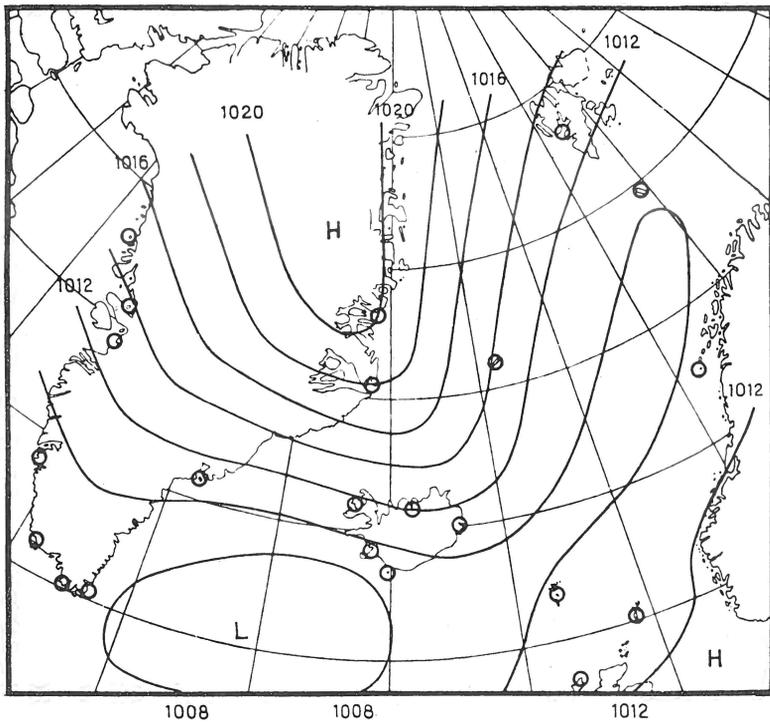


Fig. 2 b: Spring.

Fig. 2 a-d. Distribution of the mean pressure for the four

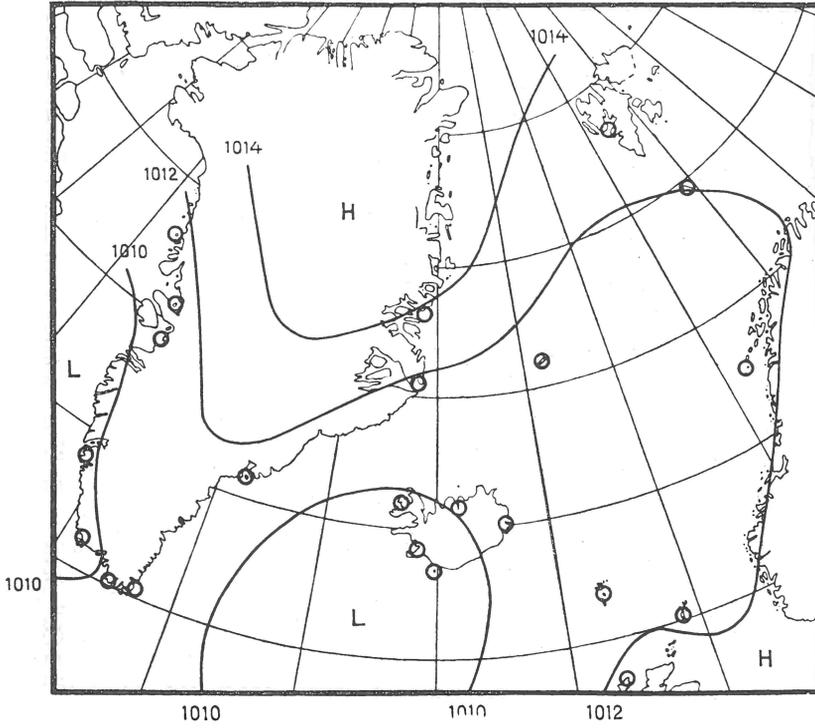


Fig. 2c: Summer.

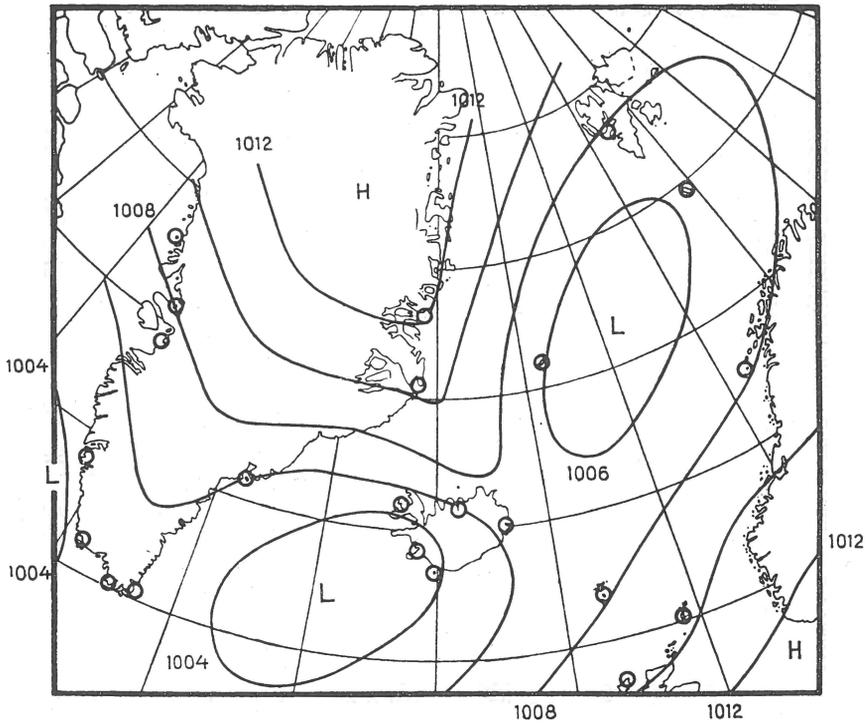


Fig. 2d: Autumn.

seasons (average of the observations during several years).

Island. In a quantitative respect the summer differs considerably from the other seasons, the gradient being only about half as steep. But in regard to the direction of the gradient, also, there is a certain difference: the isobar passing through Scoresbysund in the summer runs close past Jan Mayen, while at the other seasons it curves towards the north-east or north to the sea between northern Greenland and Spitsbergen.

Since, roughly, the isobars are curved anticyclonically near the Northeast Greenland high pressure and cyclonically near the Icelandic low pressure, the pressure gradient will be especially steep over the intermediate area; this is seen most distinctly on the map which shows the distribution of the mean pressure in the winter.

It is more difficult, on the basis of the observations, to give an opinion as to the variation of the "crowding" of the isobars with the distance from the east coast of Greenland. From theoretical points of view as well as from more or less analogous cases (the west coast of Norway, the west coast of North America, the east coast of North Asia), however, it must be assumed that during the greater part of the year the isobars lie closest together along the shore. It is probable that the ice edge—notably, of course, when it has the character of a sharp boundary between large unbroken ice fields and open water—plays a similar role to that of the coast line; to what extent, however, cannot be decided on the basis of the available material if only for the reason that no fairly long continuous series of observations is available from the Denmark Strait proper. From theoretical points of view we may assume that in winter the isobars will occur even closer together near the ice edge than near the shore, since the area of water covered by sea ice in a thermal respect should rather be compared to the ice- and snow-covered mainland of Greenland than to the open sea; but even if this assumption—which is confirmed to some extent by observations on the wind made from ships near the ice edge, cf. p. 29—holds good in the greater number of the individual cases, the mean isobars cannot be expected to show corresponding features, since the ice edge, and the "crowding" of isobars associated with it, has a different position from year to year, and even from day to day.

It may be assumed that in the summer both the inland ice and the sea ice, owing to their temperature-reducing effect, will cause a local increase of the (reduced) pressure in relation to the ice-free coastal zone as well as to the open water (which not rarely extends right in to the shore, at any rate in the late summer). On this account the picture is more complicated than in the winter; but, as mentioned above, the absolute difference—the steepness of the gradient—is smaller.

The question may be asked whether the division into four seasons used on the maps is reasonable in the present case; for we

are here concerned with arctic regions, in which the length of the winter cannot be fixed at as short a time as three months. However, a consideration of the curves in Fig. 1 a will show that the division, at any rate as regards the two stations in Greenland, is actually natural if we deal with the pressure, in so far as the transitions from winter to spring and from spring to summer are fairly sharp and occur approximately at the right dates; the transitions from summer to autumn and from autumn to winter are less sharp.

On the maps the isobars have been drawn across the interior of Greenland. This is so far in accordance with the general practice, but since we are here concerned with an essential problem which has relevance to several of the questions treated in the present paper, I shall say a few words about it.

The isobars drawn represent the reduced pressure. While the reduction to sea-level does not in principle give rise to difficulties if we are concerned with observations made from ships or at the various stations located in the coastal tracts of Greenland, the case is different for the inland ice. As is well known, the reduction is based on the fundamental equation of statics, according to which the pressure difference between two horizontal square units in a vertical column of air is equal to the weight of the column of air between them. Hence, to make a reduction of a measurement of the pressure made at the earth's surface, we must know, in the first place, the height of the point at which the observation was made, and secondly, we must insert a figure for the density of the imaginary air column between the point of observation and the level of the sea. In most cases in practice this reduction may be carried out with fairly great accuracy, the height having been determined by trigonometrical methods (independently of the measurement of the pressure) and the uncertainty which exists as to the density that should be inserted for the imaginary air column being numerically of minor importance if we are concerned with small heights (a few hundred metres at the most). But as to the inland ice, conditions are extremely unfavourable. In the first place it is very difficult to determine the heights in the interior of Greenland by trigonometrical methods (the height of the station Eismitte of the WEGENER Expedition was computed by means of pressure measurements, cf. L. 31, IV 1, p. 176 ff.), and it is obvious that on the basis of a series of pressure measurements—simultaneous measurements at the high-level station and the base stations—it is impossible to determine exactly both the height of the station and the density which should be counted upon for the imaginary air column. Secondly, it is difficult to point out a plausible value for the average density of an imaginary air column of a height of 2—3 km, all the more so since the temperature conditions over the

inland ice are of a very special nature; and for the great altitudes with which we are concerned here even a rather small difference in density plays a fairly great role for the reduction. (A difference in density of 1 per cent, corresponding to $2\frac{1}{2}^{\circ}$ C., is equivalent to a difference in the reduction of 1 per cent, which for an altitude of 2 km means c. $2\frac{1}{2}$ mb.) Thirdly, the observational data available from the interior of Greenland are so few in number that we cannot use them for climatological computations without making generalisations, the permissibility of which is doubtful.

Confronted with all these difficulties, of which the second one, in particular, is of fundamental importance, it might seem a reasonable conclusion that isobars should not be drawn across the inland ice. It must, however, be taken into consideration that the interior of Greenland is not the only place on the globe where such difficulties occur; the same problem is known from the Rocky Mountains, Central Asia, and to a smaller extent from the Alps and central Scandinavia; after all, an attempt to carry out the reduction should probably be made in these cases if there seems to be a possibility of arriving at a reasonable result. The agreement between the isobars drawn for the reduced pressure and the isobars for a level corresponding approximately to the highest stations at which observations have been made, should, if possible, be studied in order to check the result obtained by the reduction: if the agreement is found to be poor, we may conclude that a factor which distorts the picture has been introduced by the reduction. (Unfortunately we cannot draw the reverse conclusion that if there is good agreement, the assumptions on which the computation of the reduction is based are all right; errors accidentally counterbalancing each other may have been introduced.)

As regards Greenland it is not yet possible to investigate the extent of this agreement, since hitherto the aerological material available from these regions (L. 31, IV, 1—2) has hardly been sufficient for a determination of the pressure distribution in the upper air over Greenland for a single day. To say nothing of the distribution of the mean pressure; but if it should be possible one day to construct maps of the distribution of this pressure, for instance at an altitude of 3 km, it will be reasonable to let the lines for the reduced pressure follow the isobars on these maps as closely as possible within the limits that arise from the necessity of intersecting the shore-line in such places that full accordance with the observations made at lowland stations will be obtained.¹⁾

¹⁾ Since this was written, the rapid development of the aerological observation technique and the increase of the material from the upper air over Greenland have created a new and much more favorable situation.

The above considerations apply in the main not only when, as in this case, we are to draw mean isobars across Greenland, but also for the drawing of isobars on synoptic maps.

The monthly mean pressure for the individual years may differ very considerably from the average values given in Table I. Table II gives the highest and the lowest mean figures for the individual months at the four stations, Jan Mayen, Myggbukta, Scoresbysund, and Stykkishólmur:

Table II. Highest and lowest monthly means of the pressure for each of the months of the year, 1922—37. The pressure is given in mb, cf. Table I. The year is added as an index.

	Jan Mayen			Myggbukta			Scoresbysund			Stykkishólmur		
	Max.	Min.	Diff.	Max.	Min.	Diff.	Max.	Min.	Diff.	Max.	Min.	Diff.
J.	22.6 ₂₉	90.2 ₂₈	32.4	27.3 ₂₂	90.8 ₃₃	36.5	25.2 ₂₉	87.7 ₃₃	37.5	19.9 ₂₉	84.0 ₃₃	35.9
F.	18.2 ₃₆	89.8 ₃₅	28.4	25.6 ₃₆	99.3 ₃₅	26.3	23.7 ₃₆	98.0 ₃₅	25.7	25.2 ₃₂	83.6 ₂₂	31.6
M.	19.0 ₃₇	02.8 ₃₄	16.2	27.4 ₃₇	04.7 ₂₃	22.7	24.4 ₃₇	07.1 ₃₈	17.3	18.9 ₃₇	97.6 ₂₇	21.3
A.	18.2 _{23, 36}	06.6 ₂₅	11.6	28.1 ₃₂	13.6 ₂₃	14.5	24.7 ₃₅	10.7 ₃₈	14.0	19.9 ₂₉	02.5 ₂₈	17.4
M.	22.2 ₃₆	08.4 ₃₄	13.8	25.5 ₃₂	12.9 ₃₄	12.6	22.9 _{26, 31}	12.8 ₃₄	10.1	21.5 ₃₅	05.7 ₃₅	15.8
J.	19.6 ₂₆	05.7 ₃₇	13.9	14.0 ₃₁	06.7 ₃₇	17.3	19.9 ₃₁	06.3 ₃₇	13.6	15.5 _{24, 34}	02.5 ₃₀	13.0
J.	16.9 ₃₆	05.7 ₃₆	11.2	18.3 ₃₀	07.1 ₃₃	11.2	14.3 ₃₄	07.5 ₃₃	6.8	12.3 ₃₅	02.3 ₃₅	10.0
A.	17.9 ₂₈	06.5 ₃₃	11.4	18.3 ₂₈	08.3 _{33, 37}	10.0	17.3 ₂₈	16.3 ₃₇	11.0	13.2 ₃₁	03.7 ₃₃	9.5
S.	19.7 ₃₀	01.3 ₂₉	18.6	18.9 ₂₇	09.1 ₃₇	9.8	17.7 ₃₅	06.0 ₂₉	11.7	15.6 ₃₀	99.9 ₃₇	15.7
O.	15.7 ₂₂	97.4 ₃₅	18.3	22.5 ₂₆	05.6 ₃₅	16.9	21.9 ₂₆	03.7 ₃₆	18.2	17.2 ₂₆	95.6 ₂₃	21.6
N.	10.3 ¹ ₂₅	97.2 ₃₁	13.1	13.7 ₂₆	05.5 ₃₆	8.2	15.5 ₂₅	97.3 ₃₁	18.2	10.7 ₂₅	86.1 ₃₁	24.6
D.	17.9 ² ₂₇	91.4 ₂₉	26.5	17.0 ₃₅	99.0 ₃₆	18.0	18.3 ₂₇	96.7 ₃₆	21.6	10.8 ₂₇	80.9 ₂₄	29.9

¹) Jan Mayen Nov. 1921: 17.1.

As regards Jan Mayen and Stykkishólmur the table is based on complete observations for the years 1922—37; as to the two stations in Greenland the rather uncertain monthly means computed by interpolation have not been taken into account.

It appears from the table that especially high monthly means chiefly occur in the months of January—May, especially low monthly means chiefly in the actual winter months. The difference between the extreme monthly means is generally about three times as great in the winter as in the summer (c. 30 and c. 10 mb respectively).

A comparison between the individual stations shows that the difference between the extreme values is somewhat greater at Stykkishólmur than at Jan Mayen, except in the summer. The comparison cannot be directly extended to the Greenland stations owing to the

less complete series of observations available from them; but it would seem that the absolute margin for the monthly means, at any rate for some of the months, is just as wide near the northeast coast of Greenland as near western Iceland.

The diagram in Fig. 3 shows the dispersion of the individual monthly means at Jan Mayen.

Since the dispersion (for all the stations) is considerable, the monthly means computed for several years, in so far as they are regarded as normals, are subject to a fairly great uncertainty—for the winter months two or three millibars. However, the uncertainty is not so great that it will obscure the annual variation of the pressure.

Computing the differences between the mean pressures of the individual months at two of the stations, for instance Myggbukta and Jan Mayen, we shall see that these differences, also, show a considerable dispersion. Thus in April 1927 the mean pressure at Myggbukta was 15–16 mb higher, but in March–April 1923 c. 5–6 and in the period May–July 1936 c. 3–5 mb lower than at Jan Mayen. On considering the different monthly means (which are assumed to be free from systematical errors owing to erroneous instrumental corrections or the like), one may gain the impression that a certain tendency of persistence is present: a pressure distribution differing from the normal may not rarely persist for several months, apart from interruptions of such short duration that they exert no essential influence on the monthly means.

Fig. 4 a–d show some of the most remarkable examples from the 1930's of months in which the distribution of the mean pressure differed greatly from that shown in Fig. 2 a–d.

On account of the considerable dispersion shown by the pressure difference between the stations it is a somewhat questionable proceeding to substitute pressure values found by interpolation from the other stations for the missing monthly means; if it is intended to do so, the available monthly means—or rather their deviations from the average of several years—should be entered on a map, after which a graphic interpolation should be attempted by means of the map.

In the preceding pages only the distribution of the pressure near the ground has been dealt with, apart from the remarks on the drawing of isobars across the interior of Greenland. As mentioned above, the aerological material available from these regions is very scanty, so that it does not fulfil the demands that must be made if it is to be used in climatological computations. The only thing we can do is to form an estimate of the limits of the mean pressure in the upper air. A point of special interest is the variation of the gradient

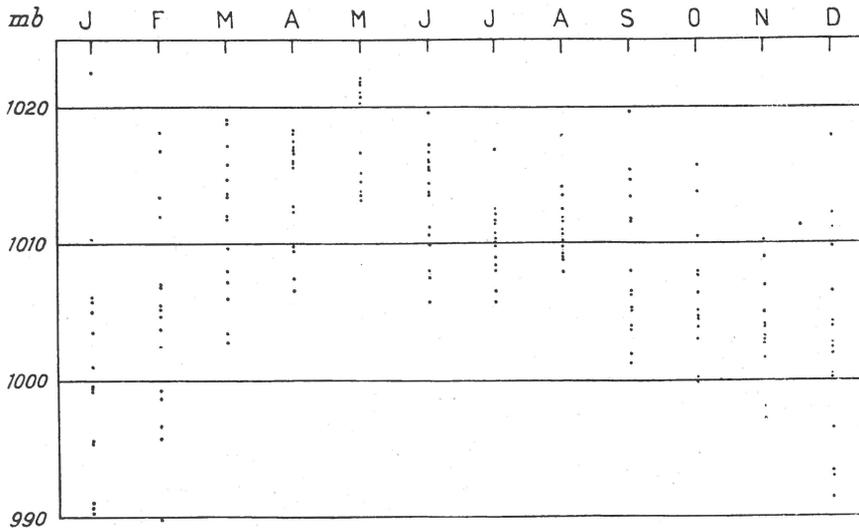


Fig. 3. Diagram showing the dispersion of the monthly means of pressure at Jan Mayen (1922—37). Each dot represents the mean pressure for a single month.

with the height. For theoretical reasons it may be assumed (and it has been confirmed by the few measurements made) that the mean temperature, at any rate in the lower half of the troposphere (i. e. up to a height of 4—5 km), is generally lower over Greenland than over the northern seas, while the pressure at a low height is generally highest over Greenland; consequently the density of the air will be greater over Greenland than farther east, which means that the pressure decreases more rapidly with increasing altitude near the coast of Greenland than for instance near Iceland and Jan Mayen. Thus the south-eastward-directed gradient, which is so considerable near the ground, decreases with increasing altitude, and it is probable—as shown by the following estimate—that even at a fairly low altitude it is “converted” to a gradient in the opposite direction, viz. a northwestward-directed gradient.

If we suppose—in accordance with the average values for the winter months—that the pressure at Jan Mayen and Myggbukta is 1000 and 1007 mb respectively and the temperature -5° and -20° C.¹⁾ respectively, the density of the air at the surface will be 6.7 % greater at Myggbukta than at Jan Mayen, which means that the pressure near the surface decreases 6.7 % more rapidly with the height at Myggbukta than at Jan Mayen. The pressure difference of 7 mb found near the ground will thus disappear already at the height at which the pressure is c. 900 mb, that is to say, at a height of c. 800 m.—Computing the

¹⁾ In the present paper all temperatures are given in degrees Centigrade.

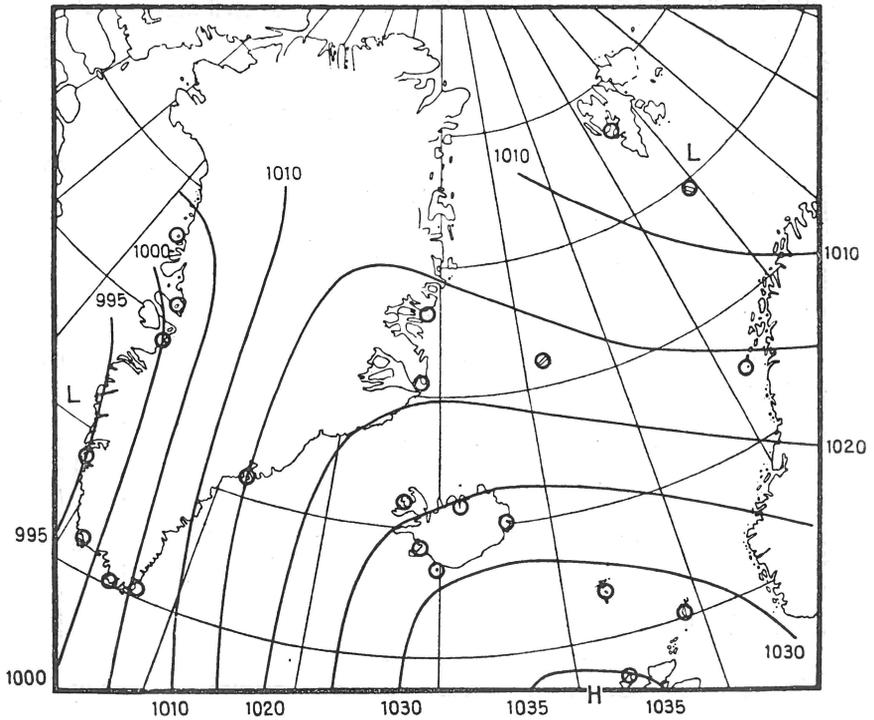


Fig. 4a: Feb. 1932.

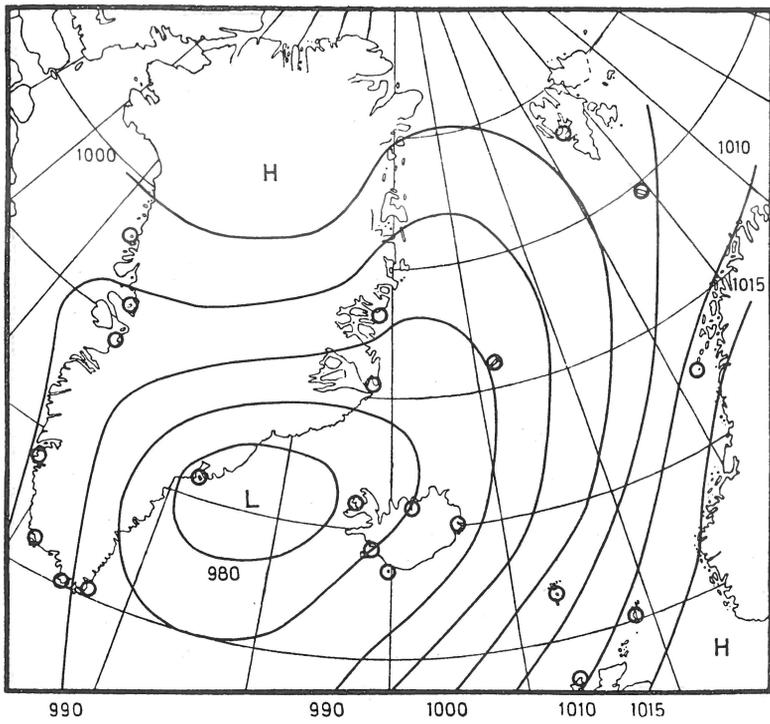


Fig. 4b: Jan. 1933.

Fig. 4 a-d. Distribution of the mean

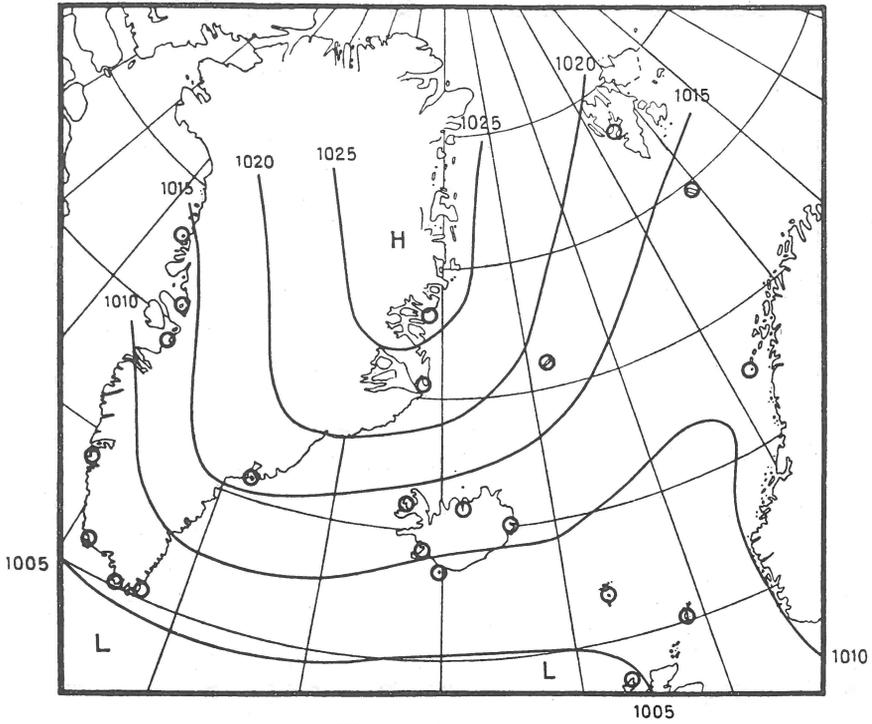


Fig. 4c: Feb. 1936.

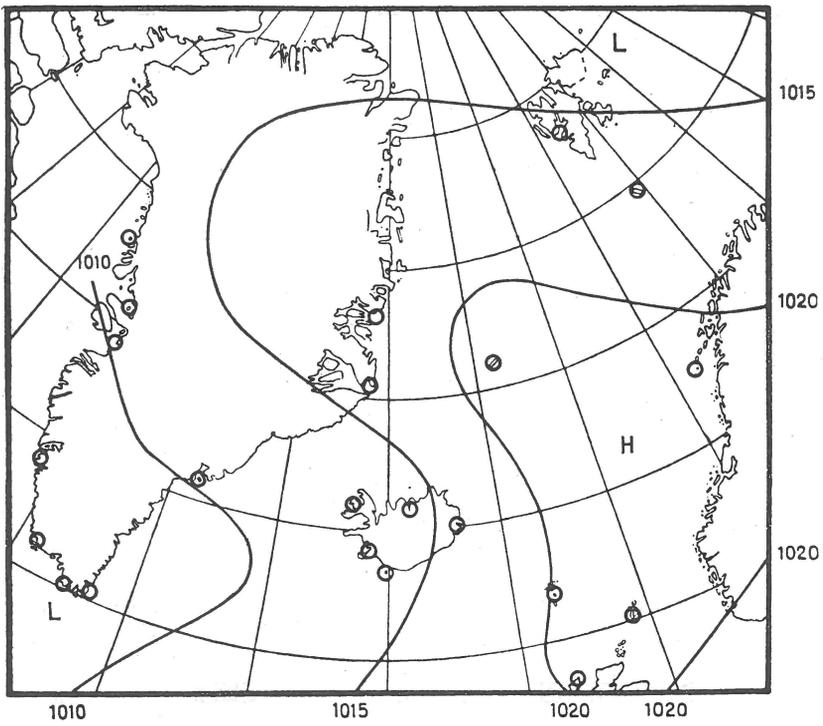


Fig. 4d: May 1936.

pressure in four "abnormal" months.

height at which the gradient is reversed in this way, we arrive, however, at too low values unless we take into account that the temperature difference in the free atmosphere is less than near the ground; if the average temperature difference in the lowermost kilometres of the troposphere does not amount to 15° , but to 10° respectively 5° , the height in question will, for a pressure difference at the ground of 7 mb, instead of barely 1, be barely 2 and barely 3 km respectively. All other conditions being equal the height of this level may be regarded as approximately proportional to the pressure difference at the ground (unless the pressure difference is combined with a small temperature difference).

A confirmation of the assumption that the prevalent upper wind over the sea off the northeast coast of Greenland in the central and upper parts of the troposphere blows from the southwest is obtained by considering the tracks followed by the cyclones, and the areas with falling and rising barometer associated with them, across the area in question. The direction southwest-northeast is strikingly prominent; while over Europe movements in any other direction than the prevalent one (which is here from west to east) occasionally occur (namely when the upper winds show corresponding deviations from the normal), movements from directions between north and southeast are, at any rate, extremely rare off the coast of Northeast Greenland—the whole material treated here hardly including more than a couple of undoubted examples. It should, however, be added that an actual determination of the track, which may at times be difficult enough even where the network of stations is close, is far from always possible over the arctic regions, and that, as to these regions more than for others, one might be tempted to use false analogisms, the irregular weather developments being thus misjudged.

The pressure conditions in a certain place cannot be fully characterised by the monthly means only; it is insufficient merely to state the mean figures for many years, and even a more or less detailed account of the monthly means of the individual years does not entirely settle the matter. There is one essential point, in particular, which is not—at any rate not directly—reflected in the monthly means, viz. the so-called “barometric variability” (cf. L. 9).

The simplest useable definition of the barometric variability is the average value of the numerical difference between the pressure at a given time, e. g. at 7 h. (or the mean pressure of twenty-four hours), on two consecutive days. Defined in this way, the barometric variability gives a fairly good numerical expression—possibly the best available—of the strength of the cyclonic activity. On comparing the amount of variability in the different months, we may gain an idea of the

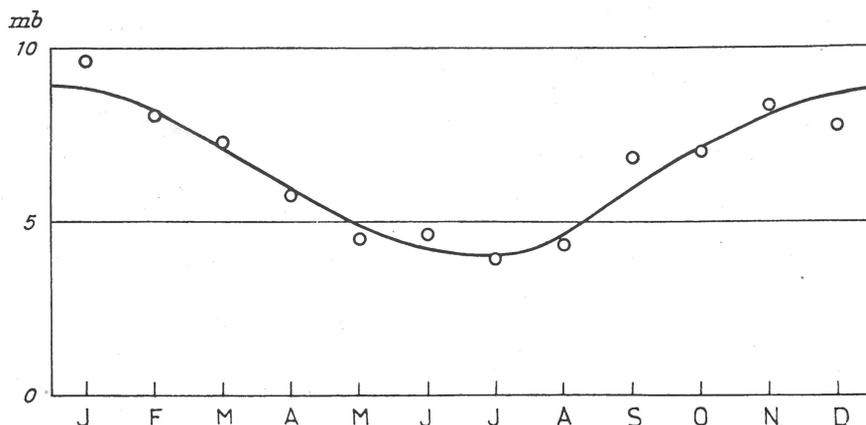


Fig. 5. Annual variation of the mean variability of the pressure from day to day at Jan Mayen.

distribution of the cyclonic activity during the year, and on comparing the amount of the variability in different places we gain an idea of the geographic distribution of this activity.

The curve in Fig. 5 shows the variations of this mean variability in the course of the year; there is a considerable annual variation with a maximum of 8—9 mb in the winter and a minimum of c. 4 mb at the height of the summer. Considering the comparatively short term of years employed for the computation, the close agreement between the points giving the actual averages of the mean variability and the smooth sinus-like curve that is drawn, is noteworthy. As to its form the annual variation is much the same as in Europe; the absolute amount is large—slightly smaller than that found near Iceland, but approximately like that found for the Faroes and the Lofoten Islands, and larger than in nearly the whole remaining part of Europe.

At Myggbukta the mean variability, judging from observations from the years 1932—37, is on an average 10—15 per cent less than at Jan Mayen, but examples of months in which the variability has been greater at Myggbukta than at Jan Mayen are on record; the annual variation is mainly the same.

3. Wind Conditions.

From the maps showing the mean pressure distribution (Fig. 2 a—d) we may conclude that the prevalent direction of the wind along the coast of Northeast Greenland and over the adjacent sea area must be northerly during the greater part of the year, at any rate in such places

in which the influence of orographic factors can be disregarded—that is to say, especially over the open sea. Apart from this we can draw no safe conclusions from the maps as to the frequency of the various wind directions or the mean force of the wind; information about these details must be obtained from the available wind observations.

However, the conclusions that can be drawn from the wind observations made at the stations cannot be directly transferred to the remaining part of the area—either of the coastal zone or of the sea. This is because the stations, though their positions have to some extent been chosen with a view to obtaining good observation posts, cannot be regarded as fully representative: in regard to wind conditions they are to a greater or smaller extent subject to local orographical influence.

Along the northeast coast of Greenland it is difficult to point out localities which meet all the demands that must be made on the position of a station from a purely meteorological point of view, especially if it is also required that the place shall be fairly habitable and the measuring instruments fairly accessible in any kind of weather. Of the places in which observations have been made so far, Danmarks Havn is perhaps that which comes nearest to the ideal; but, as mentioned above, the series of observations from this place comprises only a couple of years.

Nor is Jan Mayen an ideal station for wind observations; for the island rises to such great altitudes—though it is only a little more than 50 km long, and 15 km broad at the most, its highest point lies 2267 m above sea-level—that it sometimes gives rise to the formation of violent lee whirls. As the meteorological station is situated on the southwestern side of the highest mountain, it is especially on days on which the general flow of air is from the northeast that a deviating wind direction is observed at the station; sometimes the undisturbed wind direction may in such cases be estimated by observation of the sea or the movements of low clouds. However, the days with greatly deviating directions of the wind are hardly so numerous that they will have any essential influence on wind statistics.

It appears from Table III and Fig. 6 that the stations Scoresbysund, Myggbukta, and Jan Mayen have certain features in common though each of them has some peculiarities of its own. Since the common features are in good agreement with what might be expected from the distribution of the mean pressure, they may, no doubt, be regarded as characteristic of the whole area in question—apart from such localities near the coast of Greenland where the orographic effects make themselves felt in an even greater degree than at Myggbukta and Scoresbysund.

It will be seen from Table III that both a main maximum and a secondary maximum occur at all three stations. The distance

Table III. Wind frequency, %, and mean wind velocity v_m , for the year.

	N	NE	E	SE	S	SW	W	NW	Calm	v_m
Scoresbysund	9	26	2	4	6	3	6	6	37	1.5
Myggbukta	19	6	14	17	4	2	6	15	16	2.4
Jan Mayen	13	9	24	8	7	8	10	19	4	4.0

between the two maxima—if we only operate with the eight main directions in the frequency statistics—is likewise the same, viz. 135°. On the other hand it is not the same wind directions that are prevalent; at Scoresbysund they are northeast and south, at Myggbukta north and southeast, and at Jan Mayen northwest and east. Another inequality is found as regards the importance of the secondary maximum as compared with the main maximum.

If we examine the wind frequency in the individual months at the same three stations, we shall find that the similarity between them

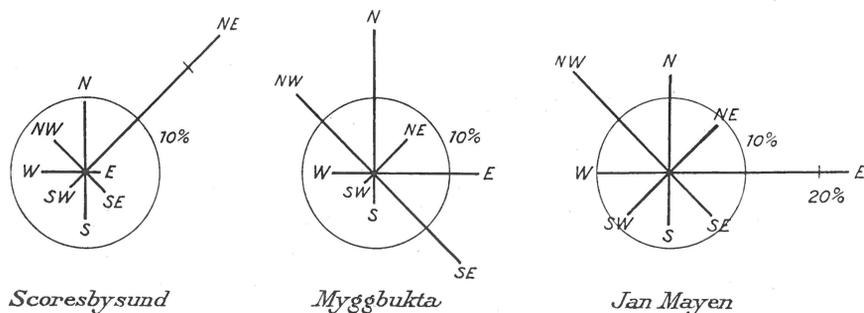


Fig. 6. Compass cards showing the frequency of the different wind directions for the year.

extends much farther than appears from the frequency distribution for the whole year. The similarity is especially obvious if we compare the frequency percentage of the various wind directions in the different months with the frequency percentage of the particular directions for the whole year (Table IV):

Table IV shows that the wind directions E, SE, and S are comparatively frequent in the summer (June—August) and comparatively rare in the winter (October—February); the reverse is the case with the wind directions NW, N, and NE. SW comes closest to the E—S group, W, at any rate at Jan Mayen, closest to the NW—NE-group.

Table IV. Against each wind direction it is stated in which months that particular direction has a greater frequency than the average frequency for the whole year. (The months are given in calendary succession and are indicated by their initials.)

	Myggbukta		Scoresbysund		Jan Mayen	
N	JF	SOND	JFM	OND	JFMA	OND
NE	JFM	SOND	JFMA	OND	JFMA	OND
E	MAMJJA		MJJ S		JJAS	
SE	MJJA		MJJAS		MJJA	
S	MJJA		AMJJAS		MJJA	
SW	FM	MJ S	MJJAS		F	MJJA
W	FMA	SON	F	JJAS	JFM	ND
NW	JFMA	OND	JFM	OND	FMAM	SO D

Of the spring months, which show a gradual, more or less regular transition from winter to summer conditions, March and April are mainly like the winter, while May is more closely associated with the summer; in September an abrupt transition takes place from summer to winter conditions.

If we disregard the only little characteristic annual variation of the rather rare wind directions SW and W, the annual variation in the wind frequency may be illustrated in a simple way (Fig. 7).

It will be seen that for Jan Mayen and Myggbukta the frequency of southeasterly winds increases almost just as rapidly in the spring as the frequency of northerly winds decreases, and that it decreases almost just as rapidly in the autumn as the frequency of northerly winds increases. In this respect the curve for Scoresbysund differs somewhat from the other two curves, as the frequency of the SW and W winds is here considerably greater in the summer than in the winter.

The difference between summer and winter is much greater at Myggbukta, where the frequency of winds from northerly directions (i. e. NW, N, and NE) as well as of winds blowing from southeasterly directions (E, SE, and S) varies from c. 10 to c. 70 per cent in the course of the year, than at the other two stations, where the corresponding differences between the highest and the lowest frequency percentages amount to c. 25—40 per cent.

While the twelve points for Scoresbysund and the twelve points for Jan Mayen lie almost in a straight line, the points for Myggbukta form a curve with the concavity upwards; the cause of this is to be found in the fact that the percentage of calms and the frequency of

westerly winds are relatively high here in the transitional months March, April, and September.

Jan Mayen, whence the most complete series of observations is at hand, shows a peculiar feature, traces of which are also found for the

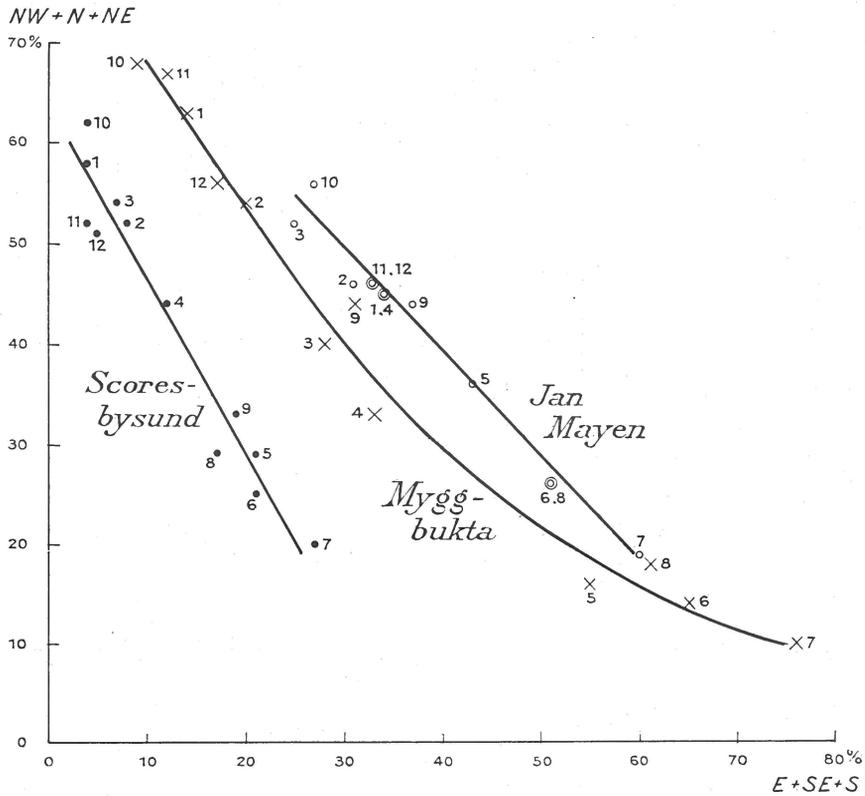


Fig. 7. The annual variation of the frequency of winds from southeasterly and northerly directions. The small figures denote the number of the month. The diagram shows, for instance, that the frequency of winds from the NW, N. and NE at Scoresbysund in the month of July amounts to 20 per cent, whereas the corresponding frequency of winds from the E, SE and S amounts to 27 per cent.

stations in Greenland: the frequency curves for NW—N—NE as well as for E—SE—S exhibit a double annual variation; the northerly winds attain their maximum of frequency in the spring and autumn, showing a main minimum in the summer, and a secondary flat minimum in the winter; conversely, the southeasterly winds have a main maximum in the summer, a secondary flat maximum in the winter, and minima in the spring and autumn (Fig. 8).

As will appear from the above, the wind distribution in the main shows good agreement with the distribution of the mean pressure. The wind is in the main determined partly by the geographical position of the area—far northward, north of the ordinary cyclone tracks—, which results in a great frequency of winds from northeasterly directions, partly by the “monsoon effect” of the continent of Greenland (and of the Polar

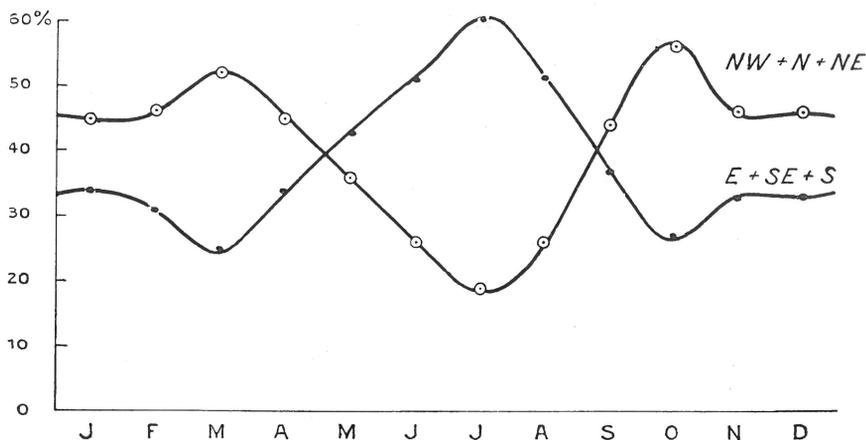


Fig. 8. The annual variation of the frequency of winds from southeasterly and northerly directions at Jan Mayen.

ice), which gives an increased frequency of northerly and northwesterly winds in the winter, and, for the coastal zone, increased frequency of southeasterly winds in the summer. The aforementioned double variation near Jan Mayen may possibly be interpreted in the way that the winter monsoon can best exert its influence about October and March, while in the intermediate period when the cyclonic activity associated with the polar and arctic fronts is especially strong, it is frequently interrupted for a shorter or longer time when the cyclones move close past Jan Mayen. (A corresponding alternation may be traced in Denmark; the occasionally occurring European “winter monsoon” from the east and southeast here plays a somewhat greater role in October—November and in February—April than in December—January, when the cyclonic activity over northwestern Europe is, as a rule, too strong to allow the monsoon tendency to prevail for a long period.)

The mean force of the wind (given in the Beaufort scale) for the whole year is, as stated above, 1.5 at Scoresbysund, 2.4 at Myggbukta, and 4.0 at Jan Mayen. Thus the difference is very considerable and can be regarded as real, although the force of the wind is in part only estimated.

Table V. Annual variation of the mean force of the wind (BEAUFORT'S scale).

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Scoresbysund	1.8	1.8	1.7	1.6	1.3	1.3	1.3	1.2	1.4	1.6	1.5	1.6	1.5
Myggbukta	2.9	2.5	2.0	1.9	1.9	2.0	2.3	2.2	2.5	2.7	3.2	2.7	2.4
Jan Mayen	4.7	4.6	4.3	4.1	3.5	3.4	3.2	3.3	4.0	4.5	4.6	4.5	4.0

Table VI. The frequency percentage of calms in the individual months.

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Scoresbysund	32	33	33	39	43	40	38	42	36	29	38	37	37
Myggbukta	17	16	21	23	20	14	10	17	16	12	11	20	16
Jan Mayen	4.0	3.4	4.1	3.9	5.3	4.1	4.2	4.5	2.3	2.6	4.0	4.2	3.9

The mean force of the wind is hardly much smaller over the sea off Northeast Greenland than near Jan Mayen if the sea is free from ice. Over areas covered with ice contiguous to the land the force of the wind may be assumed to be generally smaller than over nearby ice-free areas, notably because the gradient will, as a rule, be less steep inside the ice edge (cf. p. 14). From ships a rather abrupt transition has often been noticed, for instance between a fairly strong northerly wind over the open sea and a lighter northerly wind over the ice; however, this is, of course, a rule with several exceptions.

The annual variation of the mean force of the wind will be evident from Table V. As might be expected, there is a well-defined annual variation with a maximum in the winter half-year and a minimum in the summer half-year; the variation amounts to c. 40 per cent of the mean force of the wind for the year. The most conspicuous difference between the stations is that the minimum at Myggbukta occurs already in the spring, but at the other two stations not till the height of the summer; as shown by a closer investigation, the difference is due to the fact that the prevalent (monsoon-conditioned) southeasterly wind at the afternoon observation in the summer as a rule blows with a force of 2—4 at Myggbukta.

The frequency of calms in the different months is given in Table VI. Here, also, there is a considerable difference between the individual stations. At Scoresbysund the percentage of calms is high all the year round. It seems—as far as can be judged from the available rather sparse material—to be especially high, first in the period April—August and secondly in November—December. At Myggbukta there occurs a main maximum in the spring (March—May) and a secondary

maximum in December, while July and October—November exhibit the lowest percentages. Near Jan Mayen calms are rare in all the months of the year, notably in September and October.

It is not surprising that this percentage varies rather irregularly in the course of the year; for it depends on the more or less unsettled state of the weather as a whole, being low in periods of marked cyclonic activity, as well as on the conditions for the formation of a stable layer of cold air nearest the surface of the earth, which conditions vary in

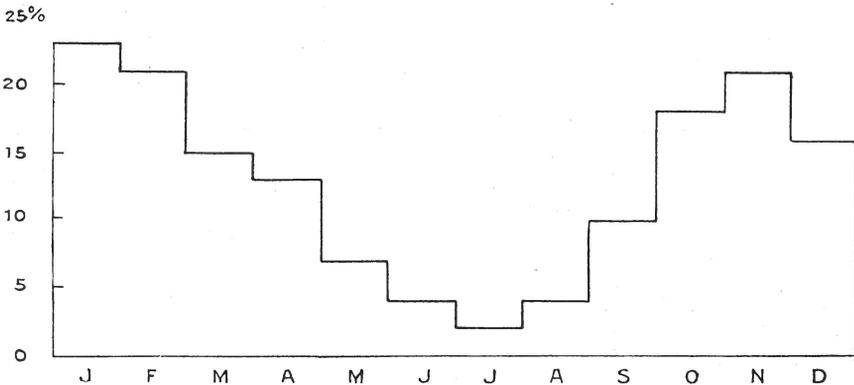


Fig. 9. Frequency of gales (wind force ≥ 9 Beauf.) at Jan Mayen. The value for January, viz. 23%, means that a gale blew, at any rate for some time, on 23% of all the days in January, etc.

the course of the year and from place to place. (Finally, we can hardly entirely disregard the fact that the possibility for deciding whether it is quite calm or a very light wind is blowing from one or the other direction is less in the polar night than during the brighter part of the year—a circumstance which may be conceived to result in a little too high figures for the percentage of calms in November, December, and January.)

The number of days with gale is much larger over the sea than over the coastal zone of Greenland, and much larger in the winter than in the summer. The annual variation of the gale frequency at Jan Mayen will appear from Fig. 9.

By far the greater number of gales blow from northerly directions; they occur in connection with passing depressions, which (as a rule) move in a northeasterly direction across the northern seas, mostly from Iceland towards the sea north of Norway; but the gale may also have the character of a specially strong, almost stationary current on the east side of a well-developed anticyclone over Greenland. However, there is no sharp limit between these two types, and occasionally, though

rarely, there occur gales which cannot be classed under any of the types. In Part II of the present paper several examples of especially heavy gales or gales remarkable for other reasons will be given.

Exceedingly high wind velocities sometimes occur at Jan Mayen; several examples are at hand in which the force is given as 12 Beaufort, and in April 1933 even a velocity of 84 m/s is reported to have been measured (cf. p. 139 and L. 16)—nearly three times the value which has been fixed as the limit between 11 and 12 Beaufort.

The wind conditions in the upper air were the subject of extensive investigations by means of pilot balloons at the East Station of the WEGENER Expedition (near Scoresbysund). The results have been published by Dr. WALTER KOPP in the report on the expedition (L. 31, IV 2, p. 77 ff.), to which the reader is referred for details. The main results of the investigation may be summarised as follows:

In the winter calm weather or light easterly winds prevailed in the lowermost air layers, up to c. 60 m; this may be accounted for by the fact that the observations were made on the west side of a small peninsula partially covered with ice. Above this ground layer, up to an altitude of c. 2 km, northwesterly or westerly winds were almost entirely predominant: evidently it is the outflow of air that lies above the inland ice which takes place in this layer. At an altitude of 2—5 km the prevalent wind directions were southwest and west (cf. p. 32), but the other wind directions were also represented.

The average wind force increased fairly rapidly up to c. 400 m, then it remained almost unchanged up to 1000 m, when it increased gradually, but rather slowly, up to a height of 5 km, where velocities of between 6 and 15 m/s were generally found.

In the summer the ascents of the pilot balloons took place from the colony of Scoresbysund. Here it was mostly calm near the ground, while a northerly wind blew from c. 500 to c. 1000 m; above this height winds from westerly directions were increasingly frequent, and from c. 4 km definitely prevalent. The average force of the wind in the upper air was very nearly the same as in the winter, but especially high velocities (more than 18 m/s) were not registered in the summer.

The aforementioned expedition report (L. 31, IV 2, p. 80 ff.) also deals with the question as to whether there is a systematical difference between days with a high pressure and days with a low pressure. This proved to be the case; on days with a high pressure northwesterly winds prevail almost generally from the ground up to a height of 7 km, while on days with a low pressure there is a layer between 1 and 2.5 km in which the wind is mostly northerly or northeasterly, and a layer between 2.5 and 5 km where southwesterly winds prevail. It is natural to connect the last-mentioned fact with the conformity known from

other parts of the globe between the direction in which the air moves in the medium layers of the troposphere and the direction in which the depressions move: when the weather in the coastal zone of Northeast Greenland is dominated by a (usually northeastward-moving) depression over the adjacent sea, the wind at Scoresbysund is mostly northeasterly up to a height of 2—3 km, above which southwesterly winds prevail.

It should be pointed out, however, that the investigations on the wind in the upper air summarised here cover a period of about one year only. The difference between the conditions of air transport in the summer and the winter is, no doubt, so great that a single year will be able to give a fairly correct idea of the annual variation, but as regards the details the observations made in the course of one year do not suffice. In the aforementioned investigation of the upper winds in high pressure and low pressure situations, a division of the material according to the season would indeed have been very desirable, but such a division is hardly feasible without "straining" the material more than is justifiable.

As regards the air layer nearest the ground the results of the pilot observations at Scoresbysund are so largely influenced by purely local factors that they cannot be assumed to be valid in any other place. But the higher we ascend into the atmosphere, the more the influence of the local factors is likely to disappear; it is reasonable to assume that the above-mentioned wind observations apply in their main features to a zone along the east coast of Greenland from an altitude of c. $\frac{1}{2}$ km and upwards; however, owing to the situation of Scoresbysund—near the point where the main direction of the coast-line changes from SW—NE to S—N—we must make reservations as to a possible systematical deviation (the direction N at Scoresbysund may perhaps correspond to the direction NW at Myggbukta). For even greater altitudes (more than c. 3 km) it is reasonable to assume that the wind conditions in very broad features are much the same throughout the whole area dealt with here—over the coast as well as over the adjacent sea area; on this account it may be assumed that the westerly upper wind so prevalent over the North Atlantic and northwestern Europe, in the intermediate layers of the troposphere extend as far northward as the central part of the east coast of Greenland and the sea around Jan Mayen—and possibly still farther. But it cannot, of course, be taken for granted that the direct and indirect influence of the mainland of Greenland on the air movements is negligible at this level. A careful investigation of the air currents in the upper air over that part of the northern seas which lies north of the axis of the semi-permanent depression (Iceland-northern Norway or Bear Island) would therefore be of considerable interest. Unfortunately the great cloudiness of the area in question

effectively hinders an investigation by means of pilot balloons alone from leading to the goal. By the aid of measurements of pressure and temperature (and humidity) at a limited number of aerological stations within the area we may, however, obtain some knowledge of the gradient wind in the free atmosphere; and, above all, the recent development of the radar method for wind measurements gives promise of great advancement of our knowledge of the subject with which we are concerned here.

4. Temperature.

Monthly Means.

Table VII gives the mean temperatures for the period 1922—37 at the stations Jan Mayen, Myggbukta, Scoresbysund, and Grimsey. The fifth line, in parenthesis, gives the mean temperatures at Grimsey for the years 1875—1923.—In addition to the monthly and annual means published in the Danish and Norwegian year books and the corresponding Icelandic publications (L. 12, 18, 20, 29) some mean temperatures for Myggbukta, which are given by BIRKELAND and SCHOU (L. 5) and stated to be determined in part by interpolation, were used in the computation; apart from these, the missing values for Myggbukta and

Table VII. The mean temperatures for the period 1922—37.

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	Year
J.M.	—3.2	—3.6	—4.3	—2.6	—0.2	2.9	5.6	6.1	3.6	—0.3	—1.6	—2.7	0.0
Mb.....	—20.0	—20.9	—21.6	—16.2	—6.0	1.4	3.9	3.1	—1.2	—10.4	—14.6	—17.9	—10.0
Sc.....	—14.9	—15.1	—15.0	—9.8	—2.9	2.7	5.5	3.8	0.7	—6.7	—10.6	—12.7	—6.2
Gr.	—0.8	—0.8	—1.0	0.3	3.2	6.4	8.4	7.9	5.7	2.3	1.2	0.1	2.7
(Gr.....	—1.9	—2.8	—3.3	—1.4	1.5	5.5	7.1	6.8	5.4	2.7	0.1	—1.2	1.6)
JM less Mb	16.8	17.3	17.3	13.6	5.8	1.5	1.7	3.0	4.8	10.1	13.0	15.2	10.0
Sc less Mb	5.1	5.8	6.6	6.4	3.1	1.3	1.6	0.7	1.9	3.7	4.0	5.2	3.8
Gr less JM	2.4	2.8	3.3	2.9	3.4	3.5	2.8	1.8	2.1	2.6	2.8	2.8	2.7

Scoresbysund found in the observational series are not replaced by interpolated values, since it was judged that no noticeable improvement of the mean figures could be obtained in this way (cf. pp. 41—42). As regards Grimsey, however, where there are better conditions for obtaining good values by means of interpolation, this method has been used for filling in some few missing values. The series of observations from Jan Mayen is complete.

The figures in the three lowermost lines of the table indicate the mean temperature difference between two and two of the stations used.

Fig. 10 a shows the annual variation of the temperature, Fig. 10 b the annual variation of the temperature difference between two and two of the stations. Fig. 11 a—c, finally, show the geographic distribution

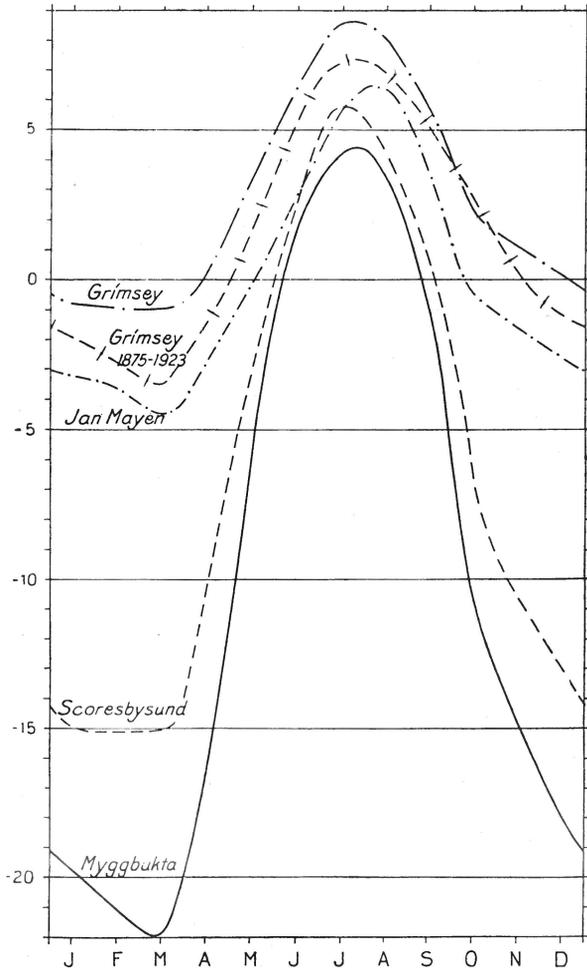


Fig. 10 a. Annual variation of the temperature at Grimsey, Jan Mayen, Scoresbysund, and Myggbukta according to observations from the years 1922—37. As to Grimsey an additional curve is given for observations from 1875—1923.

of the temperature at sea-level for the whole year and for March, which within the area in question (and the series of years considered) has the lowest monthly mean, and July, which generally has the highest monthly mean.

The stations used are all situated at such a low height that as far as they are concerned a reduction to sea level of the temperature observed is superfluous. As regards the air temperature above the

inland ice of Greenland it should be mentioned that the WEGENER expedition at the station Eismitte (altitude 3030 m) during one year's observations found an annual mean temperature of -30°C ., varying from -11° in July to -48° in February.

From the table, the curves, and the maps the following main features can be read:

The 0° isotherm for the year runs from Jan Mayen in a curve

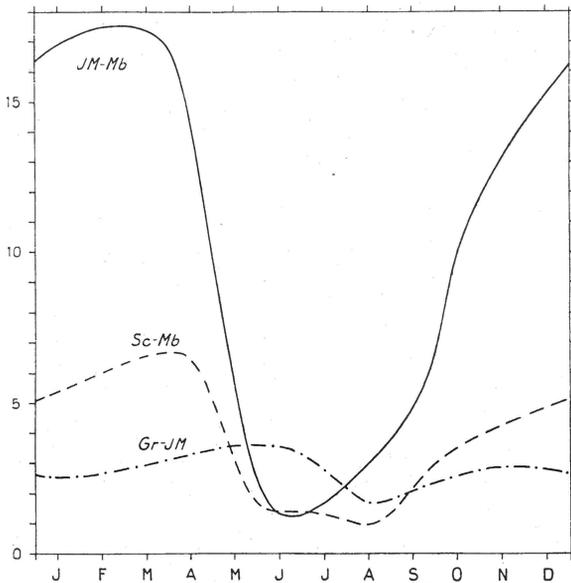


Fig. 10 b. Annual variation of the temperature difference between 1) Jan Mayen and Myggbukta, 2) Scoresbysund and Myggbukta, and 3) Grimsey and Jan Mayen.

closely northwest of Iceland and onwards to the Greenland coast, which it reaches near Angmagssalik; at Myggbukta the mean temperature of the year is c. -10° , at the north coast of Iceland c. $3-4^{\circ}\text{C}$. (Fig. 11a).

The annual temperature amplitude is much greater near the coast of Northeast Greenland than at Jan Mayen and on Iceland (Fig. 10 a), the difference between the coldest and the warmest month being c. 25° at Myggbukta, c. 20° at Scoresbysund, and c. 10° at Jan Mayen and Grimsey.

The coldest month is generally March, the warmest July (at Jan Mayen, however, August); the rise of the temperature in the spring is steeper than the fall in the autumn, and the winter minimum is flatter than the summer maximum (Fig. 10 a).

The temperature difference between Jan Mayen and Myggbukta (Fig. 10 b) in the period January—March amounts on an average to

17°, in June—July, however, to only about 1½°. As the distance between these two stations is c. 550 km, it will be found that the horizontal temperature gradient in the winter here amounts to c. 3° per 100 km. (The isotherms intersect the line connecting Jan Mayen and Myggbukta at almost a right angle.) It may be mentioned that only in a very few places on the globe does the mean temperature difference at sea-level over such a short distance attain such great values as are found here during the winter months.

The maps of the temperature distribution in March (Fig. 11 b) and July (Fig. 11 c) show a considerable difference in the course of the isotherms. The difference consists not only in the isotherms being more crowded in the winter, but also in the main direction of the isotherms (north of Iceland) being in the summer west-east, in the winter southwest-northeast; thus the isotherm through Jan Mayen in the summer also passes through Scoresbysund, while in the winter it runs close past the northwestern corner of Iceland.

There is a remarkable similarity between the course of the curves on the isobar maps and on the isotherm maps, more precisely, between Fig. 2 a—b and Fig. 11 b, and between Fig. 2 c and Fig. 11 c.

The monthly means of the temperature for the winter half-year may differ very considerably in the individual years from the average values given in Table VII; for the summer months, however, the differences are generally rather small. The highest and lowest monthly

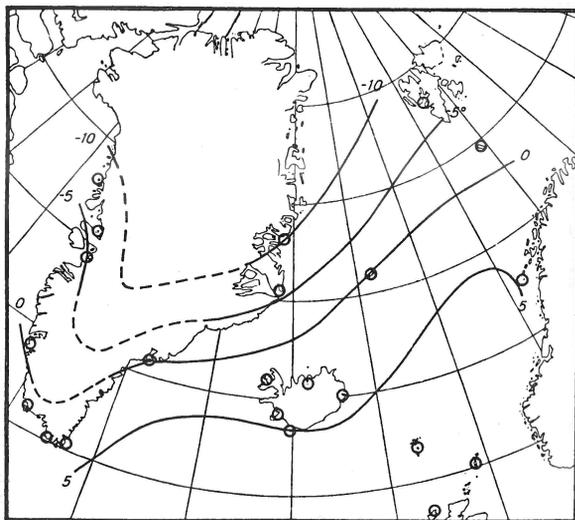


Fig. 11 a.

Fig. 11 a-c. Distribution of mean temperature: a) the whole year, b) March, c) July.

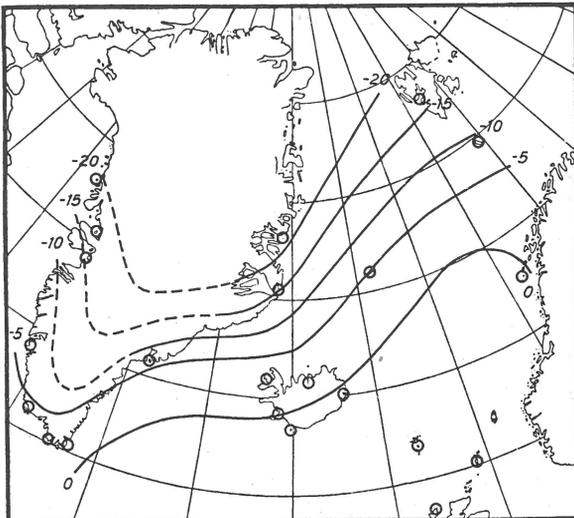
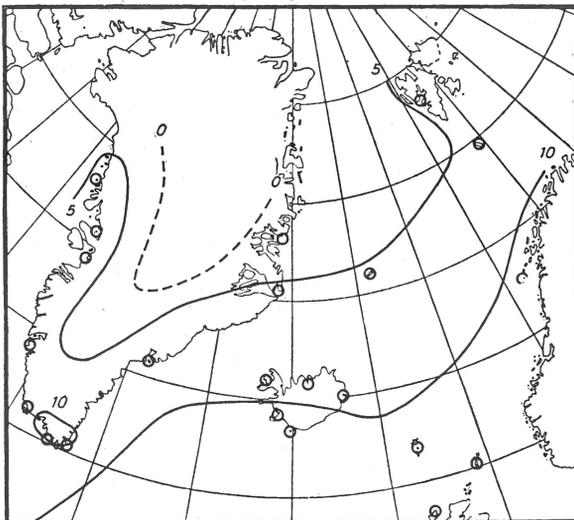


Fig. 11b.



10

Fig. 11c.

means ascertained at the four stations employed within the period considered will appear from Table VIII.

A comparison between the stations shows that the difference between the extreme values in winter is greater, but in summer rather smaller, at the Greenland stations than at Jan Mayen and Grímsey.

Fig. 12 a—d show the temperature and its deviation from the computed mean for the four months—February 1932, January 1933,

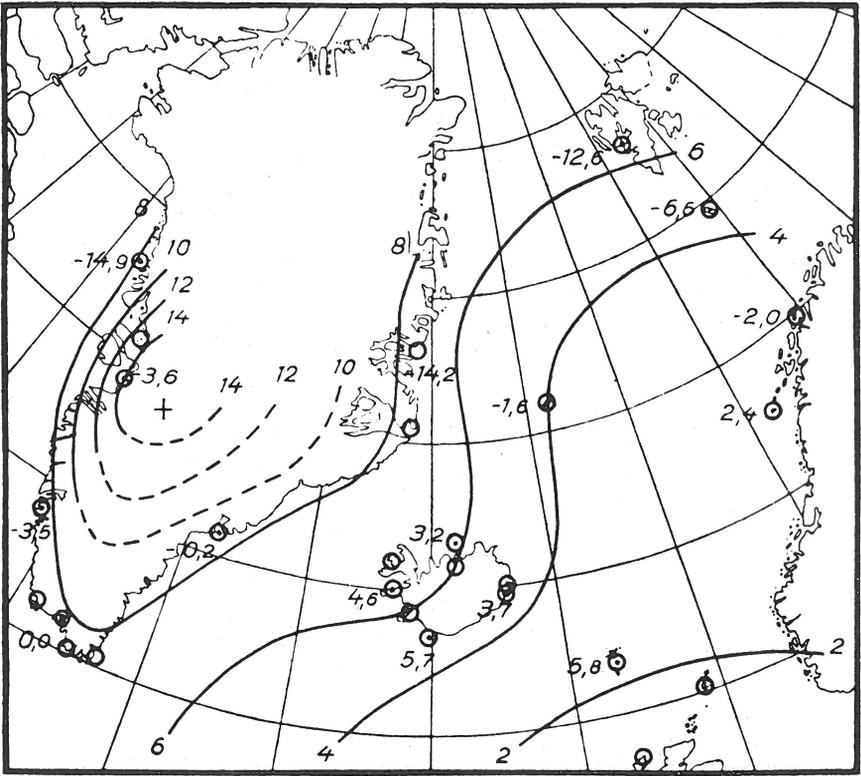


Fig. 12a: Feb. 1932.

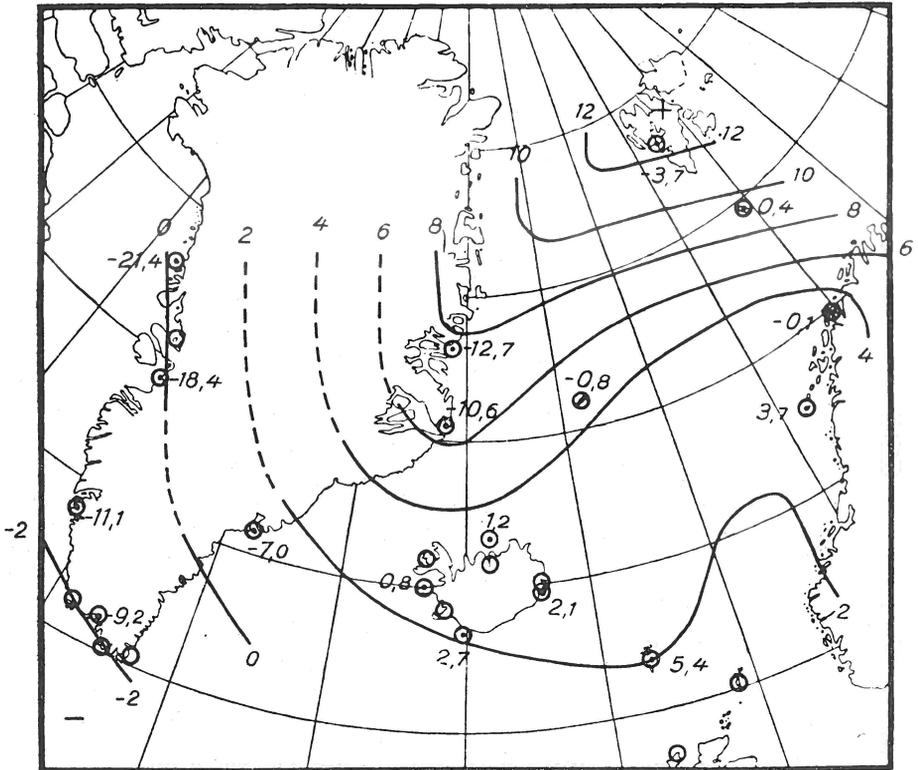


Fig. 12b: Jan. 1933.

Fig. 12 a-f. Temperature distribution in selected months (cf. Fig. 4 a-d). The figures indicated at temperature. The normals from Köppen-

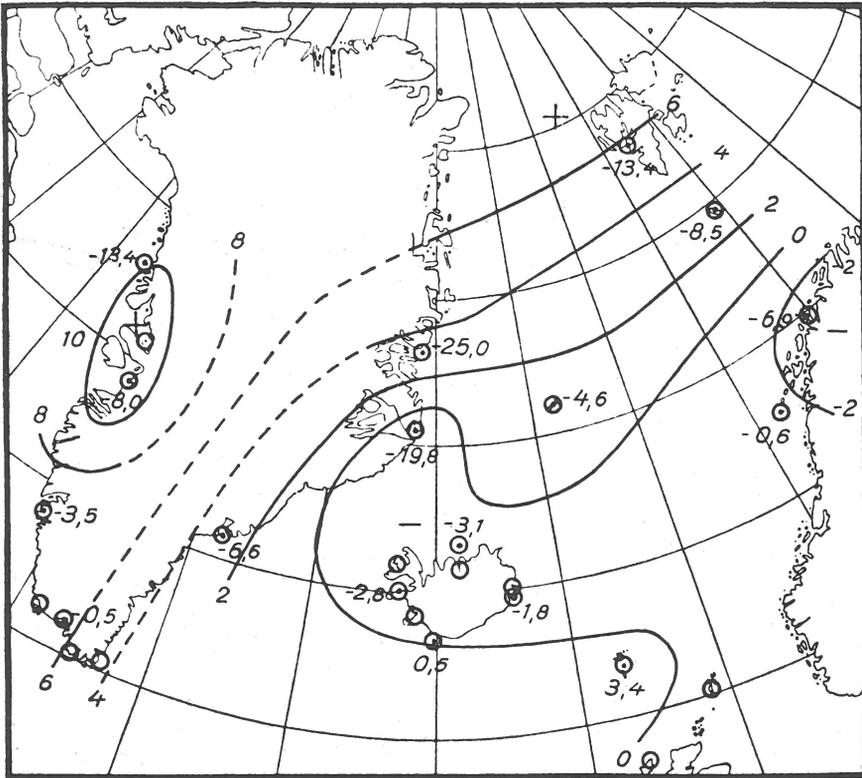


Fig. 12c: Feb. 1936.

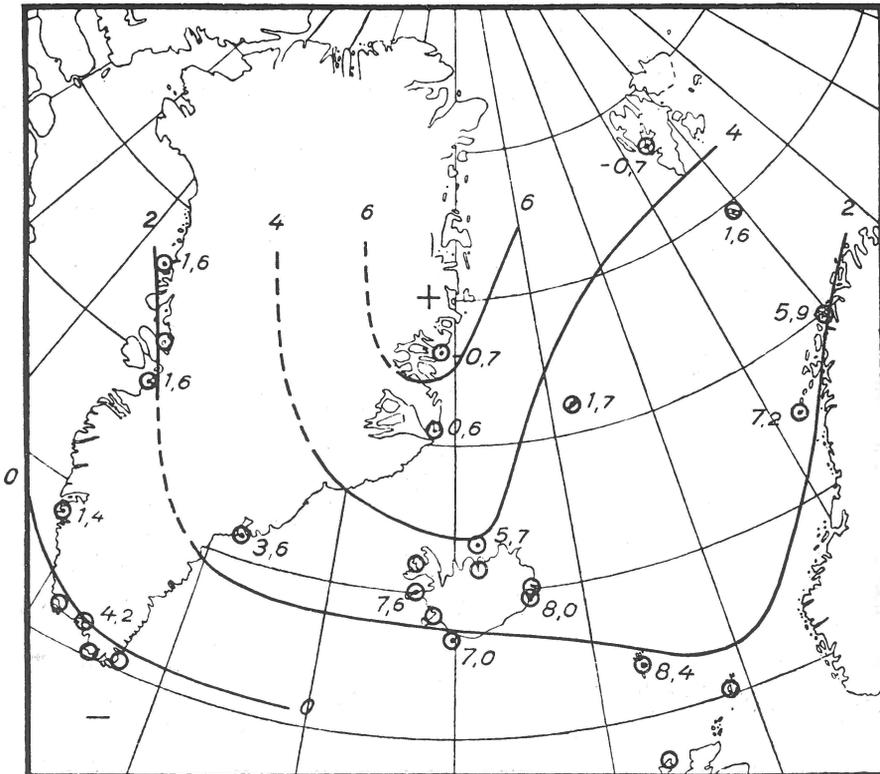


Fig. 12d: May 1936.

the stations show the mean temperature itself; the curves show the deviation from the normal Geiger's manual (L. 4, 21) have been used.

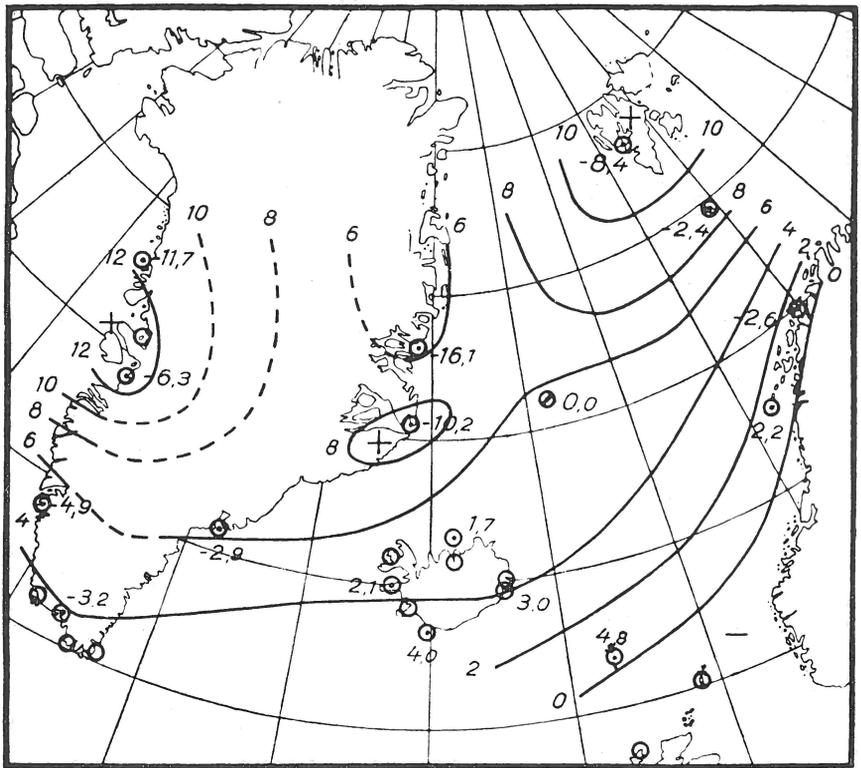


Fig. 12e: Feb. 1929.

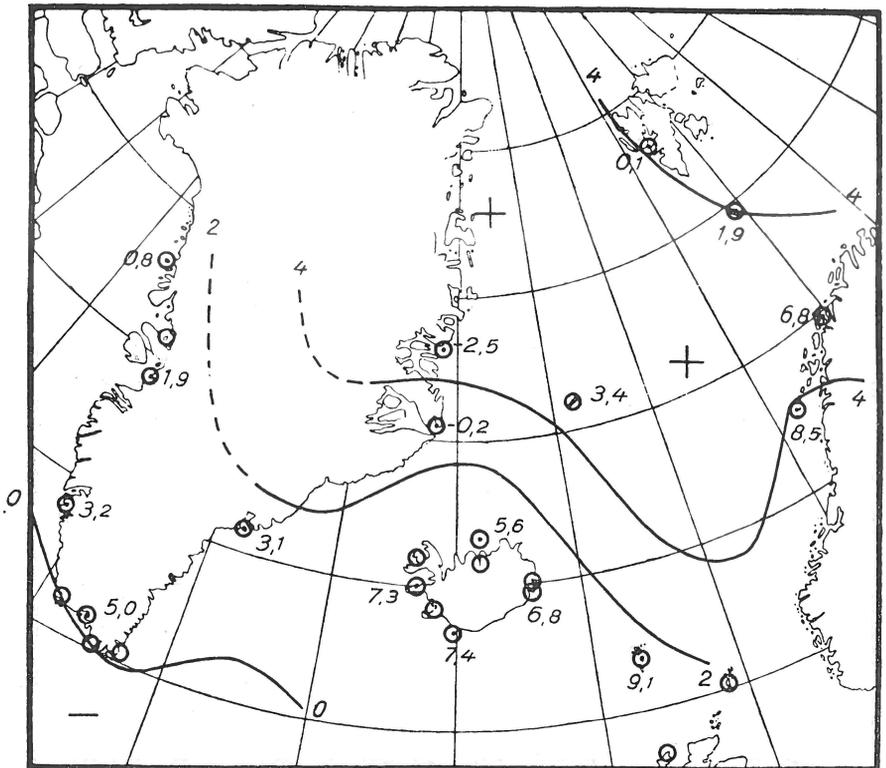


Fig. 12f: Sept. 1934.

Table VIII. Highest and lowest monthly means for each month of the year in the period 1922—37, and the difference between these extremes. The year (denoted by the last two figures) is added as an index.—As regards Jan Mayen the table is based on complete observations from the whole series of years; for the remaining stations the partially rather doubtful monthly means determined by interpolation have not been taken into account.

	Jan Mayen			Myggbukta			Scoresbysund			Grimsey		
	Max.	Min.	Diff.	Max.	Min.	Diff.	Max.	Min.	Diff.	Max.	Min.	Diff.
J.	-0.8 _{24,33}	-7.0 ₃₆	6.2	-11.3 ₃₇	-26.1 ₃₆	14.8	-10.6 ₃₃	-22.6 ₃₆	12.0	1.2 _{29,33}	-4.0 ₃₆	5.2
F.	0.0 ₂₉	-7.1 ₃₄	7.1	-14.2 ₃₂	-27.6 ₂₃	13.4	-10.2 ₂₉	-19.8 ₃₆	9.6	3.2 ₃₂	-4.8 ₃₅	8.0
M.	-0.9 ₂₃	-6.9 ₃₇	6.0	-15.5 ₃₄	-27.1 ₂₇	11.6	-9.8 ₂₉	-20.0 ₃₆	10.2	3.7 ₂₉	-4.4 ₃₀	8.1
A.	0.8 ₃₀	-5.4 ₂₇	6.2	-13.0 ₃₄	-18.8 ₂₉	5.8	-6.4 ₃₀	-13.6 ₂₇	7.2	2.9 ₂₈	-3.3 ₃₂	6.2
M.	1.7 ₃₆	-1.7 ₂₇	3.4	-0.7 ₃₆	-10.5 ₂₉	9.8	0.6 ₃₆	-5.5 ₂₉	6.1	5.7 ₃₆	0.5 ₂₄	5.2
J.	5.3 ₃₀	1.0 ₂₃	4.3	3.4 ₃₂	0.2 ₂₈	3.2	4.0 _{34,38}	1.5 ₃₅	2.5	8.0 _{33,34,36}	4.3 ₂₄	3.7
J.	6.8 _{24,34}	4.0 ₂₉	2.8	5.9 ₃₃	3.1 ₃₀	2.8	7.8 ₃₆	3.6 ₂₅	4.2	10.7 ₂₇	6.4 ₂₂	4.3
A.	7.7 ₃₄	4.1 ₂₃	3.6	5.3 ₃₆	2.5 _{28,37}	2.8	4.3 ₂₅	3.1 ₂₈	1.2*	9.2 ₃₁	6.4 ₂₉	2.8
S.	8.0 ₃₄	2.1 ₃₂	5.9	2.2 ₃₄	-2.7 ₃₅	4.9	2.3 ₃₄	-1.2 ₂₉	3.5	8.1 ₃₃	3.5 ₂₃	4.6
O.	1.9 ₃₄	-2.6 ₂₆	4.5	-6.7 ₃₄	-12.3 ₃₂	5.6	-4.1 ₃₆	-11.8 ₂₉	7.7	4.6 ₂₈	0.1 ₂₆	4.5
N.	2.0 ₃₁	-3.9 ₂₂	5.9	-10.1 ₃₅	-17.1 ₃₂	7.0	-5.9 ₃₅	-14.1 ₃₂	8.2	3.1 ₃₁	-1.9 ₂₃	5.0
D.	0.3 ₃₄	-7.0 ₃₆	7.3	-12.4 ₃₃	-21.0 ₂₆	8.6	-7.6 ₃₃	-17.6 ₃₆	10.0	1.9 ₃₄	-2.8 ₂₅	4.7

* As to Scoresbysund, monthly mean values for August are available from six years only.

February 1936, and May 1936—which have previously (Fig. 4 a—d) been used as examples of months with a mean pressure distribution differing greatly from the normal; as might be expected, the maps of the temperature during these months likewise show highly abnormal features, which can easily be “explained” by the peculiarities of the pressure distribution.

Fig. 12 e—f show two more months with highly abnormal temperature conditions, viz. February 1929 and September 1934.

Fig. 13 a and b show contemporaneous monthly means at Jan Mayen and Myggbukta, in winter (December—March) and in summer (July—August) respectively. As regards the winter months a certain agreement will be noted, but considering the relatively short distance between the two stations the agreement is not particularly good. If the mean temperature of a winter month at Myggbukta is interpolated from the simultaneous mean temperature at Jan Mayen, the result will inevitably become very uncertain; as shown by the figure, there may, at Myggbukta, be a difference of 10—12° between the mean temperatures of two months which have the same mean temperature at Jan Mayen. (Something similar applies if we try to insert missing values for Scoresbysund by means of known values for Jan Mayen; and

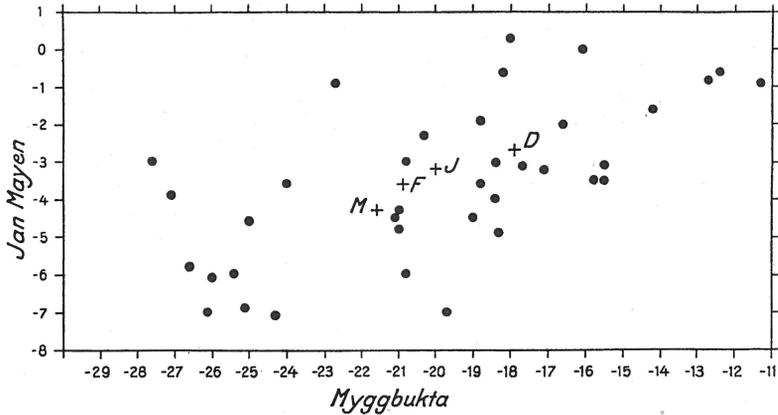


Fig. 13 a. Contemporaneous monthly mean temperatures at Jan Mayen and Myggbukta in the months January, February, March, and December. A + denotes monthly mean values for the whole period.

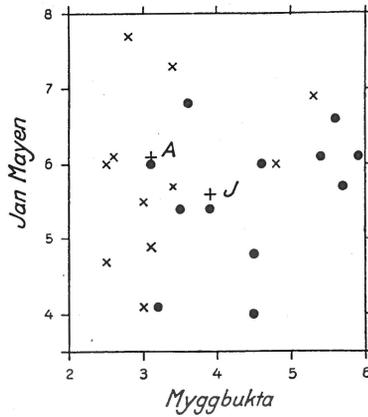


Fig. 13 b. Contemporaneous monthly mean temperatures at Jan Mayen and Myggbukta in the months July (●) and August (×). A + denotes monthly mean values for the whole period.

even as to the two Greenland stations mutually a corresponding procedure will lead to a rather doubtful result.)

In summer there is hardly any correlation between the monthly means of the two stations; on the other hand the highest and the lowest monthly means differ comparatively little at this time of the year.

From Fig. 13 a and b the most important features regarding the dispersion of the monthly means may likewise be seen: the dispersion is small in the summer, while in winter it is fairly considerable over the sea and very great near the coast of Northeast Greenland.

Diurnal Variation.

Before the description of the normal annual variation of the temperature (and such irregularities as are manifested in the monthly means of the individual years) is continued with an account of the dispersion of the diurnal means and the connection between temperature and wind conditions, some remarks on the normal diurnal variation of the temperature will be offered.

Observations of maximum and minimum thermometers are only available to a limited extent from the four stations considered here and

Table IX. Normal diurnal variation of the temperature at Jan Mayen (September 1921—December 1937). For the meaning of the figures in the last line, see the text below.

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
1 ^h G. M. T.	—3.2	—3.7	—4.5	—3.2	—0.9	2.0	4.8	5.3	3.5	—0.4	—1.8	—2.8
7 ^h	—3.3	—3.8	—4.6	—2.9	—0.4	2.6	5.3	5.8	3.5	—0.5	—1.8	—3.0
13 ^h	—3.2	—3.4	—3.8	—1.9	0.5	3.8	6.4	6.9	4.6	0.1	—1.4	—2.8
18 ^h	—3.2	—3.6	—4.2	—2.3	0.2	3.4	6.1	6.5	4.0	—0.3	—1.6	—2.8
2 <i>a</i>	0.1	0.4	0.9	1.5	1.6	2.1	1.9	1.8	1.3	0.6	0.3	0.2

are moreover unsuited for a direct determination of the diurnal variation of the temperature, since the aperiodic (mainly advectively conditioned) temperature variations play an important part all the year round and in the winter half-year are even entirely dominant as compared with the periodic (directly radiation-conditioned) variations. On the other hand, three observations a day (as published for Myggbukta and Scoresbysund) do not permit even a fairly exact determination of the magnitude of the diurnal amplitude at the different times of the year, at any rate not in such a special and slightly investigated climate as that found in Northeast Greenland. As regards Jan Mayen we are more fortunate, since here temperature readings were made four times a day at 1^h, 7^h, 13^h, and 18^h G. M. T.). Table IX gives, in the first place, the mean temperature for each of these hours month by month, and secondly the diurnal variation of the temperature (2*a*, if *a* denotes the amplitude), determined graphically for each individual month and accordingly encumbered with some uncertainty (estimated at 0.1—0.3°).

Table X shows the corresponding figures for Myggbukta; however, here the first line indicates the average of the diurnal minimum temperatures. It is quite evident that the minimum temperature—as stated above—is “something apart” during the coldest part of the year. The

Table X. Normal diurnal variation of the temperature at Myggbukta (1932—37) See further the text on pp. 43—44.

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Min.....	—23.5	—27.2	—25.5	—22.9	—9.1	—0.6	2.2	0.4	—4.0	—13.2	—18.9	—21.6
7 ^h G. M. T.	—18.0	—21.4	—21.1	—18.8	—6.0	1.8	4.6	2.6	—1.9	—9.7	—14.1	—16.5
13 ^h	—17.8	—21.2	—18.6	—13.1	—2.6	3.2	5.6	4.7	0.6	—8.6	—14.1	—16.7
18 ^h	—18.3	—21.1	—18.1	—11.9	—2.0	3.5	5.6	4.7	0.5	—9.2	—14.1	—16.8
d_1	0.5	0.3	3.0	6.9	4.0	1.7	1.0	2.1	2.5	1.1	0.0	0.3
d_2	5.7	6.1	7.4	11.0	7.1	4.1	3.4	4.3	4.6	4.6	4.8	5.1
$2a$	0.0	0.5	4.0	8.5	6.0	3.0	2.5	3.0	3.0	1.5	0.0	0.0

figures in line d_1 indicate the difference between the highest and the lowest of the three mean figures for the observations made at fixed hours while the figures in line d_2 indicate the difference between the highest fixed-hour mean and the mean minimum. The value of the diurnal periodic variation $2a$ must lie between these two limits, with the exception, however, that the small values of d_1 , which are indicated for the winter months, are hardly expressive of an actual diurnal temperature period, but have chiefly appeared because the extent of the material (6 years) is insufficient for eliminating the influence of non-periodic factors. It can be taken for granted that in the polar night $2a$ is practically nil, while in the calm months May—June, when the non-periodic temperature variations are less marked, and the minimum temperature probably occurs several hours before the morning observation is made, $2a$ is presumably fairly near the upper limit d_2 . On this basis an attempt has been made to estimate $2a$ (lowermost line in Table X), but it is obvious that the values thus determined are encumbered with a good deal of uncertainty (in some months possibly even 1°).

Fig. 14 shows the mean diurnal temperature variation, $2a$, in the course of the year at Jan Mayen and at Myggbukta. As might be expected, the variation is much larger during the greater part of the year—in the spring even 3—4 times as large—at Myggbukta than at Jan Mayen: the climate at Myggbukta, in this as well as in other respects, is largely continental, though the situation of this station near a sometimes ice-free coast involves a maritime element, especially in the summer; Jan Mayen has a markedly insular climate.

While the annual variation at Jan Mayen shown in Fig. 14 is very simple, with a maximum (c. 2°) in summer and a minimum (practically 0°) in December—January, the variation at Myggbukta during the year is more complicated: a remarkably acute maximum (probably

8—9°) in April, a flat secondary maximum (probably c. 3°) in August—September, the main minimum (practically 0°) in the winter months, and a secondary, little marked minimum in July. More or less similar conditions are known from other stations, also, north of the Polar circle. It is evident that we are here largely concerned with a simple radiation effect, but the marked asymmetry shows that other factors, also, play an important part. The very great difference between the spring and

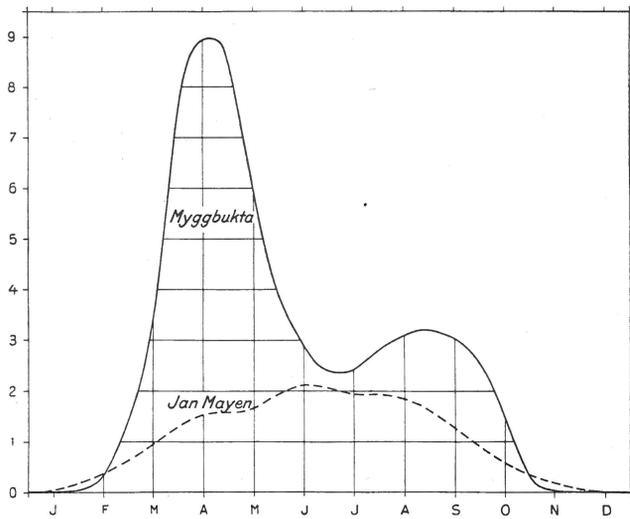


Fig. 14. Annual course of the diurnal variation of the temperature (double amplitude, $2a$) at Myggbukta and Jan Mayen.

the autumn is due to several concurrent circumstances; the cloudiness as well as the vapour contents of the air and the velocity of the wind are on an average least in the spring; moreover, it may be supposed to be of importance that the temperature fall in the September nights—unlike in the spring—is impeded by a conduction of heat from the comparatively high-temperature upper layers of the soil, which at this season of the year are not, as a rule, covered by a highly insulating, thick layer of snow.

The comparatively small temperature amplitude at the height of the summer is due i. a. to the fact that winds blowing from the sea (the directions E, SE, and S) are highly prevalent at this time of the year (cf. Fig. 7, p. 27).

The uncomplicated annual variation at Jan Mayen can in the main be explained as a consequence of the variation in the radiation balance; the annual variation of the wind force acts in the same direction.

Frequency Diagrams.

To the climatic area dealt with in the present paper it applies to a marked extent that on considering the temperature conditions of the individual days we may gain both a clearer and a more complete idea of the temperature climate than that which monthly means can give. There are features of essential importance which are either not at all or only indirectly and indistinctly reflected in the monthly means, but which are fully disclosed when the investigation is extended to comprise also the individual days. Hence a fairly detailed account of the results of such an investigation for two stations will be given below: Jan Mayen as a representative of the generally ice-free part of the sea off the east coast of North Greenland, and Myggbukta as a representative of the coast zone proper. (As to a corresponding investigation i. a. for some West Greenland stations, see L. 23.)

The investigation is—for weighty practical reasons—limited to comprise three winter months (December, January, and February), which are dealt with *en bloc*, and three summer months (June, July, and August), which are likewise treated collectively. In this way it is possible in the first place to use fixed-hour observations instead of diurnal means without the result being particularly affected; for in these six months the diurnal variation of the temperature not only over the sea, but also in the coastal zone of Greenland is of minor importance. Secondly, distortion of certain results of the investigation (thus in regard to the frequency distribution of the different temperatures) on account of the variation of the normal temperature from day to day, is practically avoided.

The material employed is the observations made at 7^h G. M. T., for Jan Mayen from the period December 1924—December 1937 and for Myggbukta from the years 1932—37. Thus the number of observations for Jan Mayen is c. 2400 (1200 from the winter months and 1200 from the summer months) and for Myggbukta c. 1100 (550 for each of the two seasons). In choosing the vertical scale in Fig. 15 a—d (and Figs. 18—19) the difference in the extent of the material for the two stations has been taken into consideration.

Fig. 15 a—d show the four frequency diagrams for the temperature at 7 h. There is a very considerable difference between these four diagrams.

Fig. 15 a (Jan Mayen, winter) shows an exceedingly skew frequency distribution; the frequency maximum falls within the temperature interval 0—1°, while the mean temperature is c. 4° lower. The most frequent temperature in the winter is even a little higher than the mean temperature of the year—no doubt a unique case! The many small and

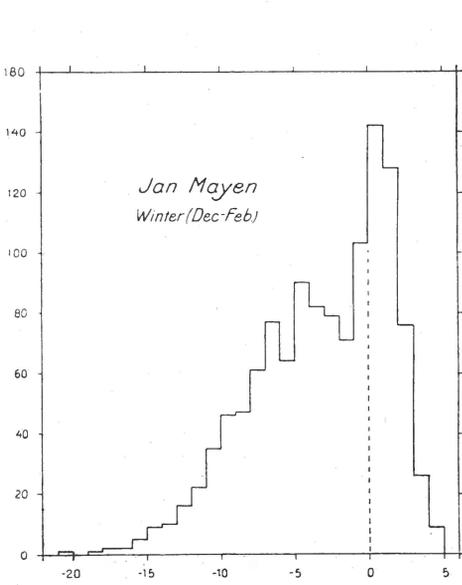


Fig. 15 a.

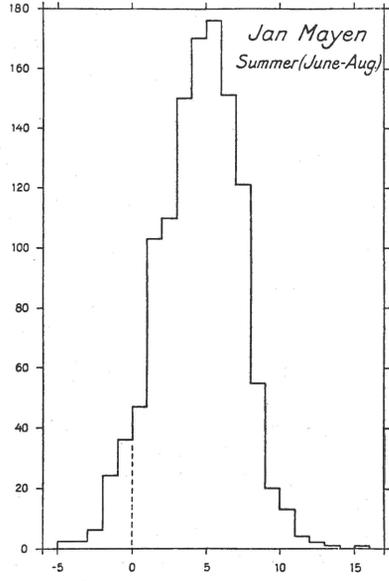


Fig. 15 b.

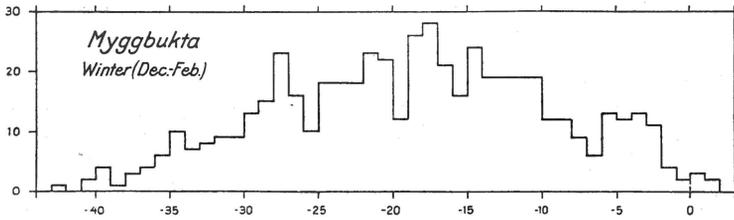


Fig. 15 c.

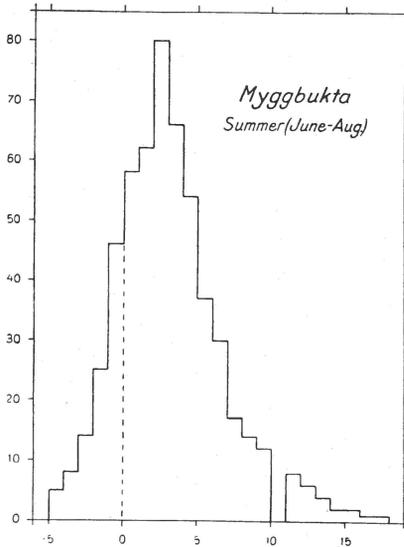


Fig. 15 d.

Fig. 15. Frequency diagrams for the temperature at 7^h G. M. T.¹⁾

- a) Jan Mayen, Dec. 1924—Dec. 1937, winter (Dec.—Feb.).
- b) Jan Mayen, Dec. 1924—Dec. 1937, summer (June—Aug.).
- c) Myggbukta, 1932—37, winter (Dec.—Feb.).
- d) Myggbukta, 1932—37, summer (June—Aug.).

¹⁾ The ordinate gives the total number of cases within each temperature interval.

moderate positive deviations from the "normal" temperature are compensated by a fairly considerable number of large, partly very large, negative deviations; while the highest temperature that has occurred is c. $4\frac{1}{2}^{\circ}$, i. e. 8° above the normal, negative deviations of more than 8° occurred on well over 50 days, that is to say, nearly 5 per cent of the total number, and the coldest day had a morning temperature of -20° , that is to say, $16\frac{1}{2}^{\circ}$ below the normal.

On a closer examination of the curve it will be noted that a secondary frequency maximum occurs almost at -4° . It is true that this may have arisen quite "casually", i. e. merely on account of the insufficiency of the material; but it is, at least, just as reasonable to regard it as a reality and to combine it with the fact that any skew distribution curve may formally be decomposed into two or more normal ("Gaussian") distribution curves (cf. L. 23). It will be shown below (p. 52 and Fig. 18) how, in a quite different way, we may arrive at the result that the frequency distribution in question should be regarded as a result of a superposition of two distributions, each rather uncomplicated, so that in this special case a simple geophysic interpretation of what takes place by the formal decomposition of the one distribution curve into two may be given.

Fig. 15 b (Jan Mayen, summer), in contrast to Fig. 14 a, shows a distribution which is fairly symmetrical and does not differ very much from the Gaussian. More than 80 per cent of all the observations come within the interval $1-8^{\circ}$; the extreme limits are -5° and $+16^{\circ}$.

Fig. 15 c (Myggbukta, winter) shows a distribution which is fairly symmetric, but whose most conspicuous peculiarity is that the maximum is extremely "flat": all temperatures from -28° to -10° are almost equally frequent, the frequency figures for the whole-degree intervals within this area lying nearly all of them between 15 and 25. Outside this flat central zone, which does not even comprise 65 per cent of all the observations, the curve descends fairly regularly at both sides, the lowest temperature observed, c. -42° , lying c. 23° below and the highest, a little over 1° , c. 20° above the mean temperature of the winter.

The distribution shown in Fig. 15 d (Myggbukta, summer) differs from each of the three already mentioned. It is skew like that shown in Fig. 15 a, but the most frequent temperature in this case is a little lower than the mean temperature: the frequency maximum occurs within the temperature interval $2-3^{\circ}$, while the mean temperature for 7^h G. M. T. in the summer months is precisely 3° . It is even more conspicuous that the highest temperature (a little above 17°) deviates much more from the normal than the lowest one (-5°). About 85 per cent of all the observations fall within the interval $-1-+6^{\circ}$.

Relation between Temperature and Wind.

The so-called "thermal compass cards", which are only of limited interest as a constituent in a climatic description of an area the climate of which has been carefully studied from geographic as well as geophysical points of view, are a rather convenient means to describe the peculiarities of a less thoroughly investigated climate, and in such a case they may sometimes afford valuable guidance if we are on the track of not too

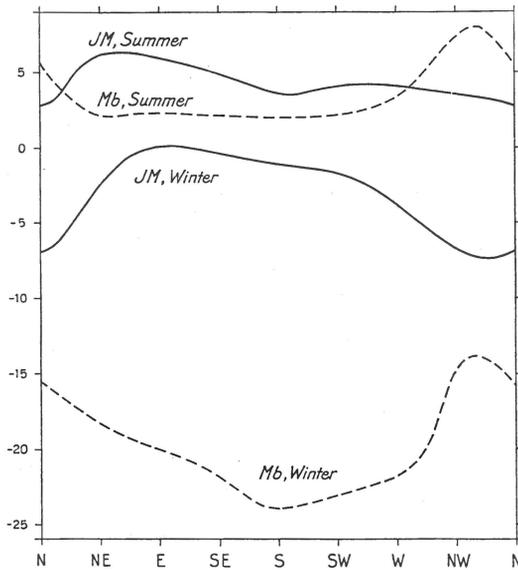


Fig. 16. Mean temperature for the different wind directions.

complicated physical connections. In order to ensure that important aspects of the climate, which are closely connected, but which it is otherwise difficult to treat together, may be dealt with in a single section, and at the same time to suggest a physical interrelationship which will appear more distinctly from the description of the individual cases in Part II, an account will be given below of the interdependence between the wind and the temperature at Jan Mayen and at Myggbukta, winter and summer (as hitherto) being treated apart. In addition to the direction of the wind, the velocity of the wind is also taken into consideration.

The investigation is based on the same material as the preceding frequency statistics, that is to say, for Jan Mayen c. 2400 and for Myggbukta c. 1100 single observations (all made at 7^h G. M. T.), distributed uniformly over the three winter and the three summer months. The quantity of the material is sufficient to permit a fairly exact deter-

mination of the mean temperature of the rather frequently occurring wind directions and wind forces; however, at Myggbukta certain wind directions and particularly high wind forces are of such rare occurrence that the corresponding average values are rather doubtful—for the same reason they are, of course, of minor importance from a practical point of view.

The result of the investigation will appear from Figs. 16 and 17. Fig. 16 shows the temperature as a function of the direction of

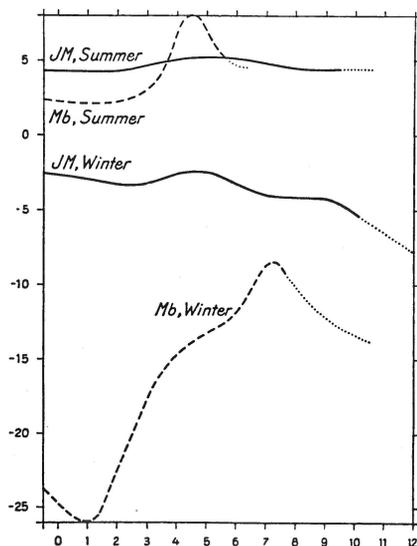


Fig. 17. Mean temperature for the different wind forces (wind scale 0—12). The dotted parts of the lines indicate values which are uncertain on account of the limited number of observations. See the text pp. 55—56.

the wind (i. e. the average temperature found on all the observations at which the particular wind direction prevailed irrespectively of the force of the wind). The curves seen in the figure are the result of a cautious smoothing of the mean figures computed; the figures themselves are found in Table XI, which in addition gives information about the number of observations on which each individual mean figure is based.

The curve for Jan Mayen, winter, shows that the temperature is generally highest (c. 0°) with easterly and southeasterly winds and lowest (c. -7°) with northwesterly and northerly winds. The reason is obvious: easterly and southeasterly winds will, as a rule, carry maritime air, northwesterly and northerly winds as a rule fresh arctic air. The only point that may seem remarkable is that southerly winds are generally somewhat (c. 1°) colder than easterly winds; in this connection it may, however, be pointed out that among the days with southerly

Table XI. Mean temperature for the different wind directions ("thermal compass card"). In addition to the temperature the number of observations on which the computation is based is stated.

	Jan Mayen				Myggbukta			
	Winter		Summer		Winter		Summer	
	Number of cases	t_m	Number of cases	t_m	Number of cases	t_m	Number of cases	t_m
N	179 ¹ / ₂	-6.7°	78	3.1°	151 ¹ / ₂	-15.6°	59 ¹ / ₂	5.6°
NE	149	-2.4	61	5.8	40	-18.4	17 ¹ / ₂	2.5
E	224 ¹ / ₂	-0.1	365	6.0	45 ¹ / ₂	-20.0	90 ¹ / ₂	2.3
SE	68	-0.3	98 ¹ / ₂	5.1	17	-20.8	154	2.1
S	71	-1.0	91 ¹ / ₂	3.7	13 ¹ / ₂	-25.4	36 ¹ / ₂	2.0
SW	91 ¹ / ₂	-1.5	119	4.0	17	-23.2	15	2.2
W	130 ¹ / ₂	-3.7	102	4.0	33	-22.2	27 ¹ / ₂	3.5
NW	234	-6.6	193	3.6	121	-15.2	48 ¹ / ₂	6.9
Calm	56	-2.6	88	4.3	104	-24.5	103	2.4

winds there are a number of cases in which an arctic air current from Greenland, moving by a cyclonically curved track near the centre of a stationary or north-moving depression, reaches Jan Mayen as a southerly wind (cf. pp. 71 and 113—14).

Considering the great difference in the mean temperature between easterly and northwesterly-northerly winds, it is of interest to examine the frequency distribution of the different temperatures for the different wind directions. The main result of such an investigation will appear from Fig. 18 a—b.

Fig. 18 a shows the frequency distribution on days on which the wind blew from one of the directions ENE, E, and ESE, as also on all the days with the exception of those on which the wind blew from a direction between W and N (incl.); Fig. 18 b shows the frequency distribution on days with one of the wind directions NW, NNW, and N, and on days with one of the directions W—N incl.

The distributions in Fig. 18 a are characterised by an very pronounced maximum at +1°; they are both skew in such a way that the maximum frequency occurs at a temperature which is above the seasonal average temperature of the wind in question, but the distribution which only comprises the easterly winds is less asymmetrical than the other, since here it is only a comparatively small number of the observations which have a great negative deviation: only 8—9 per cent of the days have a mean temperature of -5° or below.

The distributions shown in Fig. 18 b have a much less acute maximum and exhibit an almost perfect symmetry. Here the frequency maximum occurs at -6—-7°.

The frequency distribution on days with easterly winds (Fig. 18 a) no doubt corresponds fairly closely to the frequency distribution on days with maritime air, and the distribution on days with northwesterly-northerly winds corresponds to the distribution on days with fresh arctic air; we may, however, assume that the contrast between the two distributions would be even more pronounced if a division were

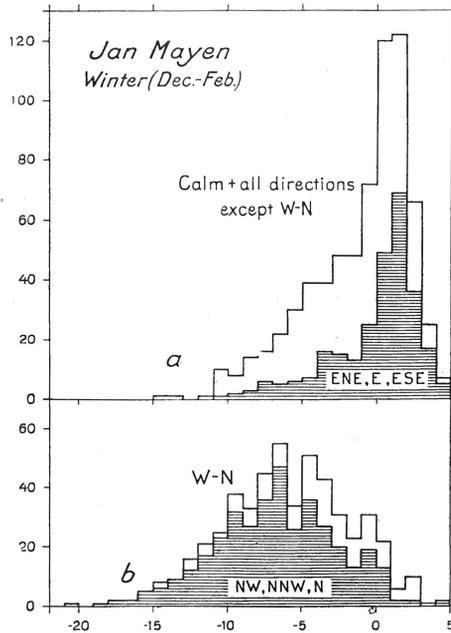


Fig. 18. Frequency distribution of temperature for different wind groups (Jan Mayen, December—February), cf. Fig. 15.

made according to air masses; the individual cases which fall outside the general picture (-5 — -10° with easterly winds or about 0° with northerly-northwesterly winds) are, no doubt, connected with the fact that air conveyed from the east may be arctic air from Spitsbergen or returning Greenlandic arctic air, while, conversely, the air which comes from the northwest or north may be maritime air, which, for instance, has moved by a cyclonically curved track. Days on which the wind blows from the NNE, NE, or a direction between SE and WNW form, quite reasonably, a more or less even transition in regard to the distribution of air mass and temperature; the same applies to days with calm weather.

It will now be immediately obvious how the peculiar distribution in Fig. 15 a arises by the superposition of the distributions in Fig. 18, and conversely, this explains what is illustrated by Fig. 15 a: the skewness and the double maximum are due to the fact that the material comprises

a large number of cases with maritime air as well as a large number of cases with arctic air, while the number of transitional cases is not high enough to obliterate the peculiar character of the curve.

The curve for Jan Mayen, summer, has a maximum (c. 6°) for easterly and northeasterly winds and a minimum (c. 3°) for northerly winds. The great difference between northerly and northeasterly winds is remarkable; it may, however, in the main be accounted for by the normal position of the ice edge in the summer and the associated temperature of the water. That the air is generally somewhat warmer with northeasterly than with southeasterly, southerly, and southwesterly winds, may possibly be due to advection from the northeast of comparatively dry polar air in which the amount of clouds is relatively small and, consequently, the conditions favourable for heating by radiation; moreover the possibility cannot be disregarded that foehn processes, on Jan Mayen proper as well as on Spitsbergen, may in rare cases play a role.

The curve for Myggbukta, winter, shows with great distinctness the fact, paradoxical as it may seem, that the southerly wind is colder and the northwesterly-northerly winds are warmer than any other wind; their mean temperatures are c. -25° and c. -15° C. respectively, so there is a considerable difference. A more careful study of the material shows, however, that the southerly wind, whose mean temperature is so low, has only occurred in a very few cases, that it has never blown with a higher force than 4 Beaufort, and that it is only those days on which its force was 1 Beaufort which exhibit a remarkably low temperature. The light southerly wind observed in these cases has evidently nothing to do with advection on a large scale, but is a purely local wind, possibly even a phenomenon which is secondary in relation to the extreme cold.

Of much greater interest is the mean temperature for northerly and northwesterly winds, which is strikingly high compared with the normal temperature of the place and considering the course of the normal isotherms. As mentioned on p. 26, winds blowing from these directions are fairly prevalent in the winter and are practically the only ones which sometimes blow with a considerable force. If, now, we examine what connection exists between their force and the temperature at the time, we shall find a very close connection (Table XII a, p. 57): with a light northerly wind (force 1—2 Beauf.) the temperature is on an average -21—24° C., with a high wind (6 Beauf. and above) on an average -9—12° C. Since, as mentioned above, the wind is nearly always light when it blows from other directions than NW and N, we may roughly, as far as wind and temperature are concerned, distinguish between the following four "main weather types" for Myggbukta in the winter:

	Force of Wind		
	0—3	4—6	7—11
Winds from NW—N	—21°	—14°	—10°
All other wind directions	—22°	—	—

Thus it is only the high and moderately high northerly and northwesterly winds which take a special position in regard to the temperature.

The most obvious, but no doubt not the only cause of the high temperature of the strong northerly winds is the disappearance of vertical temperature differences (more precisely expressed: the approachment to an adiabatic lapse-rate) which takes place when the wind is high, since in such cases—other conditions being equal—a more considerable convection is taking place between the lowermost and the somewhat higher-lying air layers; ground inversions are not readily formed when the wind is high, and inversions already existing are more or less completely destroyed when the wind is freshening. The high mean temperature on days with a strong wind may thus be regarded as a confirmation of the assumption that might be based on theoretical considerations and which in recent years could be supported by aerological material: near the coast of Northeast Greenland there is normally a considerable temperature inversion in the winter (see p. 74).

A consideration of the weather maps on which Myggbukta has a particularly high temperature (c. 0—–8°) with high northerly or northwesterly winds shows, however, that other causes, too, besides the aforementioned destruction of the inversion sometimes intervene. Thus we may find examples showing that maritime warm air has made its way right up to the north side of a well-developed depression north of Iceland and flows across the coastal area of Greenland; in such cases Myggbukta has nearly always northerly or even northwesterly winds although according to the direction of the gradient we might rather expect a northeasterly wind, and in the coastal districts the stormy weather is mostly accompanied by a continuous snowfall.

A quite different and less frequent weather type may briefly be characterised by the word foehn. In the most typical cases of this kind a strong stationary anticyclone is found between Iceland and South Greenland or somewhat farther southward; on the northwest side of this anticyclone air which originates from the North Atlantic will flow by an anticyclonically curved track across Greenland, passing the west coast for instance between Godthaab and Godhavn and the east coast between Scoresby Sund and Danmarks Havn. The air descends (more or less regularly) as a foehn at the east coast, but after its passage across the inland ice its temperature is (in winter) as a rule some degrees

below 0° C. It is remarkable that Myggbukta—probably on account of purely local orographic disturbances—in these cases has a northwesterly wind, while judging from the weather map the wind might be expected to be westerly.—In Part II this peculiar type of weather, which in other respects, also, presents interesting features, and which may occur at all seasons of the year, is illustrated by selected weather maps.

The curve for Myggbukta, summer, shows a remarkably uniform mean temperature, $2-2\frac{1}{2}^{\circ}$, for all easterly and southerly wind directions, while northerly and especially northwesterly winds are much milder, with a mean temperature of c. $6-7^{\circ}$. The low and uniform temperatures accompanying the frequent easterly and southeasterly winds are, of course, due to the fact that these winds blow from the sea; there is evidently a gradual transition between the cases in which a typical gradient wind blows across vast areas, and the exceedingly numerous cases of a local sea-breeze which only occurs along the shore proper, possibly even along certain stretches of the coast only.—It is somewhat more remarkable that the southwesterly wind, too, appears to be of a maritime character; however, wind from the southwest rarely occurs, it always blows with low force, and is evidently of a purely local character.

The high mean temperatures found for northerly and northwesterly winds are connected with the fact that the wind which blows from these directions has, in summer, as a rule a more or less distinct foehn character.

The material invites an investigation of the frequency distribution similar to that carried out for Jan Mayen for the winter. The main result of the investigation appears from Fig. 19. Fig. 19 b shows the frequency of the different temperatures for the wind directions WNW—NNE, while Fig. 19 a shows the frequency distribution for all the other wind directions (and calms) together. A separation, so nearly complete, into two groups of widely different characters as that arrived at for Jan Mayen is not obtained here; but it is remarkable that the distribution curve in Fig. 19 a is almost entirely symmetrical (and Gaussian), so the aforementioned skewness (Fig. 15 d) is evidently directly connected with the occasional occurrence of northwesterly or northerly winds of a foehn character; in almost all the cases in which a temperature of more than 10° was observed, the wind was northwesterly or northerly, as appears from Fig. 19. At the same time, however, Fig. 19 b shows that far from all days with northwesterly or northerly winds have a remarkably high temperature, and they include cases in which there is not the slightest trace of a foehn effect.

The curves in Fig. 17 (p. 50), which show the temperature as a function of the force of the wind (i. e. the mean temperature in all the observations in which force 0, 1, 2, etc., occurred, irrespectively of the

wind direction), were constructed according to the same principle as the curves in Fig. 16; supplementary information is found in Table XII (incl. XII a).

The curve for Jan Mayen, winter, shows that the mean temperature is almost the same (c. -3°) for all wind forces below 6, while the high forces of the wind are accompanied by a somewhat lower temperature; if the force is 10 or more, the temperature is -6° on

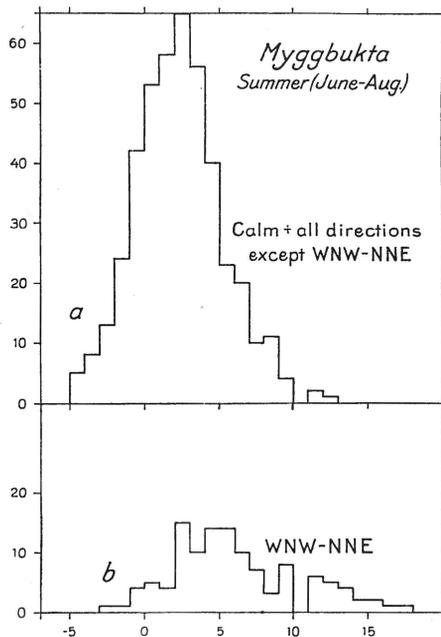


Fig. 19. Frequency distribution of temperature for different wind groups (Myggbukta, June—August).

an average. A closer investigation shows that the very high forces of wind both relatively and absolutely are far more frequent from the directions NW—N than from the other directions; for this reason alone we might expect a lower mean temperature for the high wind forces than for the lower ones (cf. p. 50). If we consider the directions NW—N apart (Table XII a), we find, however, that the temperature is actually on an average some degrees lower at a high than at a low force of the wind; as for the other wind directions the influence of the wind force is less important and just the opposite: with high northeasterly winds, for instance, the temperature is on an average c. 2° higher than with light northeasterly winds.

The fact that the temperature at Jan Mayen in the winter is particularly low when a high northerly wind blows, is even more conspicuous if we separate all the days with a particularly low temperature

Table XII. Mean temperature for the different forces of wind. In addition to the temperature, the number of observations on which the computation is based is stated.

Wind force	Jan Mayen				Myggbukta			
	Winter		Summer		Winter		Summer	
	Number of cases	t_m	Number of cases	$t_m$	Number of cases	$t_m$	Number of cases	$t_m$
0.....	56	-2.6	88	4.3	104	-24.5	103	2.4
1.....	91	-2.9	156	4.3	60	-25.8	84	2.2
2.....	164	-3.3	253	4.3	110	-22.0	194	2.3
3.....	164	-3.1	234	4.7	55	-17.8	93	3.1
4.....	163	-2.6	170	5.0	54	-14.2	47	6.8
5.....	166	-2.5	128	5.2	72	-13.7	27	7.0
6.....	122	-3.3	79	5.2	42	-12.2	3	3.6
7.....	118	-4.0	53	4.7	25	-8.7	1	5.3
8.....	53	-4.0	21	4.5	9	-11.1		
9.....	41	-4.2	10	4.4	5	-11.8		
10.....	32	-5.3	2	5.8	5	-11.7		
11.....	16	-7.9	2	3.8	1	-15.5		
12.....	18	-6.1						

Table XII a. Mean temperature for the different wind forces on winter days with winds from the NW, NNW, or N.

Wind force	Jan Mayen		Myggbukta	
	Number of cases	t_m	Number of cases	t_m
1.....	25	-4.4	18	-24.2
2.....	50	-5.8	31	-21.6
3.....	41	-5.9	19	-16.6
4.....	48	-5.8	37	-15.4
5.....	48	-6.9	67	-14.0
6.....	44	-7.3	42	-12.2
7.....	46	-8.3	24	-9.0
8.....	22	-7.0	9	-11.1
9.....	19	-7.0	5	-11.8
10.....	16	-10.0	4	-11.8
11.....	9	-10.4	1	-15.5
12.....	11	-8.3		

and examine the wind conditions on these. The wind conditions on days with a temperature below -13° appear from Table XIII, which shows that it is almost only the directions NW—N which are represented, and that the force of the wind is especially frequently 6—7, but sometimes even higher, right up to 12. This is a feature which is peculiar to the climate of Jan Mayen; it is otherwise, for temperate as

Table XIII. Wind distribution at Jan Mayen on winter days with a temperature (at 7 h) below -13.0°C .

wind direction \ wind force	1	2	3	4	5	6	7	8	9	10	11	12	Total
WSW	1	..	1	..	..	..	..	..	2
W	1	..	..	..	1
WNW	1	..	..	..	..	..	1
NW	2	..	..	1	1	2	..	..	2	1	1	10
NNW	1	..	..	..	3	4	1	..	..	..	..	9
N	1	1	3	1	..	..	1	..	7
Total...	..	3	..	..	3	5	11	2	1	2	2	1	30

well as for polar climates, a rule with few exceptions that the lowest temperatures occurring in the winter depend entirely or at any rate in an essential degree on radiation: thus they occur chiefly in connection with calm and clear weather. That conditions are quite different at Jan Mayen, is readily explained by the isolated position of the island far northward, surrounded by a sea which—during the period here concerned—is, as a rule, entirely or nearly free of ice in the immediate vicinity of the island, but where the ice edge is not far off: if arctic air is carried over the open sea in the winter, it is heated from below, in which way temperature inversions in the lowermost layers will be destroyed in the course of a very short time; for a fixed horizontal distance the duration of the heating process is inversely proportional to the velocity of the wind. If high northerly winds blow during a prolonged period, the ice edge will usually approach Jan Mayen, a circumstance which further reduces the heating of the arctic air.

The curve for Jan Mayen, summer, shows a nearly uniform mean temperature, $4-5^{\circ}$, for all wind forces (except the highest, which are rare at this time of the year). From the material on the basis of which the curve was drawn it appears, however, that the mean temperature on days with easterly winds—the most frequent wind direction—varies from c. $4\frac{1}{2}^{\circ}$ for force 1 to c. $7\frac{1}{2}^{\circ}$ for force 6—7 (for still higher forces somewhat lower again), while the mean temperature on days with northwesterly winds—the next-commonest wind direction—decreases from c. $4\frac{1}{2}^{\circ}$ for force 1 to $2\frac{1}{2}-3^{\circ}$ for force 5—7 (for still higher forces it is here a little higher). The result stated above, viz. that there is hardly any correlation between the force of wind and the temperature, thus arises because the two most frequent wind directions show a largely opposite behaviour; the relative frequency of the different wind forces is almost alike for the two directions, which contributes to make the equalisation as complete as it is.

The curve for Myggbukta, winter—in marked contrast to the winter curve for Jan Mayen—shows the picture usual for the season: a low temperature when the wind is light, and a fairly high temperature when it is high. The lowest mean temperature is -26° for wind force 1, the highest -9° for force 7. That wind force 1 gives a slightly lower (at any rate not a higher) mean temperature than calm weather, is probably a fact and may possibly be due to a connection between the wind force and the cloudiness. It is likewise probably a fact that the temperature is generally somewhat lower for the very high wind forces than for force 7 (the twenty observations with a wind force of 8—11 give a mean temperature of $-11\frac{1}{2}^{\circ}$); this is all the more striking since practically all wind forces of 7 and more occurred on days with north-westerly or northerly winds (cf. p. 53 f.). The explanation is probably that a relatively large number of the days with wind force 7 have a particularly high temperature on account of advection of maritime warm air or because a foehn wind prevails (cf. p. 54) while most of the days with very high wind forces are characterised by advection of true arctic air, which shows no appreciable ground inversion, but is very cold in the upper air. It should be pointed out, however, that the extent and character of the material is insufficient for a final answer to these questions.

The number of days with calm weather at Myggbukta is very large all the year round, as will be seen from Table VI (p. 29). The high calm percentage in the winter offers a favourable opportunity for an investigation of the connection between the cloudiness and the temperature; for if we confine ourselves to considering the days with calm weather, it will be possible to eliminate the disturbing effect which the wind exerts on the formation of the inversions. The result will appear from Table XIV.

Table XIV. Mean temperature on calm days at Myggbukta.

Cloudiness in tenths	Winter		Summer	
	Number of cases	t_m	Number of cases	t_m
0.....	51	-27.3	12	1.6
1—3.....	11	-27.8	17	3.6
4—6.....	6	-26.8	8	4.6
7—9.....	4	-25.8	19	3.4
10.....	32	-18.2	47	1.4

The great difference existing between days with a cloudless sky and days with an entirely overcast sky is only what might be expected. It is surprising, however, that the days on which part of the sky is

covered by clouds hardly differ from days with clear weather; on this account it might be assumed that on most days with a cloudiness of 1—9 the layer of clouds will be very thin.

Recurring once more to Fig. 17 (p. 50), we find that the curve for Myggbukta, summer, shows for the lowest wind forces, 0—2, a uniform mean temperature of c. 2°; for the moderately high wind forces, 4—5, the mean temperature is much higher, c. 7°. (Higher wind forces than 5 are very rare in summer.) The course of the curve must be viewed in connection with the corresponding curve in Fig. 16, as there is a marked difference in the forces with which the most frequent wind directions usually blow (see Table XV); the south-

Table XV. Distribution of wind force at Myggbukta in summer for the most frequent wind directions.

	Wind force							Total	v _m
	1	2	3	4	5	6	7		
NW—NNW—N.....	6	12	18	34	23	2	1	96	3.7
E—ESE—SE.....	50	129	49	7	..	..	..	235	2.1

easterly (easterly) wind is as a rule a kind of sea-breeze or summer monsoon, which—especially in the morning—is only light, while force 3—5 is highly dominant as regards northerly winds. Therefore, excluding all cases with a low wind force, we arrive at a wind distribution where the northerly—northwesterly winds are dominating, and these winds, which are in most cases of a more or less distinct foehn character, will often be accompanied by a high temperature.

For all the days with calm weather the connection between the cloudiness and the temperature has been specially investigated, as was done for the winter. At first sight the result is surprising, the temperature being a good deal higher on days with a partially cloudy than on days with an entirely clear or entirely overcast sky (Table XIV). The explanation is possibly to be found in the fact that calm and partially cloudy weather in the summer i. a. occurs on the few days on which cumulus formation takes place, and the cumulus formation implies that the lowermost air layers should be relatively warm. However, we can pronounce no final opinion on this problem on the basis of the available material.

Number of Days with Frost.

Table XVI and Fig. 20 show the number of days with frost in per cent of the total number of days at Jan Mayen and at Myggbukta.

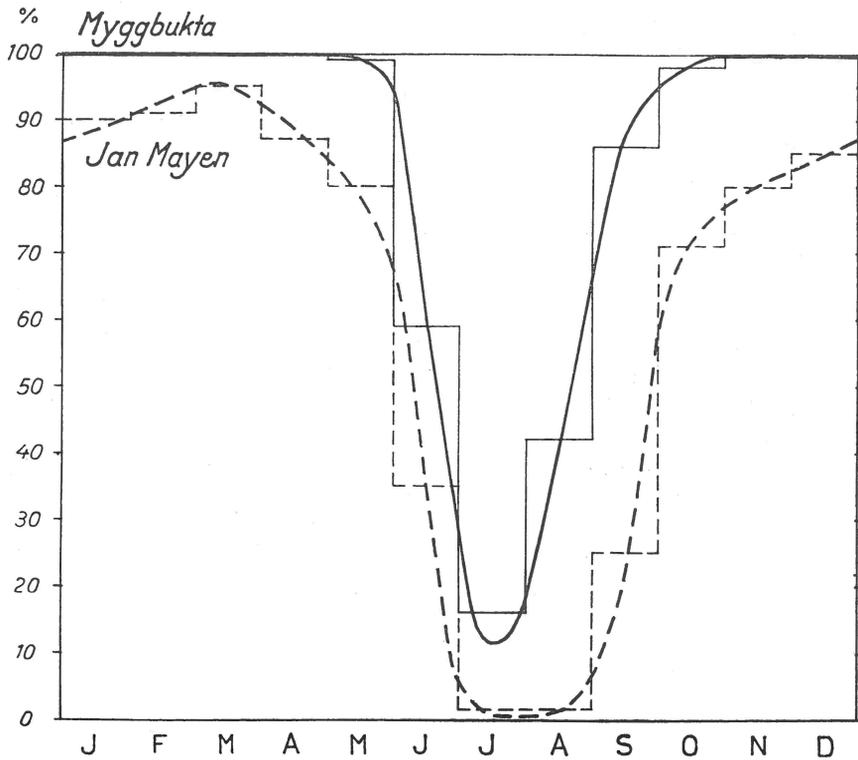


Fig. 20. Number of days with frost in per cent of the total number of days.

At Jan Mayen frostless as well as frosty days may occur at all times of the year. Frostless days are, however, rather rare during the first three months of the year, January and February having on an average three such days each and March only one and a half; on the other hand frost is a rare occurrence in July—August, the mean number of frosty

Table XVI. Number of days with frost in per cent of the total number of days.

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Jan Mayen.	90	91	95	87	80	35	1.5	1.7	25	71	80	85
Myggbukta.	100	100	100	100	99	59	16	43	86	98	100	100

days of each of these months being $c. \frac{1}{2}$. The number of frosty days increases rapidly from September (25 %) to October (71 %) and decreases rapidly from May (80 %) to June (35 %). At Myggbukta frost occurs on all days during the winter half-year (November—April); even in May and October frostless days occur quite exceptionally; in

the period June—September on an average c. 60 frostless days occur, of which c. 12 fall in June, 26 in July, 18 in August, and 4 in September. —The difference between Myggbukta and Jan Mayen is greatest in September, when Myggbukta has on an average 26, while Jan Mayen has only 8 days with frost.

Temperature Extremes.

Table XVII and Fig. 21 show the mean extremes and absolute extremes for each month of the year at Jan Mayen and Myggbukta; in addition, the mean temperature of the month and the extreme monthly means are included for comparison. (Certain minor disagreements between the figures for Myggbukta in Table XVII and the corresponding

Table XVII. Monthly (annual) means and extremes of the temperature at Jan Mayen and Myggbukta.

a: Absolute maximum temperature. b: Mean monthly (annual) maximum. c: Highest monthly (annual) mean. d: Monthly (annual) mean for the series of years considered. e: Lowest monthly (annual) mean. f: Mean monthly (annual) minimum. g: Absolute minimum temperature. h: Difference between the absolute maximum and the absolute minimum.

Jan Mayen (1922—37)													
	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	whole year
a.	5.5	5.4	6.6	7.0	9.6	12.2	15.0	14.9	13.4	9.2	6.9	5.6	15.0
b.	3.2	2.9	2.4	3.3	5.6	9.1	11.0	11.8	9.1	6.3	4.4	4.0	12.5
c.	-0.8	0.0	-0.9	0.8	1.7	5.3	6.8	7.7	8.0	1.9	2.0	0.3	0.8
d.	-3.2	-3.2	-4.3	-2.6	-0.2	2.9	5.6	6.1	3.6	-0.3	-1.6	-2.7	0.0
e.	-7.0	-7.1	-6.9	-5.4	-1.7	1.0	4.0	4.1	2.1	-2.6	-3.9	-7.0	-0.7
f.	-12.9	-14.2	-13.3	-11.5	-7.1	-2.3	0.7	0.9	-2.3	-7.6	-9.5	-12.4	-16.6
g.	-18.0	-21.3	-20.7	-15.1	-11.0	-5.1	-1.0	-1.2	-4.9	-11.9	-13.6	-18.4	-21.3
h.	23.5	26.7	27.3	22.1	20.6	17.3	16.0	16.1	18.3	21.1	20.5	24.0	36.3

Myggbukta (1932—37)													
	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	whole year
a.	1.2	5.0	2.1	7.0	11.5	19.0	20.4	15.1	10.0	8.5	1.9	3.2	20.4
b.	-3.2	-2.1	-2.6	-0.2	5.2	15.0	15.9	13.3	7.5	3.7	-2.1	-2.6	16.6
c.	-11.3	-14.2	-15.5	-13.0	-0.7	3.4	5.9	5.3	2.2	-6.7	-10.1	-12.4	-8.1
d.	-18.1	-21.4	-19.6	-16.0	-4.7	2.2	4.7	3.3	-0.8	-9.3	-14.1	-16.7	-9.2
e.	-26.1	-26.0	-18.5	-18.9	-6.9	0.7	3.5	2.5	-2.7	-12.3	-17.1	-19.7	-10.2
f.	-35.9	-40.4	-35.5	-33.6	-18.1	-4.6	-1.6	-3.3	-11.2	-23.2	-28.5	-34.2	-40.5
g.	-39.5	-44.5	-40.6	-37.7	-23.1	-6.1	-2.8	-5.1	-15.6	-30.3	-35.0	-38.0	-44.5
h.	40.7	49.5	42.7	44.7	34.6	25.1	23.2	20.2	25.6	38.8	37.2	41.2	64.9

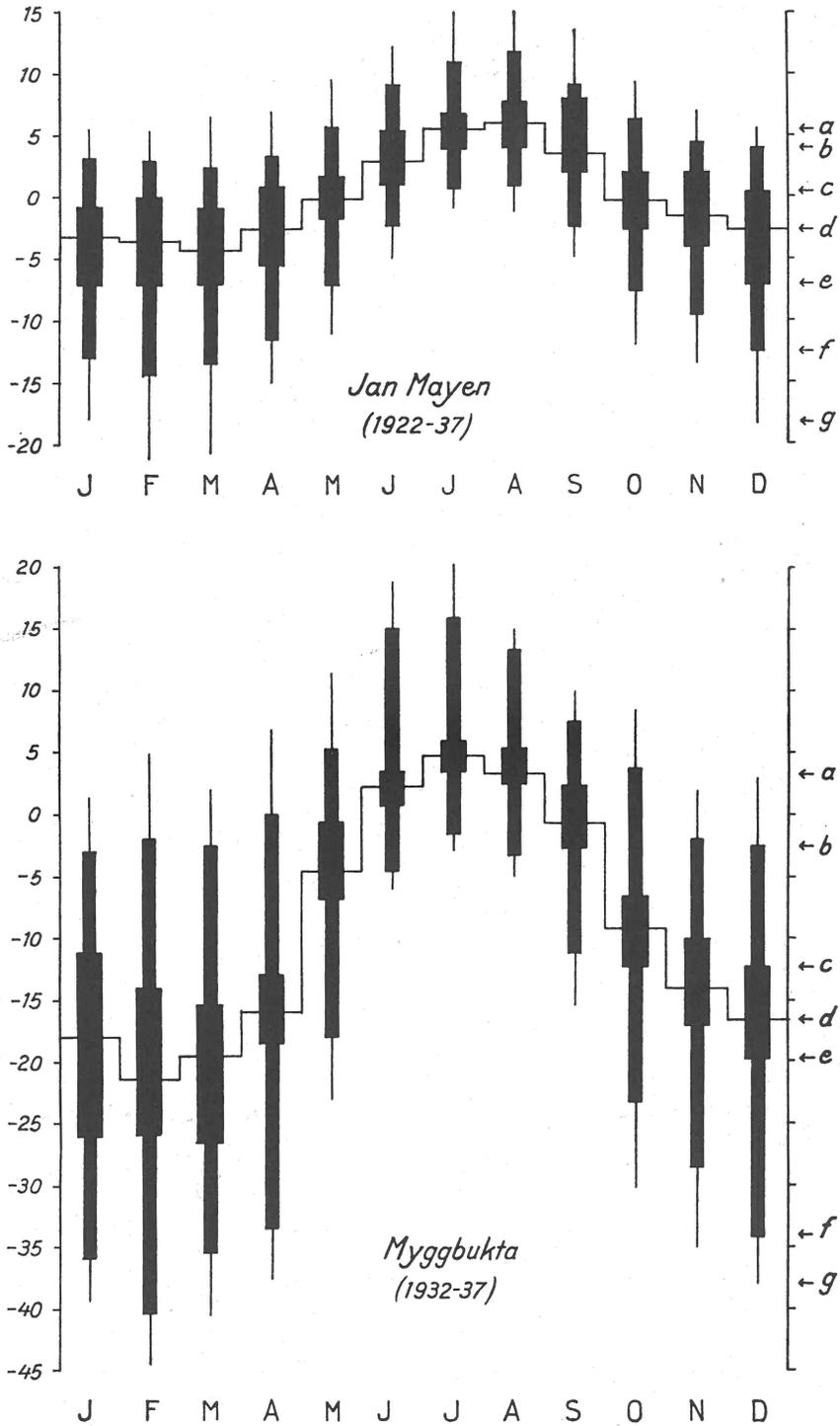


Fig. 21. Absolute temperature extremes (a and g), mean extremes (b and f), extreme monthly means (c and e), and monthly means for several years (d), cf. Table XVII.

figures in Table VIII are due to the fact that in Table VIII, but not in Table XVII, the incomplete observations for part of the year 1932 have been taken into account.) It is distinctly seen that the absolute range of temperature is greater in the winter than in the summer, and that it is greater all the year round (though especially in winter and spring) at Myggbukta than at Jan Mayen.

The absolutely highest temperature that has occurred at Jan Mayen is 15° (July 1927 and August 1924); in the winter the temperature rises to between 5° and 6° at the most. The absolutely lowest temperature registered in the same place is a little below -20° (February and March 1938); in July and August the temperature has not been below c. -1° .

At Myggbukta the temperature in the summer (June and July) may occasionally rise to 20° C. or a little more (June 1932, July 1933 and 1934); on July 25th, 1929, even 23° was registered, according to BIRKELAND and SCHOU (L. 5). The highest temperature registered here in a winter month is 5° above the freezing point February in (1932); as to the other winter months, November—January and March, the absolute maximum for the six-year period happens to be somewhat lower. In the course of the six years the temperature has only once or twice in each of the months November—April risen above zero. The absolute minimum is nearly -45° (February 1933)¹); a temperature below -40° has occurred several times in February and once in March. For July the absolute minimum is nearly -3° C., but even this month has only once been entirely free of frost.

Several of the days on which especially high or especially low temperatures occurred at Myggbukta, Scoresbysund, or Jan Mayen are dealt with in Part II.

Temperature Variations.

The variations of the temperature from day to day have been studied by the aid of the morning observations from sixteen years (1922—37) at Jan Mayen and the morning observations from six years (1932—37) at Myggbukta. In the first place the mean variability of the temperature (defined on the analogy of the mean variability

Table XVIII. Mean variability of the temperature in the individual months.

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Jan Mayen.	2.8	3.0	2.9	2.4	1.8	1.6	1.5	1.6	1.9	2.2	2.6	2.7
Myggbukta.	5.4	6.3	5.1	5.2	3.0	2.6	2.9	2.2	1.9	3.4	4.9	5.5

¹) A temperature of -49° was registered on Jan. 18, 1938 (see p. 118 ff.).

of the pressure, see p. 22 f.) is computed for each month and each of the two stations; the result will appear from Table XVIII and Fig. 22.

At Jan Mayen the mean variability of the temperature is fairly great, c. $2\frac{1}{2}$ — 3° , in the winter half-year, and rather small, c. $1\frac{1}{2}^\circ$, at the height of the summer; the annual variation is strikingly regular. At Myggbukta the variability is extremely high (c. 6°) in mid-winter and least, c. 2° , in August—September; the values which, as mentioned

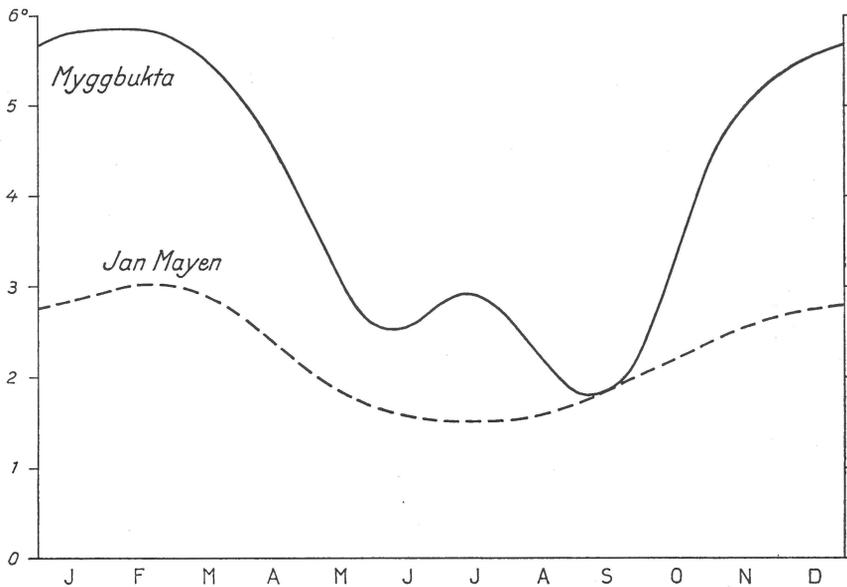


Fig. 22. Mean variability of the temperature (smoothed, cf. Table XVIII).

above, are based on observations made during only six years, here exhibit certain minor irregularities in the annual variation, and in preparing the figure it was assumed that one of these irregularities (a secondary minimum in June succeeded by a secondary maximum in July) actually exists.

The computed means of the variabilities of the temperature in September are almost the same for the two stations; it should, however, be pointed out that five of the six years for which observations are available from both localities show a greater variability for Myggbukta than for Jan Mayen; the mean values for these six years are 1.9 (Myggbukta) and 1.65 (Jan Mayen) respectively. In all the other months the mean variability is on an average 50—100 per cent larger at Myggbukta than at Jan Mayen.

In addition the material has been used in an investigation of the frequency of temperature changes of a certain amount in the different

months. The main result of this investigation will appear from Fig. 23 a—b, which shows the frequency of temperature changes to be numerically greater than or equal to any given value; this border value

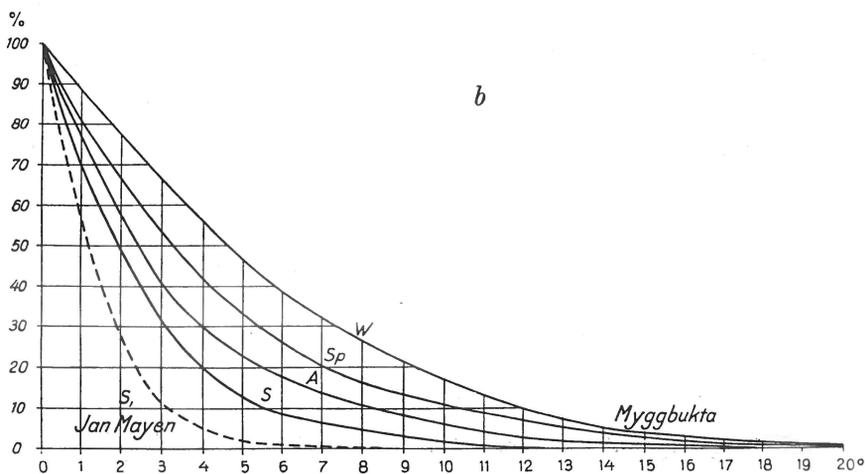
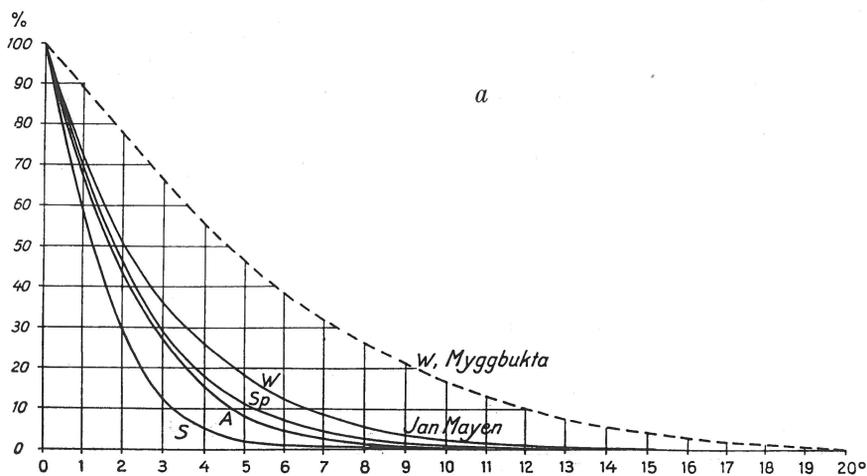


Fig. 23. Frequency (in %) of changes in temperature from day to day numerically greater than a given number of degrees. *W*: winter, *Sp*: spring, *S*: summer, *A*: autumn.

is used as abscissa, while the frequency in per cent of the number of cases comprised by the material is given as the ordinate; four curves, one for each of the four seasons of the year, have been drawn for each of the two stations, and in addition—to facilitate a comparison between the stations—one of the curves for Jan Mayen has been inserted in

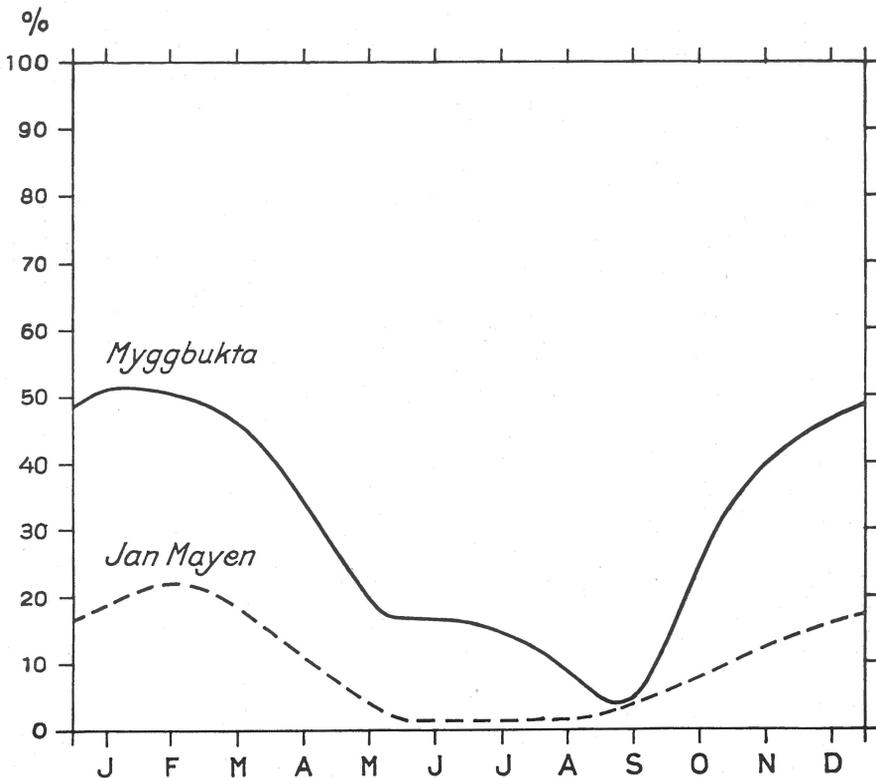


Fig. 24. Frequency of temperature changes numerically greater than or equal to 5° .

the diagram for Myggbukta, and conversely. As a confirmation of what has been stated above, the diagram shows that great changes in temperature from day to day are much more frequent in winter than in summer and much more frequent at Myggbukta than at Jan Mayen. Fig. 24 shows especially how the frequency of temperature changes $\geq 5^\circ$ varies during the year: in the middle of the winter they occur at Jan Mayen in c. 20 per cent and at Myggbukta even in c. 50 per cent of all the cases; at Jan Mayen the lowest frequency is exhibited by the summer months (c. 2%), at Myggbukta by September (c. 5%); in all the months except September the frequency of the great temperature variations is much greater at Myggbukta than at Jan Mayen (cf. p. 65). —Temperature changes $\geq 10^\circ$ occur very rarely at Jan Mayen (the frequency percentage is 2 in the winter and 0 in the summer), but are fairly common at Myggbukta, especially in the winter (in winter 17%, in spring $11\frac{1}{2}\%$, in summer 2%, in autumn $5\frac{1}{2}\%$). Even changes of 15° — 20° from one day to the other are not unique at Myggbukta; the absolutely greatest changes comprised by the material from

this station are c. 22° — 23° (altogether four cases within the months December—April). A number of the greatest temperature changes for short periods do not even appear quite distinctly in these statistics either because they extend over two consecutive intervals (having commenced, but not come to an end, at the morning observation), or because they actually took place within a shorter period than twenty-four hours. Some extreme cases of this kind are dealt with in Part II; here it need only be mentioned that at Myggbukta the temperature on February 2, 1932, rose 22° in five hours; on January 10—11, 1938, 26° in 13 hours; and on December 9—10, 1932, 31° in 24 hours. The great rises in the temperature occur when the ground inversion is destroyed—the greatest probably when the cold ground layer is entirely swept away, the force of the wind increasing considerably in the course of a short time (maritime air penetrating from the northeast or foehn air from the northwest). The greatest temperature falls cannot quite compare with the greatest rises, but they, too, are very great as compared with those known from other places; thus a fall of 13° in five hours (15 January 1936) and another of 22° in 13 hours (26 April 1932) may be mentioned. As a cause of especially great temperature falls in a short time, radiation under particularly favourable conditions seems to play a more important part than advection of cold air (cold front passages). In this respect there is a characteristic difference between Myggbukta and Jan Mayen, all great temperature changes in the latter place being due to advection.

The great temperature variations during the coldest half of the year constitute an essential feature of the climate of the Northeast Greenland coastal zone. It should, however, be borne in mind in the first place that the temperature in the winter half-year hardly ever rises above 0° , secondly that the particularly low temperatures only occur in calm weather or with light winds, while the relatively high temperatures are often associated with high winds with drifting snow, and thirdly that the considerable changes described above are limited to an area of a rather small vertical extent, being due to the formation or removal in the course of a short time of a cold ground layer, the thickness of which may range from some few metres to a few hundred metres.

Temperature Conditions Outside the Permanent Stations.

In the above the very considerable difference between the temperature conditions at Jan Mayen and at Myggbukta has repeatedly been pointed out. Scoresbysund occupies an intermediate position, though—both as regards the mean temperature and the diurnal amplitude, the frequency distribution, the extremes, and the variability from day to day—this place shows much better agreement with Mygg-

bukta than with Jan Mayen, which is only natural considering the position of the three stations.

The observational series available from other localities within the area considered here are so limited that we have to a great extent to resort to theoretical considerations if we are to form an idea of the temperature conditions outside the permanent stations.

Jan Mayen may be regarded as fairly representative of the nearest surroundings of the island; i. a. on considering the very small diurnal temperature amplitude one gains the impression that the temperature at the station not only on an average, but—with a very few exceptions—from day to day is practically unaffected by the presence of the island; this would be a natural consequence of the small extension of the island and of the rare occurrence of calms and of light winds.

In drawing the maps of the mean temperature (Fig. 10) it has been assumed that the isotherms are almost parallel and equidistant within the area between Jan Mayen and Northeast Greenland. Later on an attempt will be made to demonstrate that this assumption is fairly reasonable; but first there is reason to point out that in the individual case we are in no way entitled to assume so simple temperature conditions. Some schematic examples will suffice to show what importance the prevalent weather type may be assumed to have in this connection.

1) When the Greenland anticyclone (one day in the winter half-year) is strongly developed and the area with a weak gradient which is characteristic of the interior of an anticyclone extends as far as the coast of Northeast Greenland, the atmospheric conditions are favourable for the formation of an extensive ground inversion over land (both near the shore and farther inland). The temperature distribution over the coast-land will then be that characteristic of inversions: a great difference between sheltered valleys (where the temperature may fall to -30° — -45°) and isolated mountain peaks or steep mountain slopes (where a temperature between -15° and -25° is probably most frequent in such cases). If the weak gradient extends beyond the shore, very low temperatures may occur here over the ice-covered sea (c. -30°), but it should be pointed out that the mechanic barring of the air currents which is of such great importance for the formation of inversions over rugged ground, is here less considerable.—It would seem that in stationary weather situations the weak gradient area rarely extends beyond the ice edge (at any rate it hardly ever extends as far as Jan Mayen); the explanation of this is, no doubt, that such a condition would be unstable, since great temperature differences would very soon arise between the lowermost air layers just inside and just outside the ice edge, and these horizontal temperature differences would result in a freshening of the wind from the north or northwest

(cf. the well-known diagram for the winter monsoon or the land breeze). Precisely this weather type, when, near the ice edge, there is no sharp limit, but a fairly abrupt transition, between an area with light winds, clear weather, and very severe frost (-20° — -30°) and an area with high northerly winds, usually cloudy weather, and less severe frost (-10° — -15°), seems to be of frequent occurrence, and this condition may be almost stationary for several days until impulses from the outside (e. g. cyclonic activity over the Icelandic area) bring about a change.

2) The greatest temperature difference between the coast of Northeast Greenland and Jan Mayen occurs in connection with a somewhat different, but yet related weather type which, like the preceding one, is of common occurrence during the winter half-year: Along the coast of Northeast Greenland there prevails—as in the case described above—calm and clear weather, very severe frost (-25° — -40°) in the lower air layers, and at any rate a relatively high pressure, but the anticyclonic influence does not extend as far eastward as Jan Mayen, to which moist maritime air with a fairly high temperature (0 — 4°) is transported with more or less high winds from an easterly direction. In such cases we must assume that an actual air mass limit is found somewhere between Jan Mayen and the Greenland coast. Since the limit is generally not a consequence of the presence of the ice edge, but is formed and moves in the same (mainly kinematically conditioned) way as other principal fronts, there is *a priori* no reason to expect a close connection between the position of this limit and the ice edge; the limit of the air mass may be found inside or outside the ice edge, it may intersect it at a more or less acute angle, or may in special cases follow it over a long distance. However, there can hardly be any doubt that the front, if other conditions are equal, will be most sharply defined in the last-mentioned case.

For theoretical reasons it must be assumed that on the west side of an air mass limit like that just mentioned there is a belt with a fairly considerable gradient and a corresponding fairly high northerly or northwesterly wind; in addition clouds will normally occur over this area, and in most cases also snowfalls (because the warmer air will climb up above the wedge formed by the cold air mass). Owing to the wind and the cloudiness combined the temperature of the lower air layers immediately west of the limit of the air mass, though low (e. g. -10° — -15°), will not be so low as farther westward, where the weather is clear and calm. This, of course, is especially true if the limit of the air mass occurs outside the ice limit, since in that case the heating from below will make itself felt as a third factor of importance.

3) The highest winter temperatures at the coast of Northeast Greenland (apart from a few cases with strong foehn winds) occur

when the maritime air at the front side of a strongly developed, as a rule stationary or slowly northward-moving depression centred north of Iceland makes its way right on to the shore. In exceptional cases the temperature may then rise to the freezing point, and if the low pressure centre is found so far northward that part of the dispelled arctic air reaches Jan Mayen after passing south around the centre, it may happen that the temperature at Jan Mayen will for a short time be lower than the temperature at Myggbukta. More often, however, there will be 5—10 degrees of frost at Myggbukta and thaw at Jan Mayen. As it can hardly be imagined that the maritime air, which moves at a considerable rate, is cooled about ten degrees merely because it flows across the ice for a shorter or longer distance, it must be assumed that other conditions, also, exert their influence; it may, for instance, be of importance that the air of the lower layers just outside the shore is forced to move parallel with the main trend of the shore, that is, from north to south, in which way there will be a possibility of a certain advection, as far as these layers are concerned, of cold air (possibly true arctic air) from the area between North Greenland and Spitsbergen. There is a gradual transition between the few cases in which maritime air seems to arrive in a nearly unmodified state (with a temperature of c. 0° C.) to the coast of Northeast Greenland, and the situations in which, judging from the direction of the gradient, we might expect to find maritime air at the coast, but in which the temperature is so low that it must actually be arctic air, whose flow southward along the coast is, as it were, provoked by the attacks of the maritime air.

4) In summer the gradient is generally low and the wind conditions, broadly speaking, quiet throughout the whole area under consideration. If, in addition, the weather is clear over the ice-free part of Northeast Greenland, a fairly considerable heating of the lower air layers will take place here; the temperature of these lower layers may rise to about 10° (as mentioned above, still higher temperatures, right up to c. 20°, may occur, but chiefly or exclusively in connection with foehn winds). Over the sea, however, the temperature of the lowermost air layers is not noticeably higher than the temperature of the sea, and here the sky is, as a rule, covered by fog or low-lying clouds. Over areas covered by ice (sea ice or inland ice) conditions must in the case considered here be almost as over open water, since here, also, the surface prevents heating of the lower air layers and gives off humidity to these by evaporation (sublimation). The consequence is that an air circulation will be started which is an intermediate form between a sea breeze and a summer monsoon and is further complicated by the fact that not only the sea and the fjords (including the water areas covered by ice),

but also the inland ice will cool the air layers with which they come into touch. It is conceivable that under these circumstances complicated wind systems may arise, which, in their turn, will affect the temperature distribution. As a whole, however, the air along the coast must have a component of movement towards the shore; that this is the case, is confirmed by the available observations. Since during the warmest summer time the irradiation is active all day and night, an alternation between land and sea breezes will not generally occur, as in other places, but the velocity of the wind has a marked maximum in the afternoon. In this respect the wind system concerned resembles a summer monsoon, but it differs from it (and approaches the ordinary sea breeze) by being less extensive in a horizontal as well as a vertical direction and by not being accompanied by a noteworthy precipitation.

No definite stationary temperature distribution can be pointed out as the result of the Greenlandic summer monsoon. The boundary between cool and fairly warm air is sharp at the moment the monsoon sets in at the coast, but as the monsoon air is heated somewhat during its passage over the land, the boundary will become less well defined; this will especially be the case if the front of the maritime air passes across fjord systems or ice- and snow-covered land stretches.

5) During the most marked foehn situations of the summer, when the foehn constitutes an essential element of the air circulation, the fairly warm and dry air will move from the continent of Greenland out over the sea; if it reaches right down to the surface of the sea, it will take in humidity from and give off heat to the water (or the ice), with the result that a cold ground layer will gradually develop; but more frequently, perhaps, it does not reach the surface of the sea. On arrival of the air at Jan Mayen, every trace of its foehn character will generally have disappeared.—The temperature distribution in the said case will then, roughly, be as follows: the temperature is high over the ice-free coast-land, at any rate over part of it: outside the coast it decreases gradually to the temperature of the water if the foehn reaches the water, but if this is not the case, the coast line will form a fairly sharp limit between higher and lower temperatures as far as the lowermost layer of the atmosphere is concerned. The most important complication is, probably, that remnants of cold air may be found over land in places sheltered from the foehn wind; in less marked foehn situations it may happen that only a few localities are directly touched by the foehn wind.

On the basis of the above considerations on the temperature distribution for the simplest and most frequent weather types we may expect the temperature conditions along the stretch from the eastern edge of the inland ice to Jan Mayen to be roughly as follows:

a) The winter half-year. At the transition from the inland ice to the ice-free part of the coast-land the chief change—apart from what can be directly ascribed to the different heights above the sea—is, probably, that local temperature differences (along the surface of the ground) and rapid and large temperature changes associated with these occur to a greater extent over the broken terrain of the ice-free coastal zone than over the even surface of the inland ice.—Conversely, the transition from the land to the ice-covered sea must mean that such temperature differences and changes will again be of minor importance; in addition, with easterly winds the temperature of the inflowing maritime air will be lower over the land than over the sea ice on account of the decrease of the wind velocity near the ground caused by friction. At the transition from the ice-covered to the ice-free sea we may generally expect a considerable, more or less sharp contrast: over the ice the lowermost air layers are cold, while over the open sea they are, in many cases, heated from below.

Since, however, the ice edge varies within fairly wide limits, there is some reason to believe that the transition as regards the mean temperature of the winter (and likewise as regards the frequency distribution, variability, etc.) is rather gradual, so that—in the absence of precise knowledge as to this point—it is reasonable to draw the isotherms as parallel and equidistant curves. A reservation should, perhaps, be made as regards the sea area nearest the shore; on the one hand this area is almost constantly covered by ice in the winter, so the distance between the mean isotherms may here be assumed to be comparatively great; on the other hand, in certain situations (namely where the pressure gradient is sufficient to maintain an air current over the ice but insufficient to do so over land) the isotherms will be especially crowded near the shore.

b) The summer. During the short Greenlandic summer the sharpest thermal contrast is found between the air over ice- and snow-free land on the one hand and the air over the inland ice, the fjord and sea ice, and the open water on the other hand. The ice limit must be assumed to play a rather subordinate part, though the temperature will generally, even at this season of the year, be somewhat higher over the open sea than over the sea ice. The course of the isotherms is in the main west-east, the aforementioned sharp contrast appearing more distinctly in the diurnal amplitude than in the mean temperature. The rather considerable distance between the isotherms, that is to say, the slow fall of the temperature from south to north, is an expression of the rather close agreement as to radiation and wind conditions, irrespectively of the latitude, which is characteristic of the area concerned at this time of the year.

The especially high temperatures which sometimes occur at the East Greenlandic stations and are reflected in the skewness of the frequency diagram (Fig. 14 d) must in the main be limited to the ice-free land inside the shore, and their frequency may here vary considerably from place to place according to the terrain and the conditions of the soil.

Temperature Conditions in the Upper Air.

The considerations on the preceding pages have repeatedly suggested remarks on the vertical temperature distribution. From the polar year 1932—33 a series of about 150 observations of the temperature in the upper air is available, carried out by means of kites or fixed balloons in the neighbourhood of Scoresbysund. The soundings offer a much needed opportunity of checking the correctness of the picture that may be formed from qualitative theoretical considerations, but they are not of sufficient extent to form the basis of a quantitative presentation. Referring the reader to the report by Dr. KOPP (L. 31, IV 2), we shall briefly mention the main result:

The mean figures for the summer show almost isothermal conditions up to a height of $\frac{1}{2}$ km, and above that height up to $2\frac{1}{2}$ km a lapse rate of c. 5° per kilometre.

In the winter there is a distinct difference between days with a low and days with a high pressure. In the former case the mean will be a fairly thick inversion layer (from the surface of the ground up to a height of c. $1\frac{1}{2}$ km), but the temperature differences within the inversion layer are rather small. On days with a high pressure the temperature at the ground as well as at a height of 1—2 km is on an average much lower than on days with a low pressure; moreover we find here a typical ground inversion extending to a height of c. $\frac{1}{2}$ km, where the temperature is on an average 6° — 7° higher than at the surface of the earth.

Remarks on the Change of the Climate in Recent Times in Greenland and over the European Part of the Arctic Ocean.

Preliminary Remarks.

The survey of the temperature conditions taken in the preceding pages is, as already stated, based on observations made in the years 1922—38. This series of years is somewhat shorter than those usually employed in climatological investigations—according to an international agreement preferably thirty-year means are used—; for this reason alone

we cannot expect that the means, frequencies, etc., which may be deduced from them can simply be regarded as "normals" in the usual sense of this word in climatology. Precisely as regards the arctic regions special conditions are present, owing to which it is doubtful whether we can here ascribe to the term "normal temperature" (and other analogous terms as e. g. "normal frequency") the same unambiguity and accordingly the same significance as is otherwise ascribed to them. As an introduction to a series of graphs given below some general remarks on the problems concerning the investigation of climatic changes will be given here.

If we prepare a table of the annual or winter mean temperatures from meteorological stations in Greenland or the European part of the Arctic Ocean, we shall find a distinct, for some areas even strikingly great, difference between the values from the end of the nineteenth and the beginning of the twentieth century and the values from recent years (especially the thirties): the climate seems to have grown much milder, especially in winter.

This problem—and other, related problems—has been the subject of great attention during the last ten to fifteen years. We may approach the problem from different starting points:

1) If we have a number of figures indicating e. g. the annual mean temperature for a certain station, and from these form various means, each of them valid for a number of consecutive years, it is obvious that the means obtained in this way are not, generally, equally high; a certain difference must be expected if only for the reason that the individual years differ somewhat from each other. On the other hand it seems clear that a very great difference, for instance between the mean temperature for the first thirty and the mean temperature for the last thirty years of a sixty-year observation series, must be a phenomenon of another kind than the individual years' apparently casual deviations from the normal.

We have statistic methods by which we can ascertain whether the deviations of the individual years are of a casual character. Casual deviations, as is well known, are distributed in a law-regulated way (the so-called Gaussian distribution); however, the fact that the distribution of a number of consecutive deviations agrees with the Gaussian distribution, is merely an indispensable, not a sufficient, condition if the deviations are to be regarded as casual; another requirement is that the deviations should be mutually independent; this means, for instance, that even a great positive deviation must not involve an increased probability for any of the following deviations to have the same (or the opposite) sign; strictly speaking, no periodicities should be contained in the material.

In applying mathematic-statistical methods to a climatologic observation material there is the great difficulty that we may, so to speak, never obtain a categoric reply to the question as to whether the aforementioned conditions are complied with. The resemblance with the Gaussian distribution is sometimes small, often unmistakable, but rarely so complete that all hesitation in that respect may be abandoned. Often there does not seem to be any connection between consecutive deviations; but sometimes the presence of such a connection may be highly probable. And as regards periodicities, we often find indications of such, but rarely more.

Considering these difficulties, which are, indeed, not only of a technical character, it is a natural—often realised—idea to disregard all probability-theoretical considerations and merely let the figures speak. If we realise that we cannot in this way get to the bottom of the problem of climatic changes (for this has, indeed, a probability-theoretical aspect), a treatment of the numerical material, carried out with care and criticism, is, of course, of value in itself. However, in this connection there may, perhaps, be some reason to warn against an excessive use of a much used method, viz. a calculation of “overlapping means” (as to thirty-year means e. g. the means for 1901—30, 1902—31, 1903—32, etc.); if such overlapping means are figured graphically, we shall obtain the picture of a comparatively slow variation, which—wrongly—makes a more convincing impression than the series of means for the individual years.

Sometimes we are confronted with the view that it is possible to furnish a proof of the non-casual character of the deviations of a certain period from the normal at a certain station merely by pointing out that a corresponding deviation can be ascertained at other nearby stations. However, this view is not absolutely correct. A comparison with other stations may, of course, serve as a proof that a series of observations is homogeneous and accordingly applicable in principle in ascertaining changes in the climate; but the fact that an anomaly ascertained, which will exert its influence for a number of years, has a certain geographical extension, is a simple consequence of the circumstance that the anomalies (for the individual years) on which the calculation is based have such a distribution. It must be admitted, however, that by investigating the geographical distribution we may possibly find an area in which the non-casual character of the anomaly on a closer study proves to be relatively certain. This must then be ascertained by mathematic-statistic methods, for instance by comparing mean deviations for the period considered with the mean deviations that would be obtained for the same station if the same number of years were selected at random: instead of the years 1921—30, for instance

the years 1890, 1894, 1897, 1908, 1909, 1915, 1917, 1923, 1926, and 1928 may be considered *en bloc*, and the investigation be continued with a great number of just as casual combinations of years.

2) Considering the fact that within shorter periods (e. g. months) there is a distinct mutual connection between the geographic distribution of the different meteorological elements (e. g. between the air pressure distribution and the temperature distribution), we may examine the distribution of these elements in the different periods—especially in periods in which one element exhibits a remarkable deviation from the normal over part of the area investigated. The method is useful if we are to trace a physical connection; but this connection has reference in principle to the individual case, not to the means, and the formation of means over a long series of years does not always permit a surer distinction between what is essential and what is unessential than for instance the means for a single month.

Against the above-mentioned geographic search for anomalies for two or more of the meteorological elements it may with some right be urged that it always leads to a result, also in cases in which it ought not to do so. Even if we compute means for a quite casual selection of years, areas with a positive and areas with a negative anomaly will be found, and very likely we shall be able—or shall believe that we are able—to demonstrate a connection between the distribution of the different elements also in such a case.

However, irrespectively of the aforementioned objections certain investigations of this kind are of considerable interest; this applies i. a. to SCHERHAG's demonstration of an increased circulation over the northern hemisphere in recent years (L. 24, 26).

3) Hydrographic and glaciological observations often show a distinct agreement with fluctuations of the air temperature. Similarly, deviations from normal weather conditions are of great importance to the vegetation and the animal life, and if the deviations last for a long space of time (10—20 years or more), they may give rise to radical biological alterations. It is, of course, of great theoretical and even greater practical interest to study these effects on inanimate and animate nature; the hydrographic observations, in particular, are often of value for meteorological investigations; but it should be pointed out that the effects in themselves prove no more about the non-casual character of the deviations than the causes to which they are due: the reaction of nature to a certain deviation from that which has hitherto been normal, is independent of whether this deviation must be classed as a casual one or taken as an indication that the normal has changed.

In so far as climatic changes of earlier times are concerned, the available geological and botanical observation material (terminal

moraines, annual rings, pollen, etc.) may give very valuable information. But as regards the periods and areas in which meteorological observations have been made—especially of temperature and precipitation—and the homogeneity of the observational series has been ensured, the results of these observations are as a rule more suited for a quantitative treatment than the effects they involve; to meteorology the effects will then especially be of interest as an illuminative material—as evidential material it will in most cases be superfluous or insufficient.

4) The great changes in climate which took place in pre-historic times cannot, of course, be explained away as “casual” deviations from a constant mean condition; they are in themselves a perfectly valid proof that the climate is a function of time. On this background we may say that it would be an extremely special case if the climate should remain unaltered within even a moderately long space of time; the question is not whether the climate changes, but how rapidly it changes.

Considering the available numerical material, we can rarely or never exclude the possibility that such a change is constantly taking place, and by a graphical or numerical smoothing we may obtain an approximate expression of the rate at which it takes place within the particular period, but it cannot be taken for granted that the measure of the climatic change obtained in this way is equal to that which would be found for the same period if the material comprised a longer space of time. An existing secular variation must have a certain, not quite inconsiderable size if we shall be able to demonstrate its existence with a fair degree of certainty and determine its size with reasonable approximation by means of a material which only comprises a limited number of observations; this is especially the case if the individual values show a considerable dispersion.

Mainly for practical reasons it has been attempted (L. 8, 30) to divide the non-periodic variations of the climate into changes of climate, which take place gradually over fairly long periods (about fifty years or more), and fluctuations of the climate, which are of a somewhat shorter duration; however, no sharp distinction can be made.

In the above the word “climate” has been used in the somewhat vague sense in which it is mostly used even by climatologists. It should, perhaps, be mentioned that a really exhaustive treatment of the problem of climatic changes is only possible if we defy the difficulties with which we are confronted if we try to give an unambiguous definition of the very term “climate”.

Survey of the Observation Material and the Available Literature.

From Spitsbergen short (mostly 1- or 2-year) observational series from no less than seven different localities are available from the years 1894—1910; together they cover this period fairly well. From 1911 the following observational series are at hand:

Green Harbour	1911—30
Svalbard radio	1916—35 with interruptions
Quade Hook	1912—24 with interruptions
Isfjord radio	1934—

The whole material has been used by HESSELBERG and BIRKELAND (L. 10), who have computed the mean for the year and the four seasons, all the observations having been reduced to Green Harbour.

From Jan Mayen, in addition to a brief record (L. 33) from earlier times (1882—83), a continuous series of observations beginning with the year 1921 is available.

In East Greenland, apart from shorter series, observations have been made at the following stations:

- Myggbukta (commenced in 1922, complete 1932—39)
- Scoresbysund (from 1925, with some interruptions)
- Angmagssalik (from 1895).

In West Greenland observations have been made at a large number of stations, the most important of which are:

- Nanortalik..... (from 1884)
- Julianehaab
- Ivigut..... (from 1880)
- Godthaab
- Qôrnoq..... (from 1874)
- Holsteinsborg..... (1889—1929)
- Jakobshavn
- Upernavik..... (from 1874)

KINCER, who was one of the first to investigate the climatic changes that have taken place in recent times, in his paper from 1933 (L. 15) does not use the material available from arctic regions, but in "Annalen der Hydrographie" 1936 it is dealt with at length by Osc. V. JOHANSSON (L. 14) and SCHERHAG (L. 24, 25, 26). In the following years an ever-increasing material was brought to light; thus LYSGAARD (L. 17) employs the long series of observations from Jacobshavn. An especially complete

treatment is available as regards Norway in the above-mentioned paper by HESSELBERG and BIRKELAND (L. 10); as regards Sweden the question has especially been treated by ÅNGSTRÖM (L. 34).

A treatment of the material from a statistical point of view (cf. p. 75 ff.) has been attempted i. a. by EGEDAL (L. 8) and ÅNGSTRÖM (L. 35).

The papers mentioned so far deal principally with the facts that may be gathered from the meteorological observational material, notably the temperature observations. On the effects of the climatic change, also, a fairly copious literature is available, of which may be mentioned the papers by H. W:SON AHLMANN on the retreat of the glaciers (L. 1) and by AD. S. JENSEN on the great changes in the stock of fish in the Greenlandic fjords (L. 13).

The question of the cause of the change in the climate is a difficult one. On account of the connection between the temperature and the pressure distribution (cf. p. 37—41) it has been thought possible to regard the rise in temperature as a consequence of an increase in the general circulation (SCHERHAG, L. 24, 25; LYSGAARD, L. 17; ÅNGSTRÖM, L. 34); but the cause of this increase could not be ascertained. It is natural to seek the explanation in changes in the energy supplied by radiation from the sun, but owing to difficulties connected with the observation technique it has hitherto hardly been possible to prove that such changes have taken place.

Near Spitsbergen—and probably to some extent in other parts of the arctic regions also—a special feature is met with: owing to the abnormally high temperatures the ice edge recedes farther northward than usual, which, again, must have some influence on the temperature of the air. This explains (at any rate partially) that near Spitsbergen a “band” evidently exists between the temperature from year to year.

A thorough treatment of the whole question, with numerous references to the literature, is given by A. WAGNER in his standard work “Klimaänderungen und Klimaschwankungen” (L. 30).

Diagrams to Illustrate the Rise of the Temperature over Greenland and the Northern Seas since the Observations were Commenced.

The diagrams in Figs. 25—29 show the deviations from the normal temperature from year to year on Spitsbergen, Jan Mayen, and in Greenland; the curves cover the period from the observations were commenced up to 1938. Fig. 25, which shows the deviations for the year as a whole, in addition contains curves for Andenes (N. Norway, 69°20' N, 16°8' E), Grímsey, and Stykkishólmur. It should be noted that an ordinate distance of 1.15 mm on the year-map corresponds to a

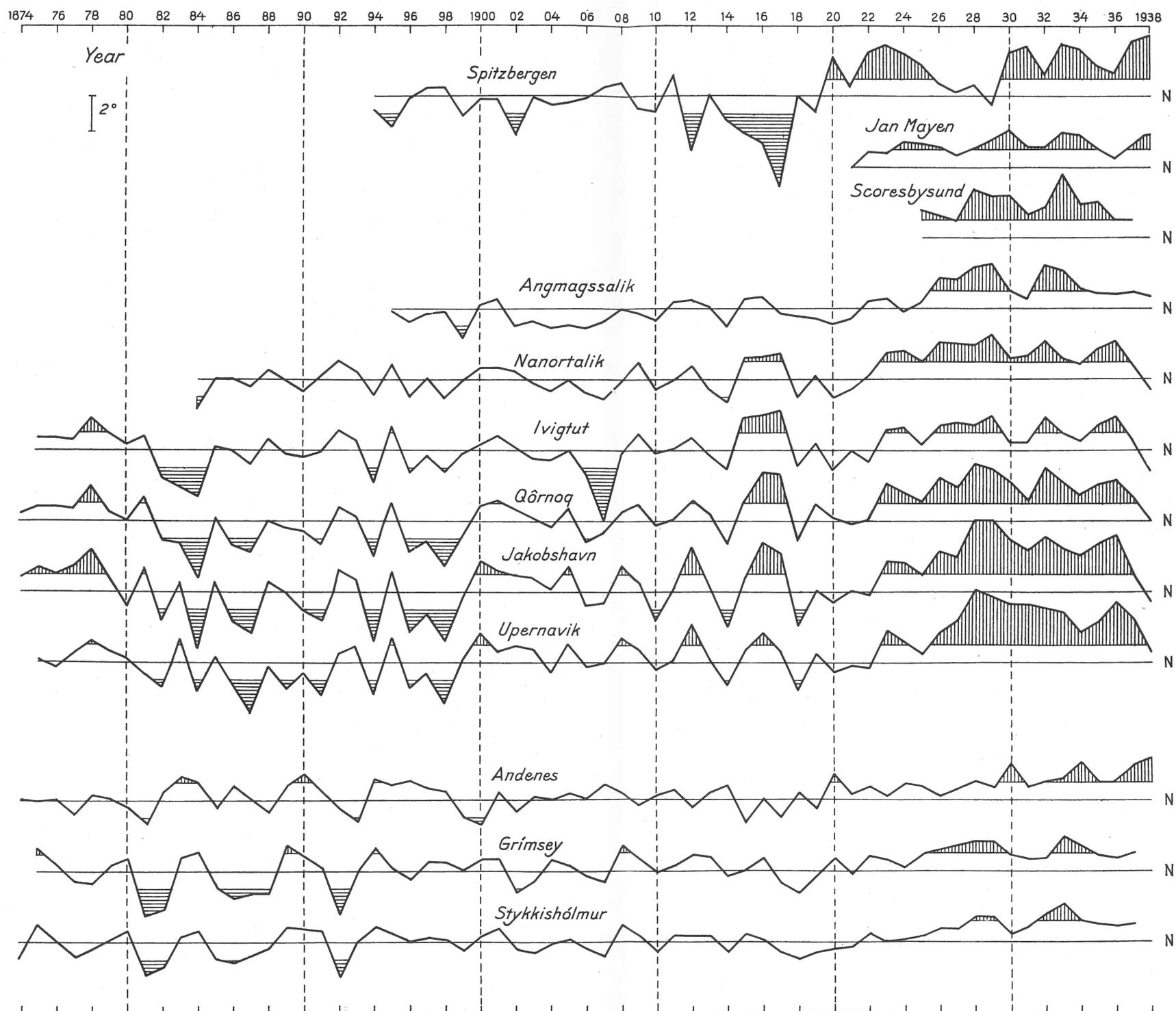


Fig. 25. Deviation of the mean temperature from the normal in the individual years.

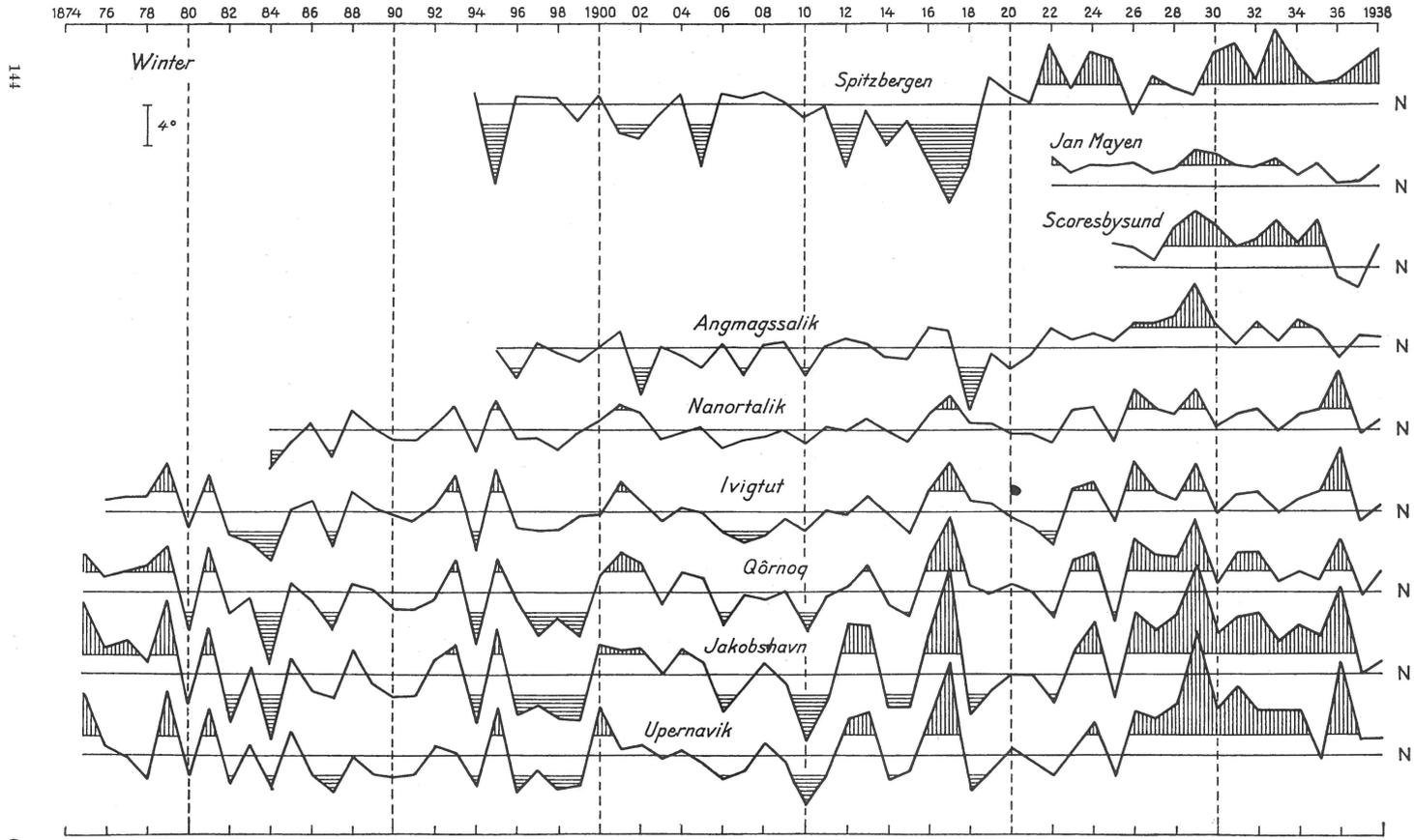


Fig. 26.

Figs. 26—29. Seasonal deviations of the mean temperature from the normal (Fig. 26: winter, Fig. 27: spring, Fig. 28: summer, Fig. 29: autumn).

141

6

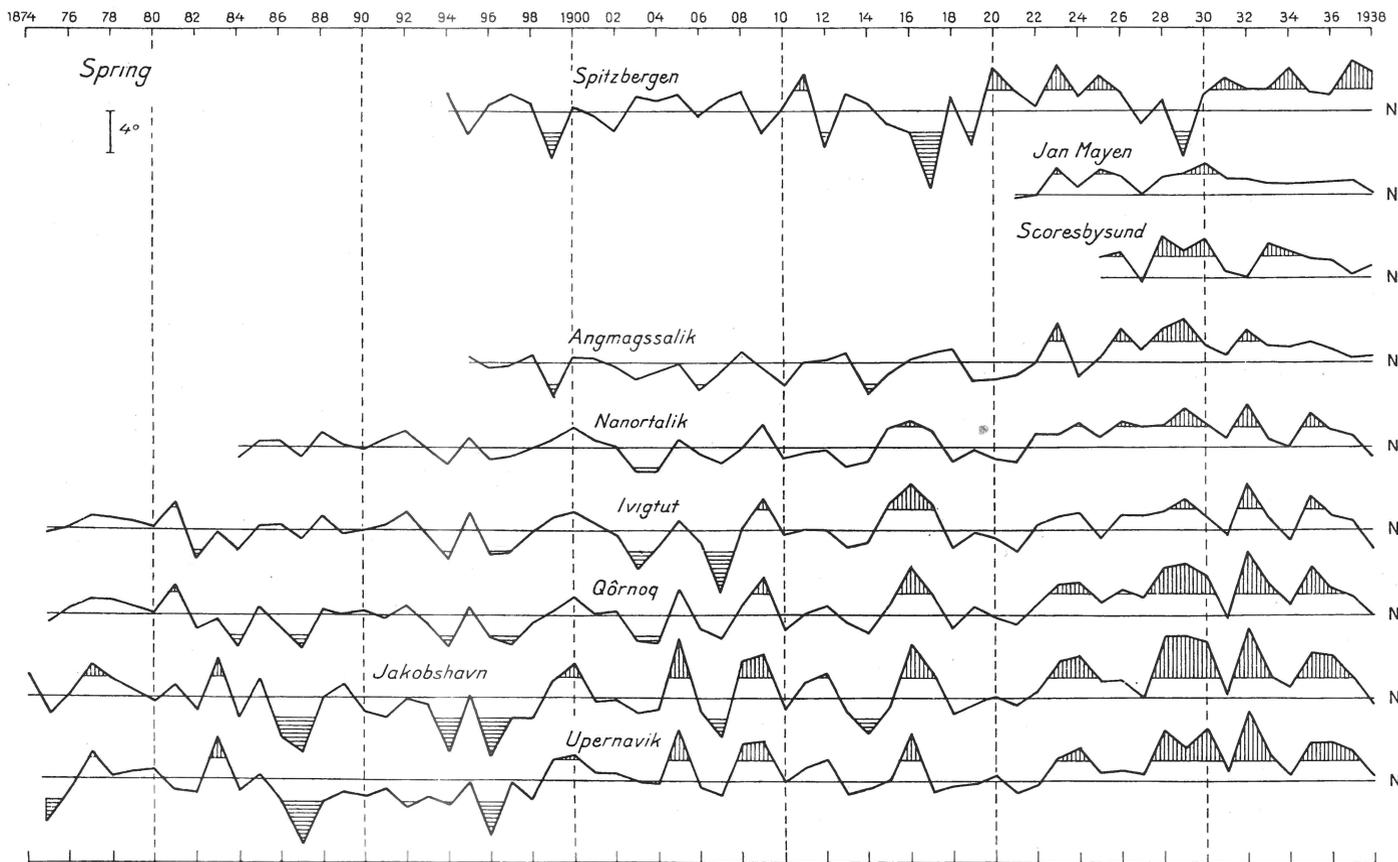


Fig. 27. See the text to Fig. 26.

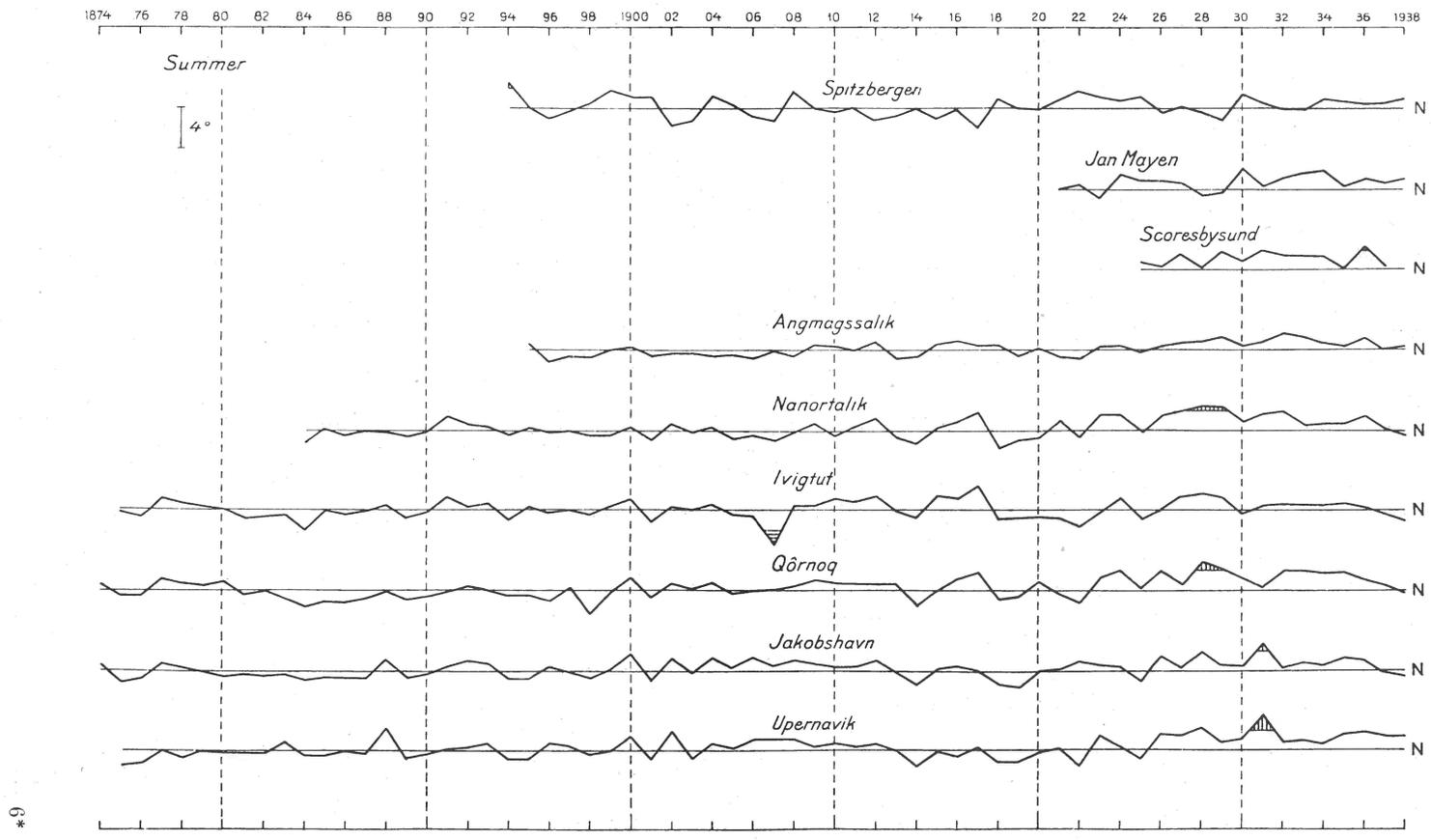


Fig. 28. See the text to Fig. 26.

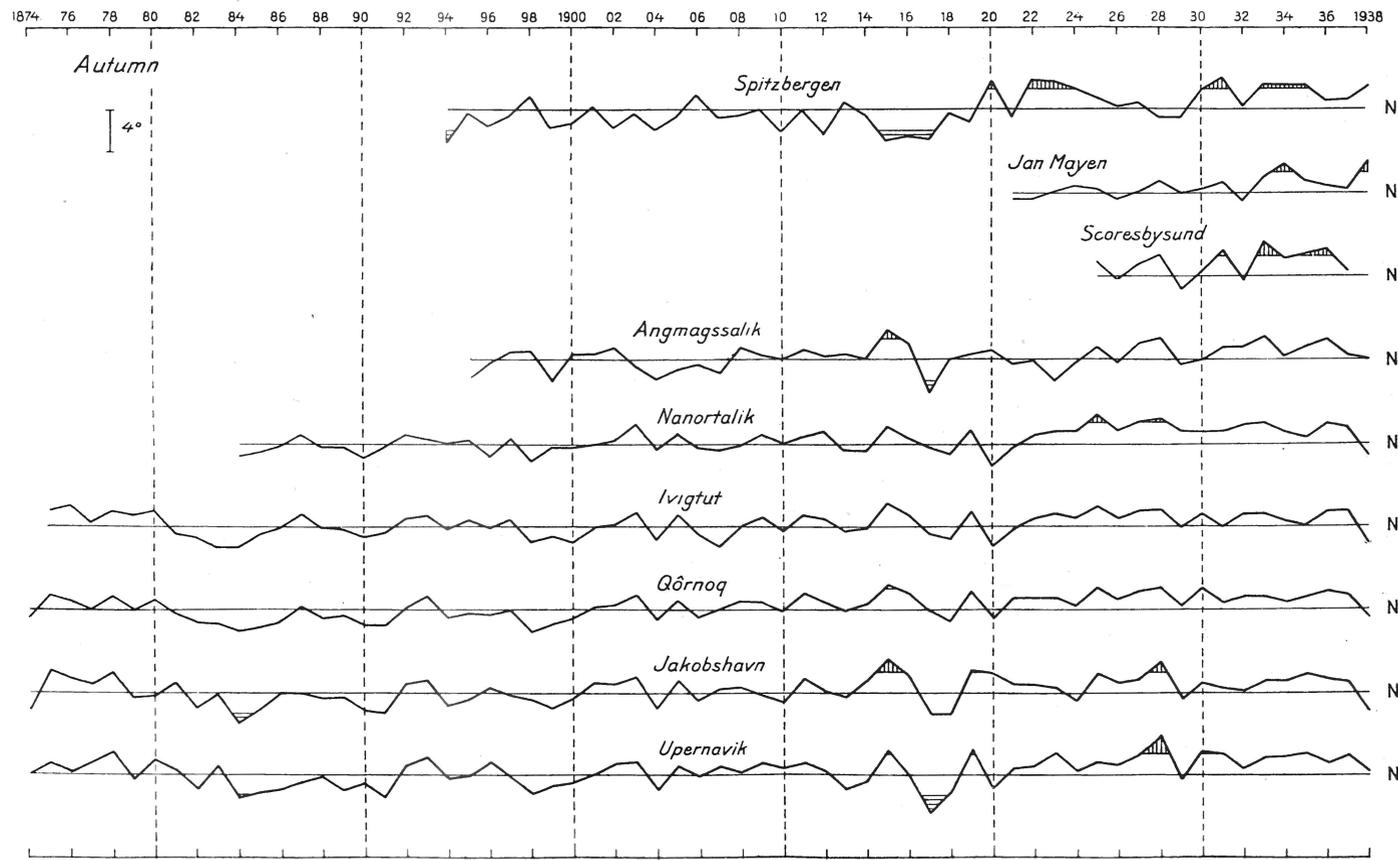


Fig. 29. See the text to Fig. 26.

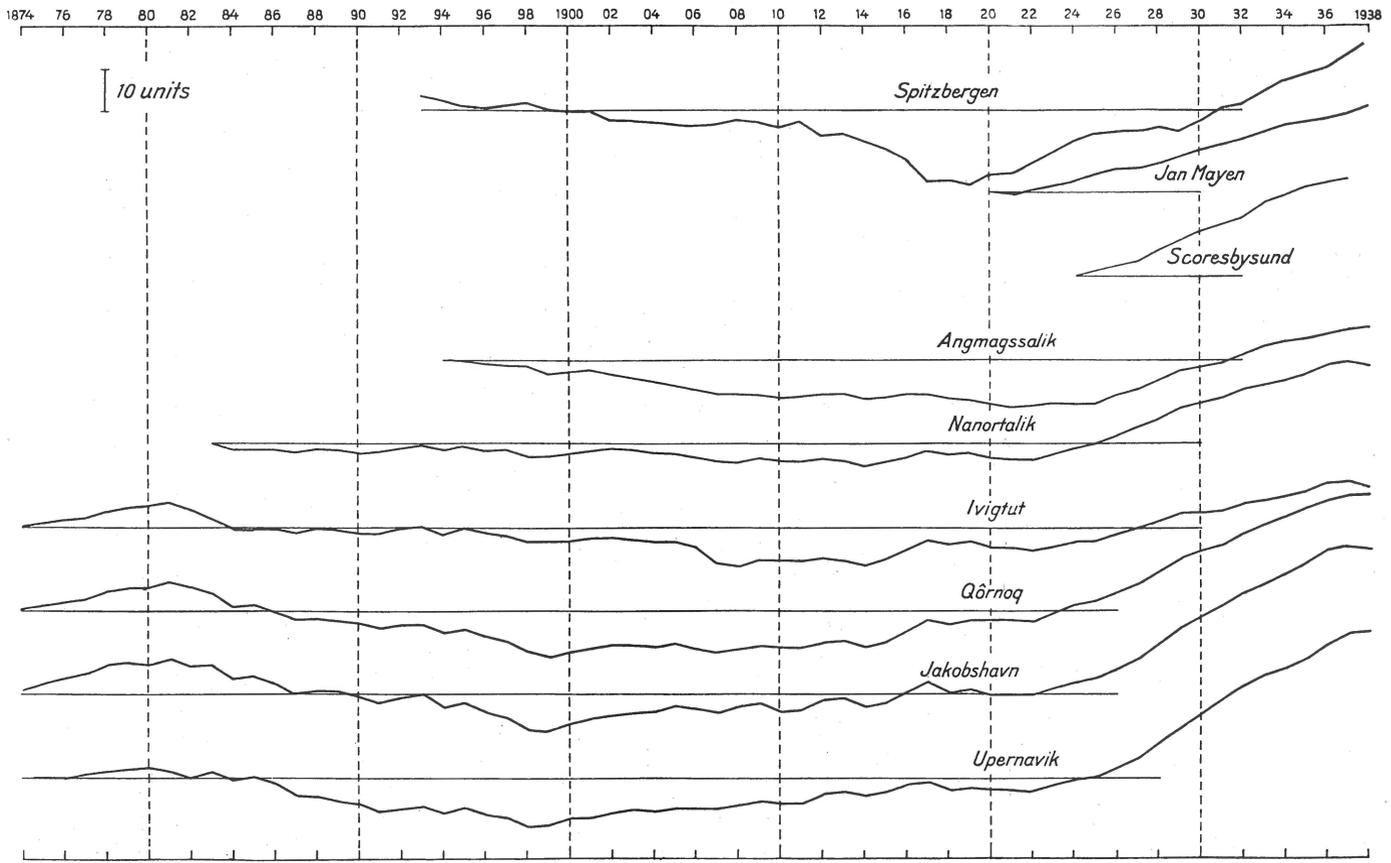


Fig. 30. Curves showing the accumulated excess (cf. pp. 86—87) of the mean temperature of the year.

temperature difference of 2° , but in the other diagrams (one for each of the four seasons of the year) to 4° . The normal period on which the calculation was based is for Spitsbergen, Jan Mayen, and Andenes 1901—30, for the two Icelandic stations 1875—1923, for Scoresbysund and Angmagssalik 1895—1930, and for the other stations in Greenland 1876—1925. The difference arising because different normal periods have been used is of minor importance in this connection; but it should be pointed out that the normal employed as regards the West Greenlandic stations is c. $\frac{1}{2}$ — 1° lower than the average for the years 1895—1930.

The diagrams show i. a. that:

1) The mean temperature for each of the years 1923—37 is practically without exception higher than the normal temperature; the deviations are in part very considerable, amounting in several places to c. 4° for one or a few of the years. This forms a marked contrast to the conditions in earlier years; thus the mean temperature in Greenland in the period 1882—1899, and on Spitsbergen from the observations were commenced (1894) up to 1919, was mostly below the normal, with negative deviations of up to 3 — 4° in Greenland and up to 5° on Spitsbergen.

2) At the end of the thirties the temperature in Greenland seems to have approached the normal; in some places in West Greenland 1938 was even a little colder than the normal. On the other hand 1938 was an exceptionally mild year on Jan Mayen and Spitsbergen.

3) The deviations are somewhat greater in the northern than in the southern part of West Greenland; they are smaller on Jan Mayen than at Scoresbysund and on Spitsbergen.

4) As a rule there is good agreement between the curves for stations situated near each other, but over great distances there may be a great difference between the deviations in a single year; in addition to 1938, we may mention 1917, which was very cold on Spitsbergen and very mild in the greater part of West Greenland.

5) If we compare the diagrams for the different seasons of the year, it will be noted that the deviations are strikingly greater in the winter and spring than in the summer and autumn. In winter the extreme positive deviations, at any rate as regards Greenland, are numerically greater than the extreme negative deviations; at Upernavik the winter of 1928—29 (i. e. December 1928, January and February 1929) was on an average 12° warmer than is normal.

If we sum up the deviations from the normal in the individual years, proceeding chronologically, we arrive at what may be called the ac-

cumulated excess, a discontinuous function the values of which show an increase when the temperature of the year in question is above the normal, and a decrease when it is below the normal. This accumulated excess, introduced by BUYS-BALLOT, recommended by KÖPPEN, and employed by HESSELBERG and BIRKELAND, is a convenient technical aid; in a graphic representation we obtain, by connecting successive points, a polygonal line the mean inclination of which for any period of time is an expression of the mean deviation within the particular period. There can hardly be any doubt that a graphic smoothing will lead to a more unambiguous determination of the mean deviation for an arbitrarily selected period of time if it is carried out on the curve of the accumulated excess, than if it is made on the basis of the deviations themselves or the means for the individual years.

Fig. 29 shows the curves of accumulated excess for the mean temperature of the whole year for Spitsbergen, Jan Mayen, and seven Greenlandic stations. The scale has been chosen so that a rise of 1:10 corresponds to a temperature which is 0.5° above the normal temperature used.

5. Humidity of the Air, Cloudiness, Visibility, Precipitation.

a. Relative and Absolute Humidity.

In table XIX the mean relative humidity for each month as well as for the year for both Jan Mayen and Myggbukta is given. The annual mean is fairly high, viz. 83 and 77 per cent respectively; all the year round the mean humidity is greater at Jan Mayen than at Myggbukta, which is in accordance with the distinctly maritime situation of the former station. The annual variation is almost the same, the humidity of the air being greatest in August—September (87—90 per cent at Jan Mayen, 82—83 per cent at Myggbukta), and least in the period October—April (81—82 and c. 75 per cent respectively).

If we look upon the individual days, it turns out that at Jan Mayen the rather low degrees of humidity principally occur with northwesterly and northerly winds. Evidently we are here concerned with an outflow of arctic air which during its transport over the more or less wide stretch of open water takes up heat and moisture, but in which the addition of vapour does not quite keep pace with the rise of the temperature. (Similar conditions are known from other places also.) However, the connection between the wind and the relative humidity is not particularly close; a low degree of humidity may occur with any direction of wind and,

Table XIX. Average values of humidity, cloudiness, precipitation, etc., at Jan Mayen (1922—37) and Myggbukta (1932—37).

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	Year	
Relative humidity, %	{ Jan Mayen..	82	81	81	81	83	86	90	87	84	81	82	82	83 %
	{ Myggbukta...	76	74	76	74	81	78	82	83	75	70	74	78	77 %
Cloudiness: Jan Mayen	{ %.....	83	82	78	81	83	83	88	86	80	82	82	81	82 %
	{ clear days....	0.6	0.7	1.0	1.2	1.0	1.7	0.4	0.2	0.8	0.2	0.6	0.4	0.7 %*
	{ cloudy days....	62	65	60	61	64	68	77	73	61	65	63	59	65 %*
Myggbukta	{ %.....	58	48	49	44	61	64	61	66	57	57	62	51	57 %
	{ clear days....	26	34	29	39	20	14	17	15	22	20	16	32	24 %*
	{ cloudy days....	36	26	29	24	42	44	38	41	36	33	42	30	35 %*
Frequency of fog, %	{ Jan Mayen..	7	10	11	17	20	32	44	39	23	10	13	11	20 %*
	{ Myggbukta...	15	9	19	7	32	33	37	43	15	8	14	16	21 %*
Precipitation, mm.	{ Jan Mayen..	48	46	31	32	17	20	36	38	55	57	43	47	471
	{ Myggbukta...	29	15	16	8	13	13	14	36	32	21	19	22	220
Jan Mayen:														
No precipitation.....		14	13	23	23	26	36	35	35	23	14	14	15	23 %*
No measurable prec. ...		19	20	21	23	31	25	26	22	22	27	21	24	23 %*
0.1—0.9 mm.....		35	27	29	27	27	22	17	15	19	23	31	25	24 %*
≥ 1.0 mm.....		32	40	27	27	16	17	22	28	36	36	34	36	30 %*
Myggbukta:														
No precipitation.....		59	67	63	76	63	70	71	63	73	67	62	61	66 %*
No measurable prec. ...		7	10	11	5	13	12	8	10	7	7	7	6	9 %*
0.1—0.9 mm.....		11	9	9	8	12	9	9	10	3	12	12	13	10 %*
≥ 1.0 mm.....		23	14	17	11	12	9	12	17	17	14	19	20	15 %*
Snow, % of all days	{ Jan Mayen..	56	61	53	41	32	12	2	1	20	38	50	51	35 %
	{ Myggbukta...	34	23	26	19	22	11	2	4	13	24	31	33	20 %
Number of days with snow in % of days with ≥ 0.1 mm of precipitation	{ Jan Mayen..	83	91	95	77	75	30	5	3	36	64	77	83	64 %
	{ Myggbukta...	100	100	100	100	93	69	10	16	66	92	100	100	90 %

*) percentage of all the days.

at any rate as far as the majority of directions are concerned, at both low and high wind forces.

Although even a relative humidity as low as 50 per cent must be characterised as rare, the absolute limit of what may occur seems to be very low; thus on November 13th, 1929, at 1 h. G.M.T. (force of wind 10 from the NNE, temperature 3.0° C.) a relative humidity of 18 per cent was registered, and at 7 h. of the same day (wind NNE force 11, 2.3° C.) even 10 per cent only (see pp. 162—63).

At Myggbukta conditions are less complicated, since here a low relative humidity (under 50 per cent) almost exclusively occurs in connection with northwesterly or northerly winds of a moderate force (c. 3—5 Beaufort); as a rule the temperature is at the same time above the normal. In general we are here concerned with a more or less typical foehn wind. In Part II some examples of typical foehn situations are given.

According to the measurements of humidity available from Scoresbysund the conditions here seem in the main to be the same as at Myggbukta. That the humidity is low at one of these stations on days on which it is low at the other, is such a common thing that it can almost be called a rule.

The absolute humidity of the air is much greater in the summer (when the relative humidity is greatest and the temperature highest) than in the winter, and much greater at Jan Mayen than at Myggbukta. The mean vapour pressure at Jan Mayen is c. 4.0 mm mercury (5.4 mb), varying from c. 2.8 mm (3.7 mb) in March to c. 6.2 mm (8.3 mb) in July—August, while at Myggbukta it is 2.5 mm (3.3 mb), varying from c. 0.8 mm (1.1 mb) in February to 5.5 mm (7.3 mb) in July.

b. Cloudiness.

The annual variation of the mean cloudiness at Jan Mayen and Myggbukta will appear from Table XIX. As regards Jan Mayen the figures stated in the table were obtained by a reduction of the mean computed for three observations a day to a mean for four observations a day, which will probably come closer to the actual diurnal mean, by using observations from the thirteen years (1923—35) for which a computation of both kinds of means is rendered possible by the material published in the year-book (L. 20); the correction amounts to 2 per cent, at most. As to Myggbukta the uncorrected means are given.

It will be seen from the table that the cloudiness at Jan Mayen is considerable, 80—88 per cent all the year round with a maximum in July—August, while at Myggbukta it is rather small, about 50 per cent, in the months December—April and greatest, though by no means great.

in the summer (60—65 per cent). In both places the annual variation corresponds closely to the variation in relative humidity, but the difference between the two stations is much more pronounced in the cloudiness than in the relative humidity.

Table XIX in addition gives the percentage number of clear and cloudy days (mean cloudiness $< 20\%$ and $> 80\%$ respectively) in the individual months. At Jan Mayen clear days are very rare (on an average there are only 2—3 a year), while two-thirds—in July and August even about three-fourths—of all the days are cloudy. At Myggbukta, however, on an average about one-fourth of all the days are clear and about one-third cloudy. The annual variation is here fairly marked, thus April has about 40 per cent clear and about 25 per cent cloudy days, while June—August have about 15 per cent clear and about 40 per cent cloudy days.

At Scoresbysund the mean cloudiness in winter seems to be slightly greater, while in summer it is rather smaller than at Myggbukta.

The diurnal variation of the cloudiness appears more or less completely in the difference between the mean cloudiness at the different hours in the different months. As regards Jan Mayen, as stated above, we are so fortunate that for a period of thirteen years (1923—35) observations (and means) for four hours a day—at 1, 7, 13, and 18 h. G. M. T.—have been published; by means of these observations the deviations from the mean for the last three hours only have been computed for each of the four hours and then each of these means has been reduced from the thirteen-year to the sixteen-year series. The final result is as follows (Fig. 31 a and b):

1) In summer (the months May—August) the cloudiness is a little greater in the night and the morning hours than in the afternoon; during the remaining part of the year, especially in the months September—December and February—March, the cloudiness is less in the night observation than in the afternoon observation.

2) The annual variation of the cloudiness at 1 h. and 13 h. G. M. T. differs mainly in regard to the amount of the amplitude: the limits at 1 h. are 73% (March) and 89% (July), at 13 h. 80% (March—April) and 88% (July).

Since the cause of the diurnal variation of the cloudiness, direct or indirect, is the diurnal variation of the radiation, it is easily understood that the difference between day and night is altogether greater at the equinoxes than about the summer and winter solstices. The cloud-dissolving effect of the outgoing radiation is manifested in the nocturnal minimum which occurs all the year round except in the four lightest months; the afternoon minimum at the height of the summer (especially June) is probably due to a certain tendency to convection (and

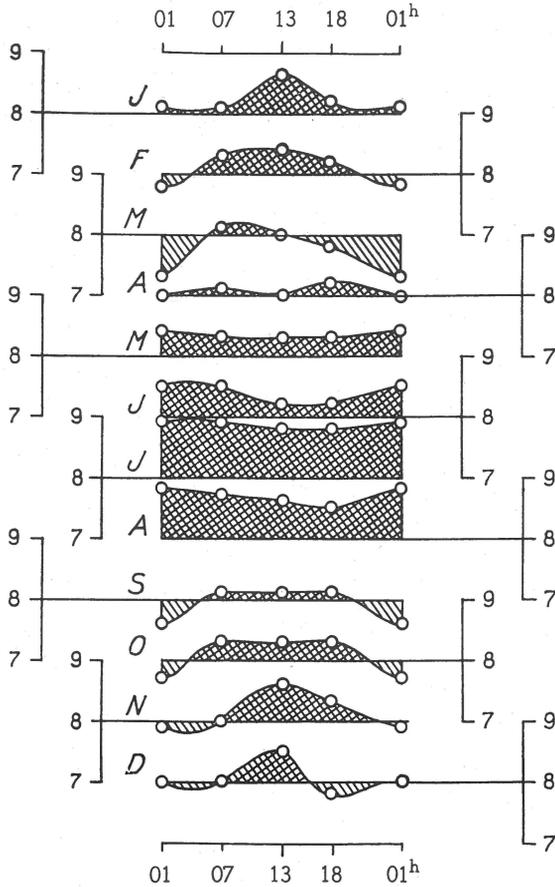


Fig. 31 a. Diurnal variation of the cloudiness (in tenths) at Jan Mayen.

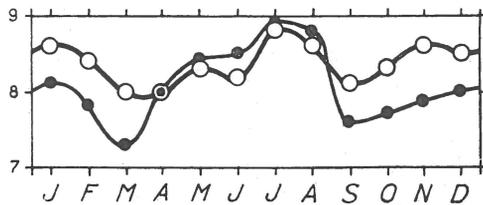


Fig. 31 b. Annual variation of the mean cloudiness (in tenths) at 1 h. and 13 h. G.M.T. at Jan Mayen. The curve —●—●—●— gives the values for 1 h. and the curve —○—○—○— the values for 13 h.

accordingly a transition from stratus or continuous stratocumulus to less compact cloud formations) at this time of the year and of the day.

As regards Myggbukta the printed material is more scanty, viz. three observations a day during six years. If we compare the means of the cloudiness at 13 h. with the corresponding values at 7 h. and 18 h., we

find, however, an unmistakable similarity to the conditions found for Jan Mayen: in winter (October—February) the cloudiness is rather considerable in the afternoon, in summer (May—July) it is at any rate less in the afternoon than in the morning.

The predominant cloud-form, especially in the summer half-year, is a stable layer of low stratus (cf. the great frequency of fog). The aerological material available from Scoresbysund confirms that this cloud-form is normally associated with a temperature inversion arising through cooling from below (in winter dependent on radiation, in summer on contact with the cold surface water). Over that part of the sea which is not covered with ice, convection clouds, whose formation is due to heating and accordingly labilisation of the arctic air from below, are frequent in the winter half-year. Of the medium clouds, i. a. a good deal of alto-stratus and nimbo-stratus (formed in maritime warm air climbing over a more or less wedge-shaped layer of arctic air) and, especially along the shore of Greenland, true foehn clouds (altocumulus lenticularis) occur (cf. L. 31, IV 2, p. 67). As regards the cirrus clouds it may be mentioned that in the coastal regions of Greenland "ice clouds" have occasionally been observed in the lowermost kilometres of the atmosphere.

No registrations allowing a determination of the number of hours with sunshine are available.

c. Visibility. Fog.

As a main rule it applies, especially to the coastal area of Greenland, that the visibility is either good or very poor; moderately good visibilities (range c. 2—20 km), so frequent over the European continent, are comparatively rare here, evidently because the atmosphere's contents of solid particles of microscopic size (apart from ice crystals) are negligible. Excellent visibility is the normal thing on days with northerly or westerly winds and is also common at Myggbukta on calm days, whereas fogs are very frequent on days with easterly or southeasterly winds. Table XIX shows the annual variation in the frequency of fog at Jan Mayen and Myggbukta; the frequency is greatest in the summer (July—August: c. 40 % of all the days) and on the whole varies in conformity with the frequency of winds from the southeasterly quadrant (pp. 26—27). The difference between the two stations is inconsiderable (annual mean 20 and 21 per cent respectively).

The most frequent form of fog is the advection fog, produced by cooling from below of humid maritime air of a southern origin. In winter, however, the radiation fog is of greater importance for the coastal area of Greenland (and probably also for the innermost part of the sea area covered with unbroken polar ice).

d. Amount of Precipitation.

Measurements of the precipitation in arctic regions, where by far the greater part falls in the form of snow, are attended with considerable and in part insurmountable technical difficulties. Even at moderate forces of wind it is very doubtful whether the quantity of snow that accumulates in the gauge will give a reliable numerical expression of the average value of the precipitation over an area of a suitable size (e. g. 1 km²); and an essential part of the snow falls even at very high forces of wind, especially on Jan Mayen. In cases of gale the gauging of rain likewise yields rather uncertain results.

As a consequence of the above-mentioned source of error we cannot ascribe any particular accuracy to the quantities of precipitation found by direct registration or to the means calculated from them. Conditions are hardly more fortunate if we are to ascertain the distribution of the precipitation over the individual months, for here it is of importance that the amount of snow in proportion to the total amount of precipitation varies in the course of the year; moreover the orographic conditions will probably make themselves felt in that the amount of precipitation registered will be relatively great (i. e. great as compared with the actual amount of precipitation) in some months in which certain directions of wind are frequent, and relatively small in other months in which other wind directions dominate.

However, the average figures for the two stations Jan Mayen and Myggbukta (Table XIX) in themselves give no grounds for suspicion, since the absolute amounts (annual means c. 470 and c. 220 mm) are of a reasonable magnitude and the annual variations with a maximum in autumn and winter and a minimum in spring and early summer agree well mutually and with that which might be expected *a priori*. And in spite of all sources of error we may, indeed, assume that at any rate this fairly marked annual variation is a climatic reality.

Fig. 32 shows the dispersion of the monthly means for Jan Mayen; the figures added indicate the years for the highest and lowest precipitation in each of the months of the year. It will be seen that a monthly precipitation of c. 100—125 mm may occur in the summer, autumn, and winter months, while, on the other hand, a precipitation of c. 2—5 mm is on record for May—June and one of c. 10—15 mm for all the months of the year except September.

The figures indicating the precipitation for the period January 1926—June 1927 (L. 20) are remarkably low—so low that a heterogeneity of the material about this time may be imagined. Thus the annual total for 1926 is 197 mm, while the mean annual total for the whole observational series is 471 mm and the highest annual total is 648 mm (1935).

For Myggbukta the highest monthly totals vary between 20 mm in April and 90 mm in September; for most months there are examples of a monthly total of 2 mm or less.

Great amounts of precipitation in twenty-four hours, c. 10—30 mm, may occur all the year round (most rarely in the spring). At Jan Mayen 47 mm was measured on October 3rd, 1931, and even

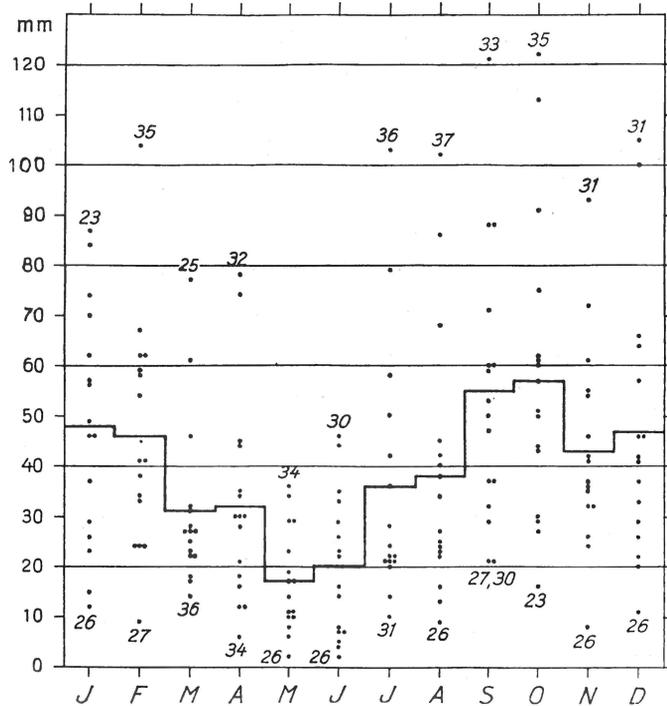


Fig. 32. Monthly precipitation at Jan Mayen (1922—37). The polygonal line gives the average values for the twelve months of the year, and each of the dots represents one month; the figures indicate the year in question, e. g. it is seen that the extreme values of precipitation in January were 87 mm (1923) and 12 mm (1926).

87 mm on July 29th, 1936; at Myggbukta the highest precipitation registered for twenty-four hours is 29 mm (October 2, 1934, and August 15, 1936). These weather situations are dealt with in Part II (pp. 153 f, 146 f, and 159 f).

The distribution of the precipitation according to the way in which it arises (climbing over a frontal surface, orographically forced ascent, instability showers in maritime arctic air) cannot be determined quantitatively on the basis of the available material, i. a. for the reason that precipitation of two or more different types have often occurred within twenty-four hours. It may be estimated that for the coastal area of Northeast Greenland the orographic precipitation is considerable and

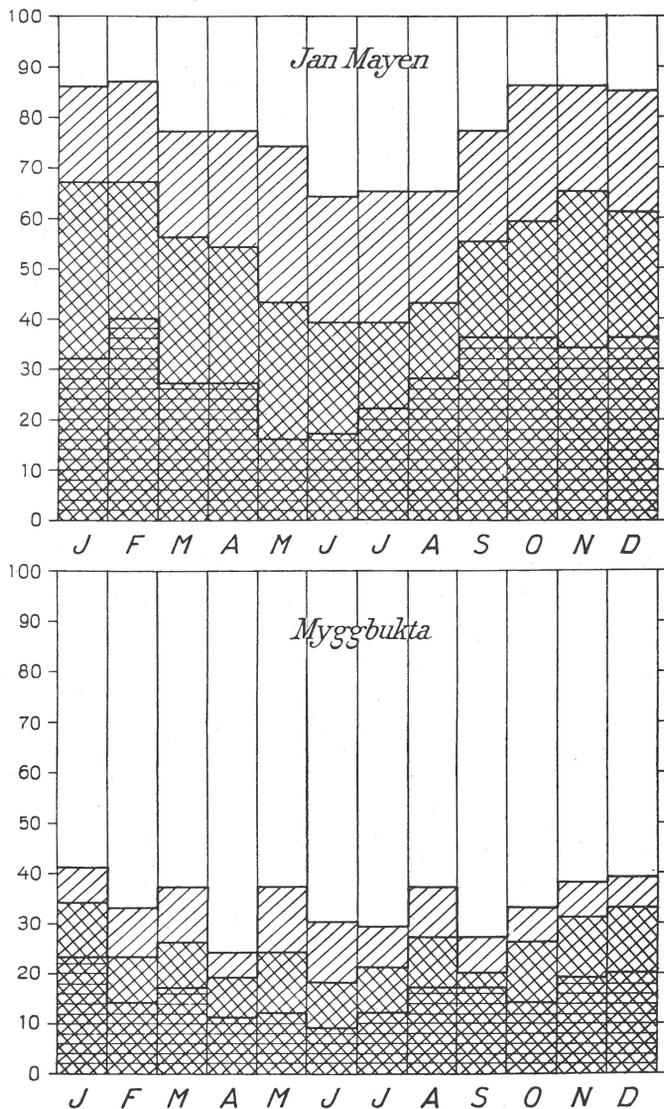


Fig. 33. Diagram showing the number of days with a precipitation of at least 1.0 mm (heavy shading), with 0.1—0.9 mm (moderate shading), with a trace of precipitation but less than 0.1 mm (light shading), and days without any precipitation at all (white).

the instability showers are of little importance, while a relatively great proportion of the total precipitation over the open sea in the winter half-year will be of a showery character.

e. Number of Days with Precipitation.

A valuable supplement to the statistics of the amount of precipitation is obtained by computing means for the number of days with

precipitation for each of the months of the year. The result of such a computation is given in Table XIX and in Fig. 33, which shows the frequency percentage of days entirely without precipitation, days with precipitation in non-measurable quantities, days with 0.1—0.9 mm, and days with at least 1.0 mm of precipitation.

Some characteristic features appearing from these figures will be briefly mentioned:

Jan Mayen: The four groups into which the days are divided are almost of equal size; thus precipitation falls on about three-fourths, and measurable precipitation on about half, of all the days. The number of days with no precipitation is greatest, c. 35 per cent, in the summer, and smallest, barely 15 per cent, in the period October—February; the number of days with a precipitation of at least 0.1 mm is greatest, 65—70 per cent, in January—February and smallest, c. 40 per cent, in June—July; the number of days with a precipitation of at least 1.0 mm is greatest, c. 35 per cent, in the autumn and winter months and smallest, hardly more than 15 per cent, in May—June.

Myggbukta: Precipitation occurs on only about one-third of all the days of the year; the number of days with precipitation is a little larger in the winter than in the summer half-year. One-fourth of all the days have measurable precipitation—in November—January 30—35 per cent, in April—July c. 20 per cent. The number of days with a precipitation of at least 1.0 mm amounts, for the whole year, to 15 per cent, varying from c. 20 per cent in November—January to c. 10 per cent in April—July.

At Jan Mayen all the months show examples of more than twenty days with measurable precipitation; according to the sixteen years' observations the smallest number of such days is c. 5 for June, July, and August, but c. 15 for January.

At Myggbukta June in each of the six years had at least one and not more than ten, while January had at least three and not more than eighteen, days on which the precipitation was measurable.

f. Number of Days with Snow and Hail.

The number of days with measurable precipitation, entirely or partially in the form of snow, is at Jan Mayen c. 65 per cent and at Myggbukta c. 90 per cent of all the days with measurable precipitation. At Jan Mayen the percentage varies from 3 in August to 95 in March; however, the absolutely largest number of days with snow is not recorded for March, but for January and February (c. 17 days each); only in the period June—September is the number of days with snowfall less than half of the number of days with precipitation. At Myggbukta

snow falls comparatively rarely in July and August (c. 10—15 % of all the days with precipitation); in June and September snow falls on 65—70 per cent, in May and October on 90—95 per cent, and in the remaining months even on 100 per cent of all the days with measurable precipitation; during the actual winter the precipitation rarely or never falls in the form of rain.

At Jan Mayen hail on an average occurred six times a year. The frequency seems to be somewhat greater in the autumn and winter than in the summer. At Myggbukta hail is much rarer (altogether eight times in six years). In this connection it may be mentioned that thunder has been observed a single time at Jan Mayen (on February 21st, 1930).

II. EXAMPLES OF TYPICAL AND EXTRAORDINARY WEATHER SITUATIONS

As a supplement to the description, on a statistic basis, of the climate in Northeast Greenland and over the adjacent sea area given in the preceding pages I shall give below a number of examples of weather situations which may be characterised as typical of the particular area, as well as of weather situations and developments which may for other reasons be judged to be of special interest.

There is no sharp limit between these two categories of examples. In the first place the weather maps which are to illustrate something typical (e. g. a high pressure over Greenland in winter) have generally been selected so as to show the particular typical phenomenon in an intensity far exceeding the normal and in many cases even representing the absolute maximum shown by the available observational material. Secondly, although the length of the series of years employed enables us to point out certain typical, frequently experienced features of the weather development, it is insufficient to allow us in all cases to decide whether an isolated event may rightly be called exceptional. In the text accompanying each of the weather maps, however, some remarks are made to point out whether the conditions shown in the maps are typical or exceptional.

Fronts are indicated on most of the weather maps. The analyses made by the weather services and recorded i. a. on the maps of the Deutsche Seewarte have in some cases, especially as regards more recent years, provided a useful basis, and as regards the Polar Year the author has to a great extent drawn benefit from the circumpolar maps prepared by the Deutsche Seewarte and issued at international instance (L. 6). In so far as the arctic area is concerned (Greenland, Jan Mayen, Spitsbergen, Bear Island) it has been endeavoured to utilise the material now available in the form of annuals, etc., which both in a qualitative and a quantitative respect is much superior to the material consisting of synoptic wireless messages. But in spite of this extension of the basis of the analysis it is obvious that the small number of stations and in

some cases their somewhat peculiar position often render an analysis difficult and the result of the analysis disputable.

It was first planned to arrange the maps systematically, but this proved to be difficult because a fairly large number of maps are to illustrate several different phenomena at the same time (high pressure and severe cold, low pressure and strong gales, etc.); hence, it was decided to arrange the maps month by month, giving at first a brief systematic synopsis with references to the individual maps.

Among the weather maps for the winter half-year there are several examples showing that the Greenland anticyclone is particularly strongly developed (Fig. 35: $^{24}/_1$ 29, Fig. 36: $^{26}/_1$ 29, Fig. 48: $^{15}/_1$ 40, and Fig. 59: $^{25}/_2$ 37). This distribution of the pressure is generally associated with a southward transport of arctic air, so that the temperature at Jan Mayen will be very low (Fig. 59: $^{25}/_2$ 37); Fig. 48: $^{15}/_1$ 40 shows a very peculiar exception from this rule. On the other hand, the temperature in West Greenland or part of it may at the same time be high, namely if a ridge of high pressure extends far southward or southeastward from the central area of the anticyclone, so that mild maritime air from the Atlantic is carried towards Greenland on the western slope of the ridge and is further heated by being foehned on its way across the inland ice (Fig. 37: $^{24}/_1$ 29).

The Greenland anticyclone, as stated by KURT WEGENER (L.31,VII) partially polemising against HOBBS (L. 11), is no permanent feature. On the other hand it is very often stationary over the continent of Greenland for several days, and when it is expelled from there, a distinct decrease in intensity will often be seen at the same time.

It sometimes happens that the development of the weather over a large part of Greenland is dominated by a well developed high, the centre of which does not lie over the inland ice, but for instance south of Iceland (Fig. 41 a: $^{30}/_1$ 1934), between Iceland and Norway (Fig. 51: $^{10}/_2$ 32), or even near Scotland (Fig. 34: $^{11}/_1$ 29). Characteristic of these weather types is a transport of warm air from the Atlantic northward along the east coast of Greenland (Fig. 34: $^{11}/_1$ 29 shows an extraordinarily high temperature at Scoresbysund and Myggbukta, Fig. 42: $^{31}/_1$ 34 an extraordinarily high temperature at Jan Mayen); often the mild air is separated from the arctic air by a sharp front, so that very great temperature variations occur in connection with the passages of fronts (Figs. 41 a—42: $^{30}/_1$ — $^{31}/_1$ 34). On the front a wave will sometimes form, which moves northeastward at a high speed and as a rule with rapidly increasing intensity, accompanied by great pressure variations (Fig. 42: $^{31}/_1$ 34).

There is a gradual transition between such cases in which the weather along the coast of Northeast Greenland is entirely dominated by an anticyclone over the inland ice and such in which it is dominated by a cyclone with its centre e. g. near Iceland or Jan Mayen. The weather maps showing a marked cyclonical weather type include some on which the depression is extraordinarily deep (Fig. 37: $\frac{3}{1}$ 33, Fig. 58 a: $\frac{9}{2}$ 35, Fig. 61: $\frac{23}{3}$ 38), others on which it lies much nearer the coast of Northeast Greenland than is usually the case (thus Fig. 54: $\frac{11}{2}$ 33), and some few showing both these features (Fig. 38: $\frac{4}{1}$ 33, Fig. 39: $\frac{14}{1}$ 33). It is characteristic of the deepest, slowly moving cyclones that the temperature on their northeastern side is comparatively high on account of advection of maritime air from the sea between Iceland and Norway to the sea off the coast of Northwest Greenland; sometimes the maritime air moves right in to the shore, even as far north as Myggbukta (Fig. 37: $\frac{3}{1}$ 33).

Another type of cyclones follows approximately an air-mass limit existing beforehand; at first they have the character of waves on the front, but gradually as they develop, a more or less complete occlusion of the front will take place, the warm sector air thus being removed from the lower air layers within the interior part of the cyclone. The cyclones belonging to this category move as a rule at a fairly rapid rate, and their speed corresponds in most cases fairly well to the speed with which the air moves in their warm sector. As a main rule it applies that the farther the Azores high is displaced to the north, the more northerly tracks will the cyclones follow over the North Atlantic; if for instance the centre of the anticyclone is found west of Ireland, the cyclones will often pass north of Iceland, and if there is a stationary anticyclone over Scotland or Scandinavia (or, similarly, if the Siberian anticyclone extends as far westward as to Scandinavia), they often move close past Jan Mayen.

Although cyclones of this type occur all the year round, they are most strongly developed and in addition most frequent in the winter. The series of weather maps Figs. 93 a—98 (5—10 December 1932) shows several examples of sharp fronts over the sea off the east coast of Greenland and some examples of waves forming on such fronts with subsequent cyclogenesis; the abrupt changes in the temperature at Jan Mayen are especially noteworthy. In addition to this series, examples of cyclones of the type mentioned here are given below from the following months: January (Fig. 40 a: $\frac{20}{1}$ 34), February (Fig. 58 a: $\frac{9}{2}$ 35), March (Fig. 61: $\frac{23}{3}$ 38), June (Fig. 68: $\frac{25}{6}$ 37), September (Figs. 75—76: $\frac{17-13}{9}$ 29 and Fig. 77: $\frac{24}{9}$ 29), and November (Fig. 87: $\frac{12}{11}$ 30).

For some of the cyclones which—like the majority of the above-mentioned cyclones—move roughly parallel to the east coast of Green-

land, at a greater or smaller distance, from Kap Farvel to Scoresby Sund and thence continue close past Jan Mayen towards Spitsbergen or Bear Island, it would seem that in addition to the air-mass constellation orographic conditions have taken part in the cyclogenesis. Thus it fairly often happens that a cyclone which approaches South Greenland from the southwest is, as it were, "split" against the coast between Ivigtut and Kap Farvel, so that one cyclone (which, as a rule, is at first the deeper one) moves slowly northward along the west coast of Greenland, while another follows the east coast to Scoresby Sund. As examples of this may be mentioned Fig. 54 ($11\frac{1}{2}$ 33) and Fig. 62 ($1\frac{1}{3}$ 40). Fig. 89 ($19\frac{1}{11}$ 34) shows an example of a cyclone cut off from the east side of a deep cyclone over the Denmark Strait; possibly the bend of the coast at Scoresby Sund (Kap Brewster) has here played a similar role to that of the coast at Kap Farvel in the aforementioned case.

As mentioned in part I, most cyclones over the Denmark Strait and the Greenland Sea with the adjoining land and sea areas move in a northeasterly direction, but examples of other directions of movement may be found. Thus the maps reproduced on the following pages include examples of northward-moving cyclones (i. a. Fig. 99: $15\frac{1}{12}$ 36 and Figs. 73—74: $24\text{--}25\frac{1}{8}$ 37—the last-mentioned cyclone may be traced right up to the North Pole), southward-moving cyclones (Fig. 82: $26\frac{1}{10}$ 33), and even one, probably rather unique, example of a westward-moving cyclone (Fig. 70: $8\frac{1}{7}$ 30).

As is well known, old cyclones with occluded frontal systems often move slowly, following cyclonical, highly curved tracks. Fig. 85 ($9\frac{1}{11}$ 29) shows an example of a deep storm centre at Jan Mayen, whose track seems to form a loop.

As pointed out by several authors, the continent of Greenland, on account of its great altitudes as well as on account of the peculiar thermal conditions (due to the presence of the inland ice) forms a rather effective barrier to the travelling cyclones—more effective than for instance the Scandinavian ridge and probably almost just as effective as the Rocky Mountains. However, it does not constitute any absolute obstruction; at any rate the author is of opinion that the examples pointed out by KOPP and WEGENER (L. 31) may withstand criticism and may be supplemented with more examples, but it must be admitted that the lack of stations on the inland ice in most cases makes it impossible to furnish an actual proof that a cyclone has passed across Greenland.

If we inspect more closely the cases within the material used in which it would seem that we may most reasonably speak of the passage of a cyclone across Greenland (see e. g. Figs. 64—65: $22\text{--}23\frac{1}{5}$ 36 and Fig. 81 a: $25\frac{1}{10}$ 33), it proves to be a characteristic common feature that a strong, almost stationary anticyclone lies over the northern part of the

North Atlantic (in Fig. 81 a south of Iceland, in Fig. 64 some distance farther westward). It would seem that only under such circumstances will there be a sufficiently strong westerly current in the upper air as far north as central Greenland. The phase differences between the pressure waves on the west and east coasts of Greenland (Figs. 49 and 81 b) give plausible values for the velocity at which the pressure waves travel across the continent of Greenland.—After their passage across the inland ice the waves (cyclones) as a rule continue eastward to the sea between Norway and Spitsbergen (Fig. 66: $^{24/5}$ 36), often increasing considerably in intensity, but examples are also at hand showing that they curve southeastward or southward; Figs. 81 a—82 ($^{25-26/10}$ 33) represent such a case, in which the cyclone in question moved from the Greenland Sea to the North Sea, dominating the weather conditions in north-western Europe for several days.

Most of the strong cyclones occurring over the Greenland Sea are accompanied by high winds not only on the front, rear, and right side, but also—unlike the majority of lows over Europe—on the left side of the centre. If we are to judge from the observations available from Jan Mayen (which, however, are perhaps not quite representative), we receive the impression that the highest wind velocities are associated with backing winds from northerly directions and a rising barometer. However, such cases are not wholly responsible for the absolutely as well as relatively high frequency of northerly gales, examples of pseudo-stationary weather situations with northerly gales on the eastern side of an anticyclone over the continent of Greenland being also available.

Of the weather maps represented on the following pages we may point out the following ones which show a specially high wind velocity at Jan Mayen: Fig. 43 a ($^{23/1}$ 35), Fig. 60 a ($^{26/2}$ 37), Fig. 63 ($^{10/4}$ 33), Fig. 71 ($^{28/7}$ 36), all with northerly gales, and Fig. 88 ($^{7/11}$ 32) with a westerly gale. The best example of gales along the coast of Northeast Greenland is Fig. 37 ($^{3/1}$ 33).

In the chapter on the temperature conditions it was pointed out that the temperature at Jan Mayen is almost entirely advectively conditioned (i. e. independent of local radiation processes), while radiation exerts a very great influence on the temperature in the coastal zone of Northeast Greenland. The weather map examples on the succeeding pages reveal, indeed, a very striking contrast between those maps which show extreme temperatures at Jan Mayen and those which show extreme temperatures near the coast of Greenland. Extreme conditions at Jan Mayen are shown in Fig. 59 ($^{25/2}$ 37: exceptionally severe frost with northerly gale) and Fig. 72 ($^{24/8}$ 29: advection of Scandinavian warm air), at Myggbukta in Fig. 45 ($^{18/1}$ 38: calm and clear weather with very severe frost) and Figs. 67 and 69 ($^{16/6}$ 32 and

$^{25}/_7$ 29: mild and fine weather at Myggbukta, in the former case with a distinct foehn).

The lowest winter temperatures in the coastal zone of Northeast Greenland do not, as might be expected, occur in cases in which the Greenland high pressure is especially well developed. This may be due to the circumstance that the most important conditions for a strong cooling of the lowermost air layers by radiation (a cloudless sky, causing a great loss of heat, calm weather, permitting the formation of a well-marked ground inversion, and a thick layer of powdery snow, isolating the air from the ground) are often completely fulfilled; thus, to obtain extremely low temperatures it is also of importance how large quantities of air are found over the particular area and how high its temperature is; within the anticyclones the pressure may be c. 10 per cent higher and the radiation reflected to the ground from the atmosphere accordingly also, other conditions being equal, c. 10 per cent greater than if the pressure is low, and at the same time the temperature within the anticyclones, owing to subsidence, is often relatively high in the upper air. Fig. 45 ($^{13}/_1$ 38) gives an example of especially low temperatures in Northeast Greenland.

Of the examples of especially high temperatures in winter, in addition to those mentioned above (p. 99—100), viz. Fig. 34 ($^{11}/_1$ 29) and Fig. 37 ($^3/_1$ 33), we may point out Fig. 44 ($^{26}/_1$ 37), when Northeast Greenland had thaw with easterly wind, and Fig. 52 ($^{24}/_2$ 32), when advection of maritime warm air on the northwest side of a cyclone south of Iceland was taking place. In this connection mention may also be made of Fig. 47 ($^{14}/_1$ 40), which shows a peculiar example of mild air of maritime origin returning from Spitsbergen to Jan Mayen.

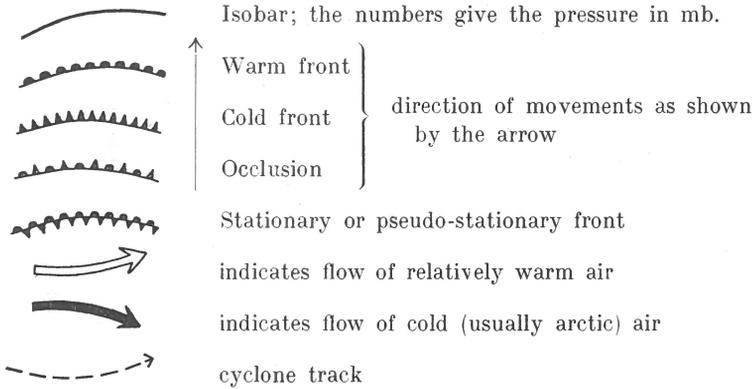
Fig. 69 ($^{25}/_7$ 29) shows an exceptionally great temperature difference between Myggbukta and Jan Mayen, Fig. 83 ($^1/_10$ 34) advection of warm air from North Scandinavia, giving rise to a heavy—no doubt orographic—precipitation near the coast of Northeast Greenland, and Figs. 79 and 82 ($^3/_10$ 31, $^{26}/_{10}$ 33) two examples of early winter cold at Jan Mayen with northerly winds.

A number of the weather maps have been selected mainly because the weather situations which they represent provide good examples of great temperature variations in the course of a short time, either at Jan Mayen or near the coast of Northeast Greenland. Of these the following have been mentioned above: Fig. 40 a ($^{20}/_1$ 34), Fig. 58 a ($^9/_2$ 35), Fig. 60 a ($^{26}/_2$ 37), and Figs. 95—98 ($^7/_12$ — $^{10}/_{12}$ 32); hereto may be added Fig. 50 ($^2/_2$ 32: great rise of temperature at Myggbukta owing to a foehn breaking through), Fig. 88 ($^7/_11$ 32: violent fall of temperature at Jan Mayen with a westerly gale), Figs. 90—91 ($^{22}/_{12}$ — $^{23}/_{12}$ 29: very great temperature variations at Myggbukta, owing to the formation

and disappearance of a radiation inversion), and Fig. 100 ($^{17/12}$ 37: great temperature rise at Scoresbysund owing to advection of warm air from the south). A number of maps, mainly included for other reasons, likewise show situations in which great changes in the temperature took place (Fig. 42: $^{31/1}$ 34, Fig. 67: $^{16/6}$ 32, Fig. 69: $^{25/7}$ 29, Fig. 79: $^{3/10}$ 31, and Figs. 81 a—82: $^{25-26/10}$ 33).

The best examples of days with very dry air are Fig. 67 ($^{16/6}$ 32: humidity at Myggbukta 26 ‰) and Fig. 86 ($^{13/11}$ 29: 10 ‰ at Jan Mayen). Particularly great amounts of precipitation occurred at Jan Mayen on $^{23/7}$ 37 (Fig. 71) and $^{2/10}$ 31 (Fig. 78), in Northeast Greenland on $^{1/10}$ 34 (Fig. 83) and $^{4/10}$ 38 (Fig. 84).

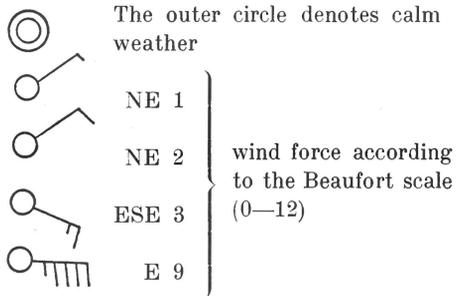
Symbols used in the weather maps.



Symbols used to indicate the weather observed at the individual stations:

- Cloudiness 0 tenth
- ◐ — 1—3 tenths
- ◑ — 4—6 —
- ◒ — 7—9 —
- ◓ — 10 —
- Rain
- ◌, Drizzle
- ✱ Snowfall
- ✱ Sleet
- ≡ Fog
- = Mist
- ∞ Dry haze
- ↑ Drifting snow
- ◊ Showers of rain
- ✱ — - snow
- ◊ — - sleet
- ✱ — - hail
- ◊ — - soft hail

Examples of the designation of the wind:



The figures near the stations give the temperatures in degrees centigrade.

Note.—The distinction between the different hydrometeors is not equally complete at all the stations; thus, drizzle may in some cases be denoted as rain; mist as fog or dry haze; showers of soft hail as showers of hail; and precipitation in the form of showers as ordinary rain, snow, or sleet respectively. This is, in particular, the case for most of the stations in Greenland.

at the time of observation

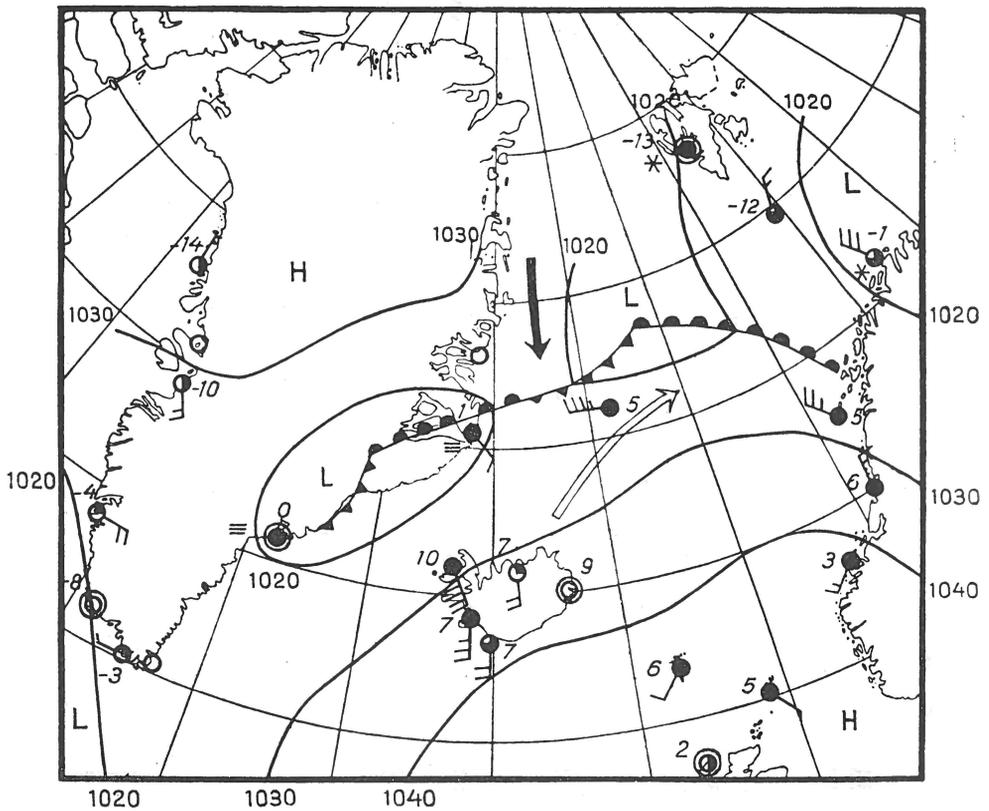


Fig. 34. January 11th, 1929, 16—18 h.

January 11th, 1929.

The centre of a very large anticyclone lies near Scotland. On its northern slope very mild maritime air flows from the North Atlantic across Iceland and Jan Mayen towards northern Norway. The temperature at Jan Mayen at 18 h., $5^{\circ}\text{C}.$, is very nearly the highest temperature observed at this station in a winter month. However, arctic air is found a short distance north of the island, and in the course of the night it advanced southwards. As late as 1 h. of January 12th Jan Mayen reported $5^{\circ}\text{C}.$ with wind S 4 (evidently on the front side of the depression seen in the figure between Angmagssalik and Scoresbysund), but at 7 h. the temperature was $-3\frac{1}{2}^{\circ}\text{C}.$ with wind NW 7, and at 13 h. $-6\frac{1}{2}^{\circ}\text{C}.$ with wind NNW 11; this fall of the temperature is one of the greatest known from this station.

January 24th, 1929.

From an exceptionally strong anticyclone over Northeast Greenland a broad ridge of high pressure extends southward across the Den-

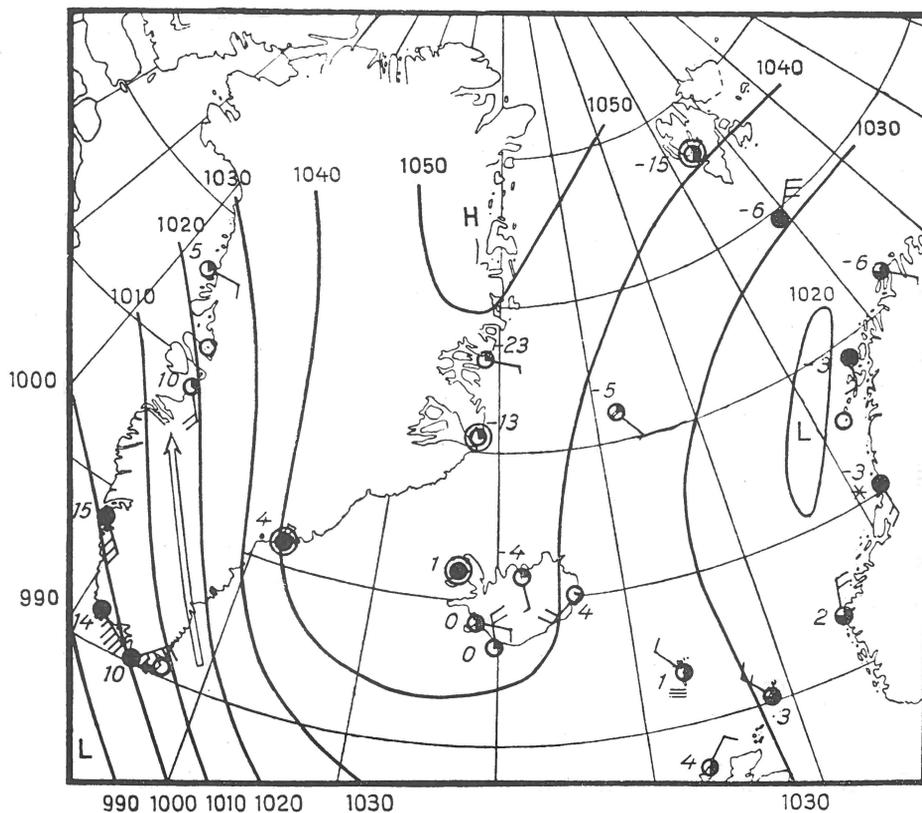


Fig. 35. Jan. 24th, 1929, 13—17 h.

mark Strait and Iceland. Along the western slope of this ridge very mild maritime air flows towards the north or northwest over South and West Greenland; the coastal stations from Nanortalik to Jakobshavn report 10—15° C., some of them with marked foehn winds (cf. L. 22).

As regards West Greenland the weather situation remained nearly unaltered for several days; in the days from the 22nd to the 25th January the mean temperature at Nanortalik was c. 7°, at Ivigtut c. 11°, at Godthaab c. 6½°, at Jakobshavn c. 9°, and at Upernavik c. 2° C.

Northeast Greenland was on the whole not affected by this flow of mild air; only on the 23rd seems a branch of it to have pushed so far eastward (probably across Greenland), Myggbukta reporting —2° at 7 h. that day as against —32°C. on the previous day.

January 26th, 1929.

The centre of an extraordinarily strong anticyclone lies over Northeast Greenland; at Myggbukta the pressure rose to 1068 mb (801 mm), which is one of the highest values ever measured in any place. In the

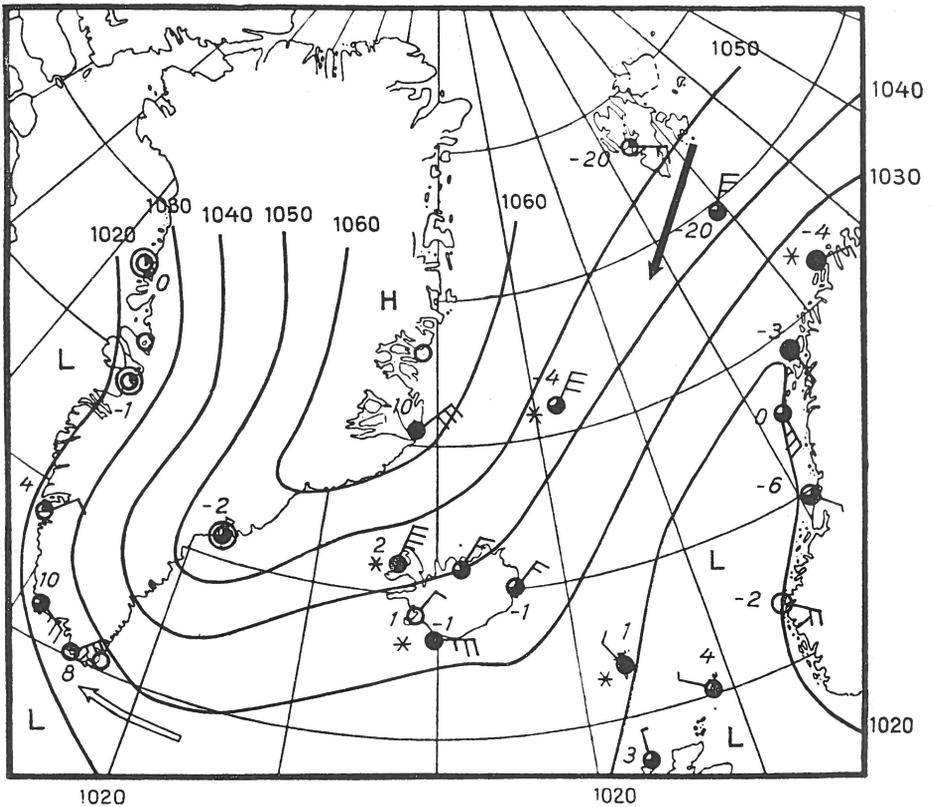


Fig. 36. January 26th, 1929, 13—17 h.

central area of the anticyclone the temperature is rather higher than the seasonal average and in West Greenland the weather is mild (Ivigut 10°C .). Quite possibly there is a close association between the rise of the pressure in the upper part of the troposphere which must have accompanied the considerable advection of warm air to the Polar regions during the previous week (cf. pp. 106—107), and the formation of the exceptionally strong anticyclone. However, on the eastern side of the anticyclone genuine arctic air now pushes its way from the sea north of Siberia across Spitsbergen and Bear Island (-20°C .) towards Jan Mayen, where the temperature decreased to -8 — -9°C . during the following twenty-four hours.

January 3rd, 1933.

The figure shows an extremely deep cyclone near Iceland; over the whole of Iceland and a large area north and west of this island the pressure is below 940 mb, and at Vestmannaeyjar a pressure of 924 mb

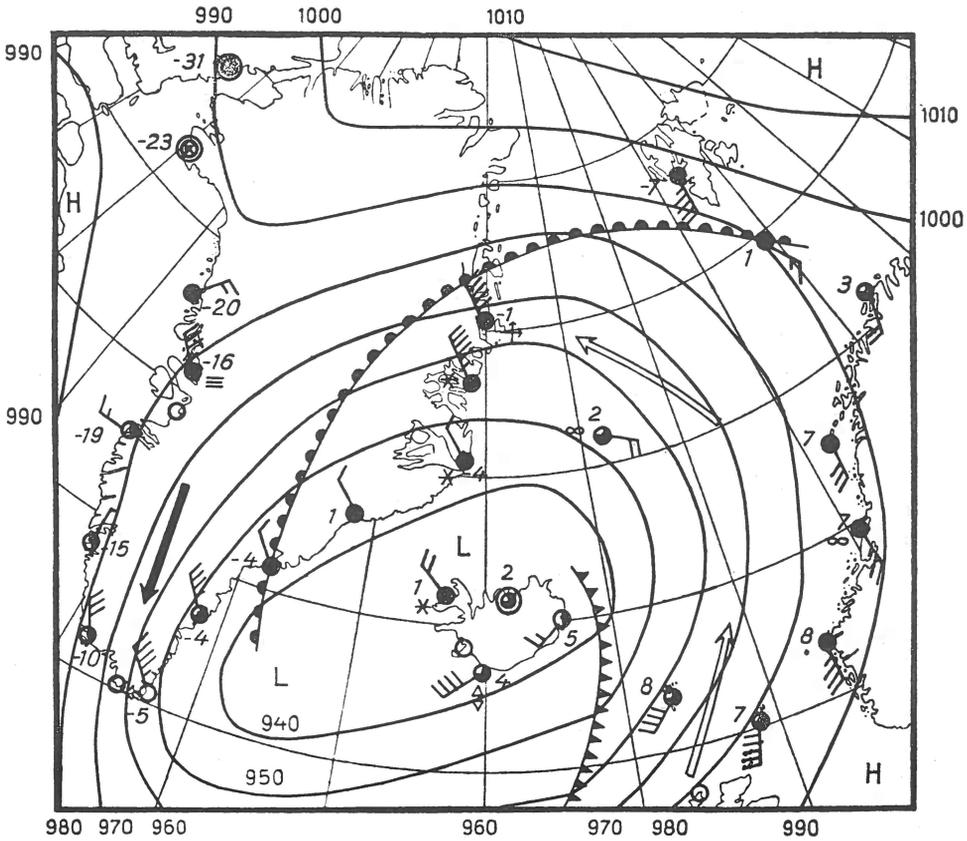


Fig. 37. January 3rd, 1933, 11—13 h.

(693 mm) occurred in the night before the 3rd, which is one of the lowest pressure values ever measured anywhere. On the eastern side of the depression mild maritime air is flowing across the northern seas, continuing towards Greenland. At Myggbukta and the station Jonsbu situated some distance farther northward an exceptionally heavy gale is blowing from the NNW with drifting snow and light frost; the high temperature shows that we are here concerned with maritime air; the circumstance that the wind is northerly and not easterly is evidently due to the orography and it is, by the way, the normal thing along this part of the east coast on days with a pressure distribution of the type in question. The warm air did not push as far as West Greenland; here a transport of arctic air towards the south is taking place, and the arctic air on the south side of the depression has reached South Iceland, whence Vestmannaeyjar reports showers of hail with a southwesterly gale and 4°C .

At Scoresbysund a pressure of 944 mb (708 mm) was registered, which is the lowest value on record for this station.

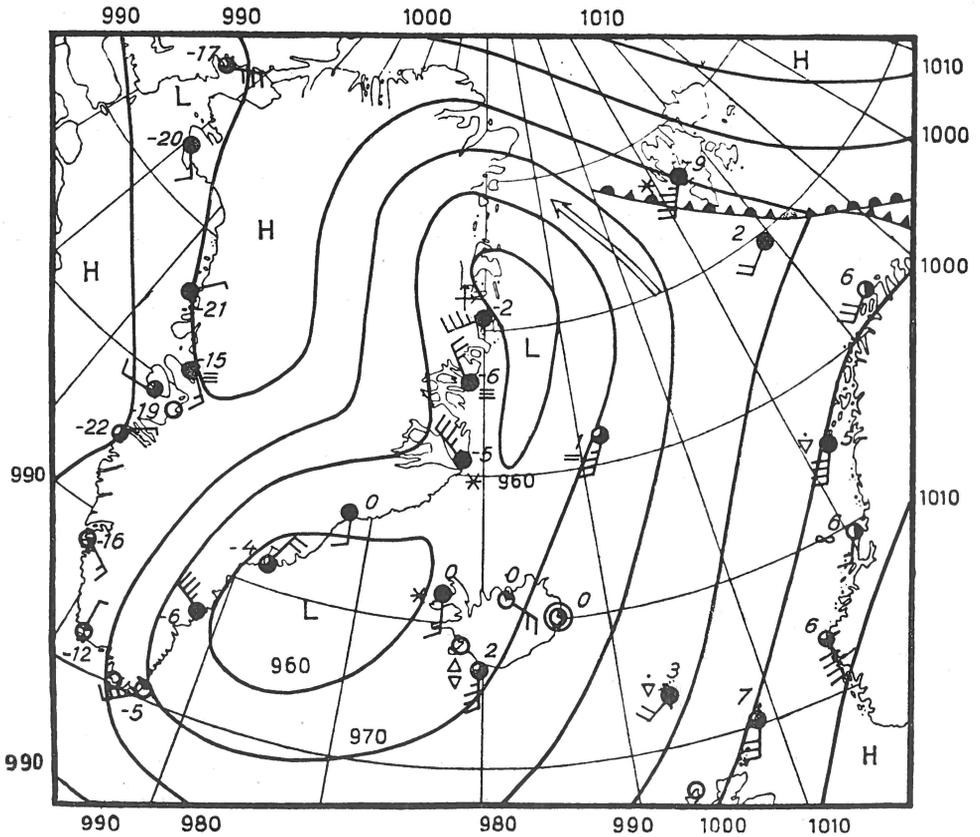


Fig. 38. January 4th, 1933, 11—13 h.

January 4th, 1933.

The deep cyclone near Iceland (pp.108—09) has been separated into two and filled up; the pressure is still below 960 mb over an area off the coast of Northeast Greenland as well as over the sea between Iceland and South Greenland. No marked fronts are seen within the central area of the cyclone; no change of the air mass has taken place in West Greenland; the arctic air, moving east on the southern side of the cyclone, has penetrated as far as northern Norway and Bear Island, but the temperature over the northern seas is somewhat above the average for the season, the bottom layers of the arctic air having been heated considerably during the long transport over the sea. The greatest positive temperature deviation is found at Northeast Greenland (Jonsbu — 2° C.), where remnants of the warm air covering most of the northern seas on the previous day are probably still present.

January 14th, 1933.

From the middle of December 1932 to the middle of February 1933 the weather conditions were as a rule much disturbed over the sea off

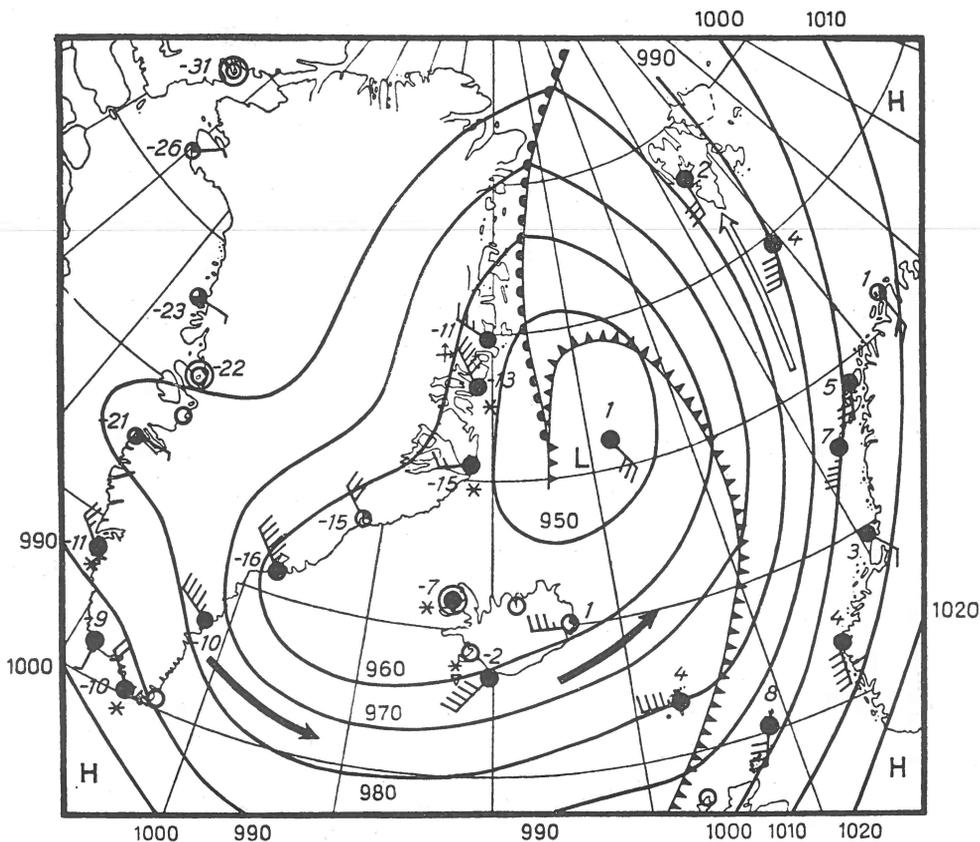


Fig. 39. January 14th, 1933, 13—17 h.

the east coast of Greenland, where many deep cyclones occurred. Near Iceland and along the coast off Scoresby Sund the lowest pressure was measured on the 3rd, but at Jan Mayen and Myggbukta on the 14th January (at 7 h. these two stations had 944 and 947 mb respectively); over the whole area the pressure minimum of the winter was the lowest known, or at any rate the lowest within the series of years considered here.—The map for the 14th January shows a storm centre of c. 940 mb moving northward just west of Jan Mayen; during its passage Jan Mayen had great pressure variations—up to 17 mb in seven hours—while the variations in the temperature were not particularly great. On the eastern side of the cyclone there is a rapid flow of mild air from Scotland to Spitsbergen; the warm air has not reached the coast at Myggbukta and Scoresbysund, but the snowfall here may be explained by the advance of the warm air in the free atmosphere. The Greenlandic arctic air flowing across the Denmark Strait (Angmagssalik — 16° C., with an exceptionally heavy northwesterly gale) has reached Iceland; the cold front forming the boundary between

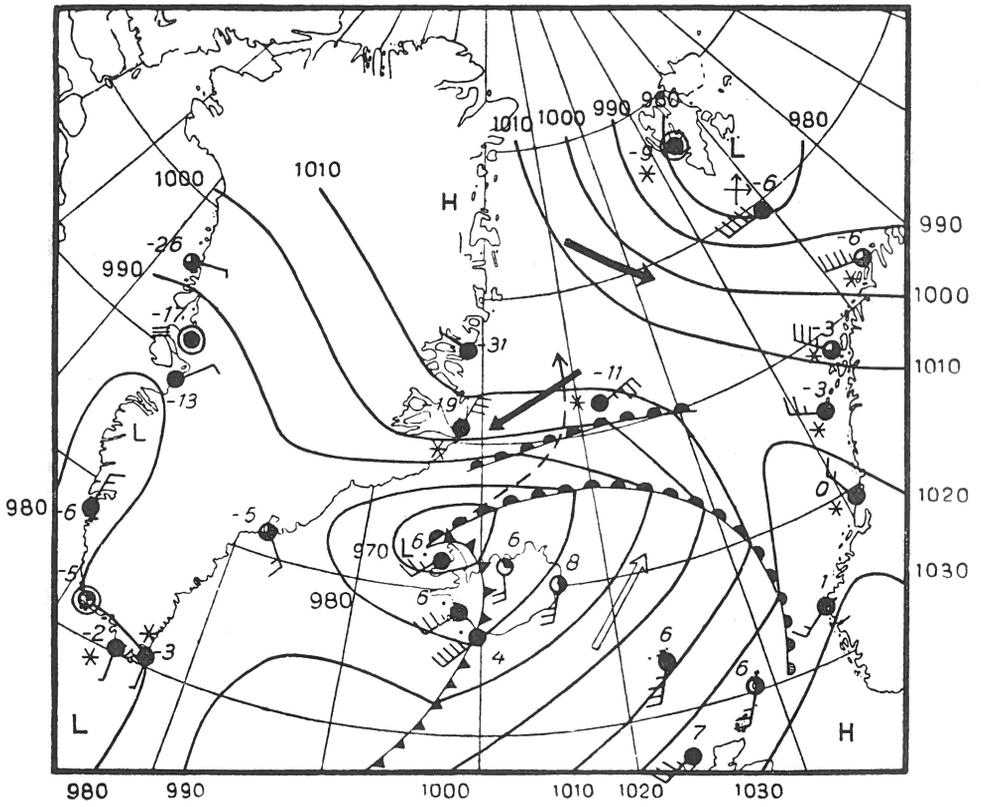


Fig. 40 a. January 20th, 1934, 16–18 h.

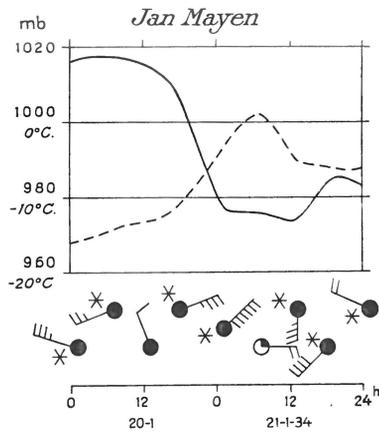


Fig. 40 b. Variations of pressure (—), temperature (---), and weather at Jan Mayen, January 20th–21st, 1934.

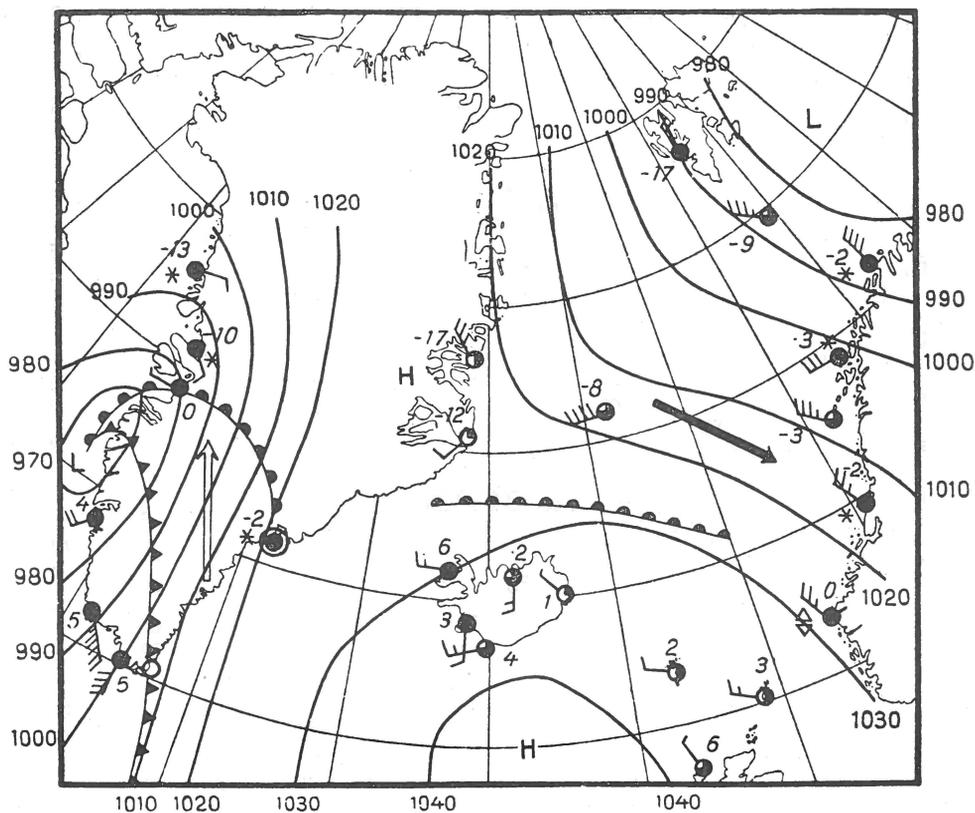


Fig. 41 a. January 30th, 1934, 16—18 h.

the mild and the cold air mass had just passed Thorshavn (at 7 h. SSW 10, 8° C., but at 13 h. W 9, 4° C.).

January 20th, 1934.

In the rear of the violent cyclone now situated near Spitsbergen, a considerable outbreak of arctic air across the northern seas took place during the previous twenty-four hours; on the night before the 20th Jan Mayen had a temperature of -16° C. with a strong north-westerly gale. Now, however, another cyclone is advancing through the Denmark Strait, and warm air is carried in a broad stream across the Faroes and Iceland towards the northeast. Jan Mayen still lies within the arctic air, but the wind has changed to east and the barometer is falling rapidly. The subsequent development at Jan Mayen will be seen from the accompanying diagram; the storm centre itself passed at a short distance to the west of the island; almost at the same time as the pressure reached its lowest value, the temperature was for a short time above the freezing point—after a rise of 15° in the course of twenty-

four hours—but already six hours later the arctic air, the movement of which must have had a strong cyclonic curvature, reached Jan Mayen, which then had -5°C . with a southerly gale and rising barometer.

January 30th, 1934.

A strong anticyclone, centred off the south of Iceland, dominates the weather of northwestern Europe. Between the anticyclone and a depression moving away over the Barents Sea, arctic air is flowing

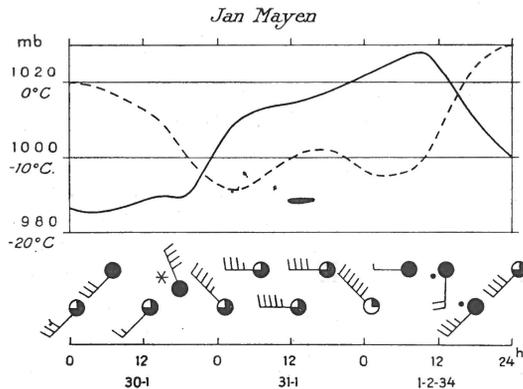


Fig. 41 b. For explanation see the text to Fig. 40 b.

down across the sea between North Greenland and Norway. The violence of the arctic outbreak will appear from the accompanying diagram for Jan Mayen.

A strong northward-moving cyclone is found near the west coast of Greenland between Godthaab and Godhavn. The warm front belonging to this cyclone passed Umanak between 17 h. and 24 h. G. M. T., causing a rise of the temperature from -10° to 6°C . In the rear of the depression there first followed a slight fall of the temperature, evidently owing to advection of maritime polar air from the south, and subsequently a greater fall due to advection of arctic air from the west (Godthaab at 11 h.: $7\frac{1}{2}^{\circ}$, at 17 h.: 4° , at 24 h.: -4°C .; similarly at Ivigtut and Nortalik).

Judging from the observations made at fixed hours at Angmagssalik the passages of the fronts are less marked here. Through stemming against the steep coast, the warm air is forced to rise, giving off a large part of its moisture; the precipitation at Angmagssalik in the twenty-four hours from 11 h. of the 30th to 11 h. of the 31st amounted to 44 mm.

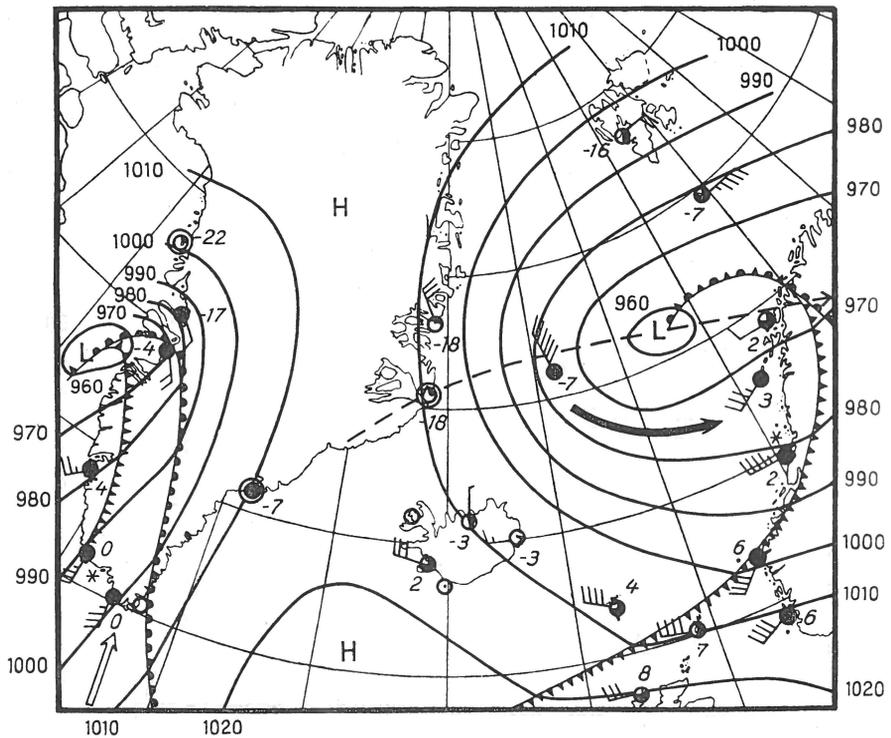


Fig. 43 a. January 23rd, 1935, 07—11 h.

bukta (passage of a masked cold front with foehned Canadian arctic air behind it).

Over Iceland and Jan Mayen the warm air extended right down to the surface of the earth; at Jan Mayen the temperature rose to a value which is exceptional for the winter, viz. $5\frac{1}{2}^{\circ}$, after a rise of 17° in the course of 18 hours (see also Fig. 42 b).

In the course of the succeeding twelve hours the East Greenland depression developed into an extremely violent storm centre. At 7 h. of February 1st it had already reached Spitsbergen, where the barometer had fallen from 1004 to 960 mb in the course of the night.

January 23rd, 1935.

The centre of the deep depression seen in the figure northwest of the Lofoten Islands passed north of Jan Mayen in the early morning; the ensuing rise of the barometer was extraordinarily rapid (35 mb in 17 hours), and the wind increased to a hurricane blowing from north-westerly directions. The temperature culminated already twelve hours before the passage of the centre (Jan. 22nd, 13 h: $+1^{\circ}$. Jan 23rd.

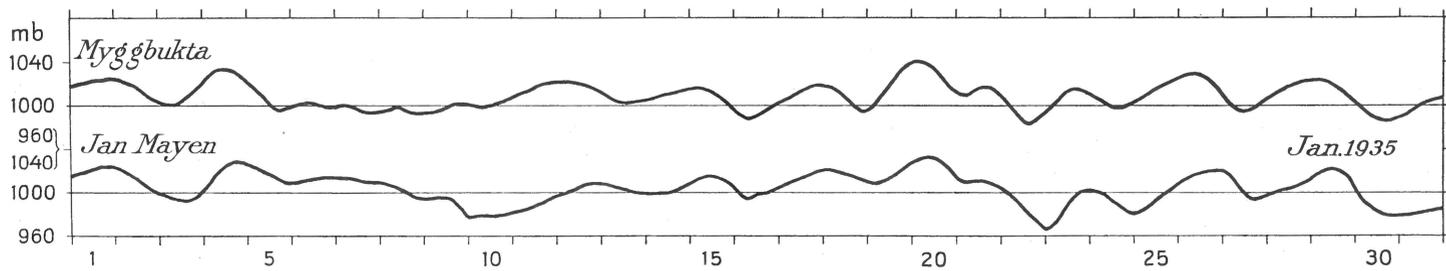


Fig. 43b. Barograms showing variation of pressure at Myggbukta and Jan Mayen in January 1935.

1 h.: -5° C.). The temperature variations near Iceland were much greater, especially along the east coast, where Seyðisfjörður at 7 h. of the 22nd (within the warm sector and under the influence of foehn) had 15° C., but twenty-four hours later -3° C.

The depression dealt with here was the last but one in a series of cyclones; the cyclone preceding it seems to have crossed the inland ice from Disko to Myggbukta on the 18th and to have passed Bear Island in an east-southeasterly direction on the evening of the 19th; the last cyclone of the series, which developed into a very deep storm centre, passed North Iceland on the 24th and reached central Scandinavia on the 25th.

Altogether the pressure and weather conditions near the coast of Northeast Greenland were very much disturbed during nearly the whole of January; the accompanying diagram shows the pressure variations at Myggbukta and at Jan Mayen in the course of the month.

January 26th, 1937.

The figure shows a rather exceptional weather situation. The pressure is very high from Northeast Greenland and Spitsbergen to Northern Scandinavia and Russia, while it is very low near Southwest Greenland. Over the intermediate area east-southeasterly winds are transporting air from the European continent over the northern seas to Greenland. On leaving the continent this air has a temperature a little above the freezing point, and this temperature remains almost unaltered until the air reaches the coast of Greenland, Myggbukta having 1° , Scoresbysund 0° and rain, and Angmagssalik 2° C. The air continues across Greenland and on its arrival at the central part of the west coast has the character of a foehn (Upernavik $+5^{\circ}$ C.). In southwestern Greenland, which belongs to the central area of the depression, and is not influenced by the east-southeasterly air transport, the temperature is somewhat below the freezing point.

Only a very few examples are known of the temperature at Myggbukta having risen above the freezing point in the winter; in addition to the case described here only one case (7th December 1938) is known in which such a high temperature was due to an advection of maritime air without the influence of foehns.

January 18th, 1938.

A deep storm centre is situated c. 1000 km west of Scotland, moving slowly northward; Iceland has freshening easterly wind with snowfall

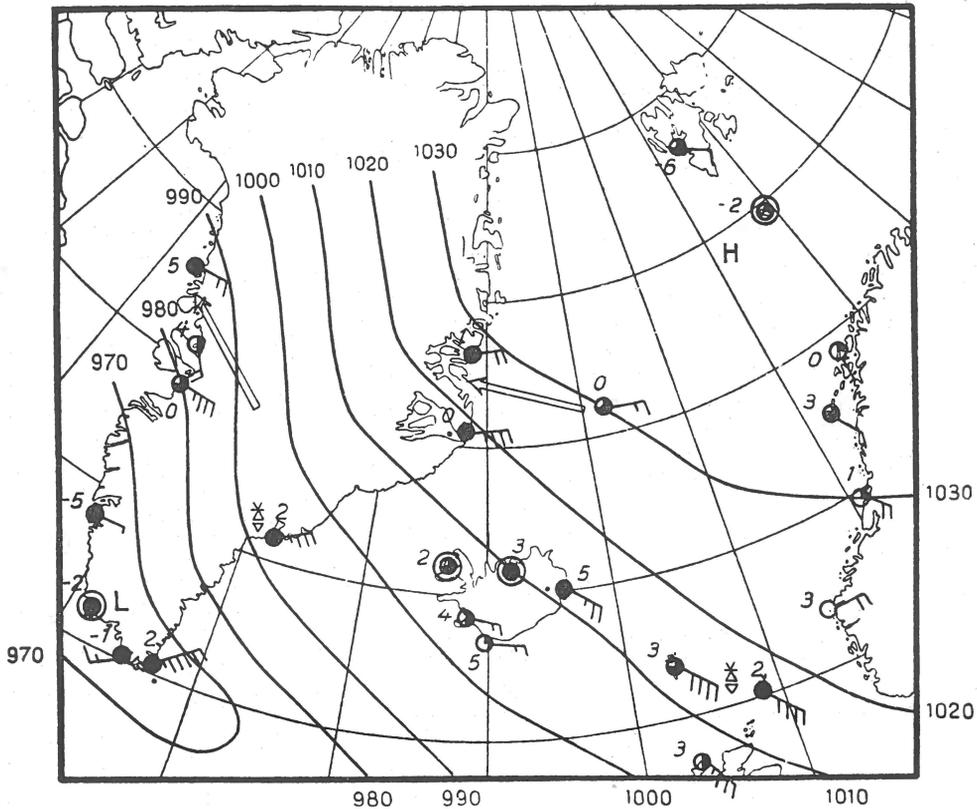


Fig. 44. January 26th, 1937, 10—13 h.

and rising temperatures. Between a slightly developed high over Northeast Greenland and a trough extending from Spitsbergen to central Scandinavia there is a decreasing transport of arctic air from the north; Jan Mayen has -14°C . At Myggbukta, near the centre of the anticyclone, an extraordinarily cold ground layer has formed in the calm and clear weather; the temperature measured here, -49°C ., is the lowest temperature known from this station.

Next morning the centre of the cyclone lay near South Iceland, exerting its influence beyond Jan Mayen, which reported ENE 9 and -2°C ., and as far as the coast near Myggbukta, where the temperature had risen to -38°C . though the weather at the station, at any rate at the time of the observation, was calm and only partly cloudy. Then followed a further rise of 27° in the course of twenty-four hours, the depression advancing farther northward without filling noticeably up; the wind increased to a gale from the north, and considerable quantities of snow came down (17 mm of precipitation in the twenty-four hours preceding 7 h. of the

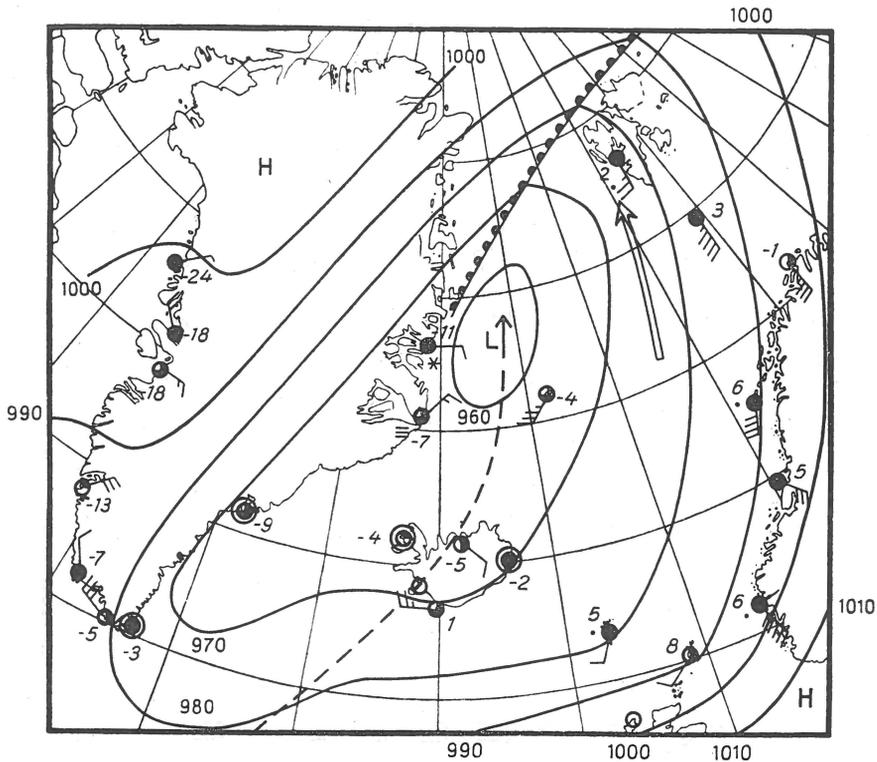


Fig. 46. January 21st, 1938, 07—11 h.

Barents Sea; on Spitsbergen and Bear Island the temperature was now a little above, now a little below the freezing point. About the 12th the advection of warm air ceased, and the pressure gradient changed its direction, an anticyclone forming near Northeast Greenland. It then turned out that the air, which as a consequence of this began to flow westward again from the Barents Sea to the Greenland Sea, had retained its character of a mild maritime air—the map shows that on January 14th Spitsbergen and Bear Island have temperatures near the freezing point, in spite of the rather strong easterly wind. At Jan Mayen a somewhat colder air mass has in the meantime arrived from the north; on the front side of the warm front delimiting the milder air towards the west the northerly wind has increased to a gale. The warm front passed Jan Mayen in the course of the day; at 13 h. the temperature had risen to -2°C . In the lowermost layers of the atmosphere the warm air did not reach the coast of Northeast Greenland, but no doubt it did so in the upper layers. As shown by the map, the pressure was very high over Northeast Greenland as early as the 14th, and the great rise of the barometer (at Myggbukta 37 mb in 30 hours), which is possibly in some

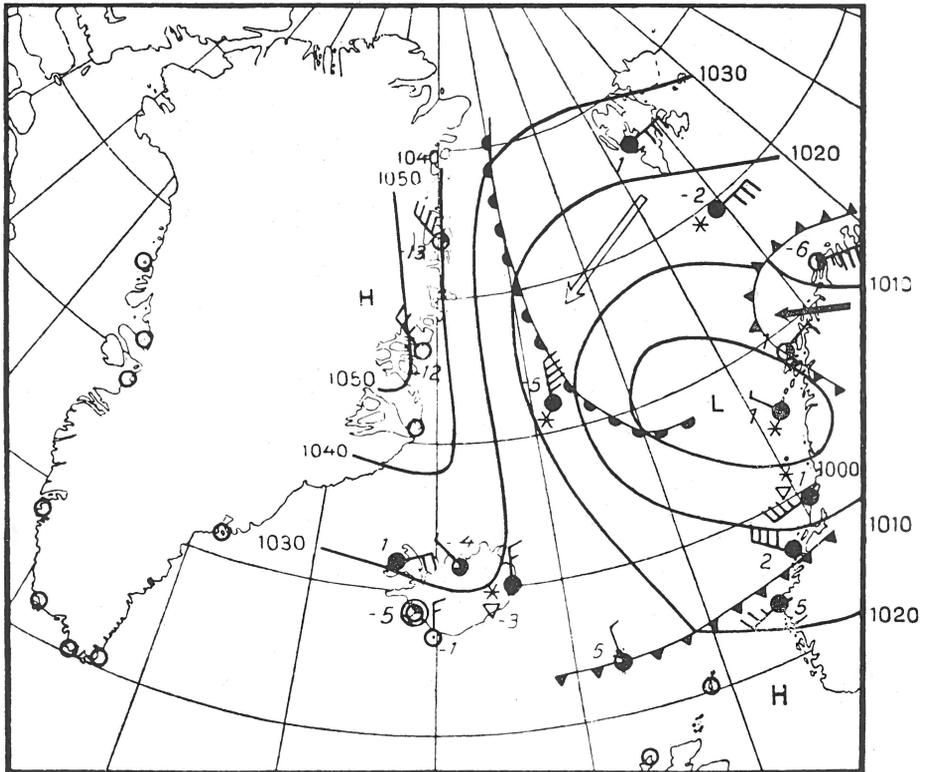


Fig. 47. January 14th, 1940, 07 h.

way associated with the advection of warm air from the east in the upper air, continued until next day (see Fig. 48).

January 15th, 1940.

The fairly mild maritime air flowing back from the Barents Sea (see p. 121) has now reached Iceland and the Faroes; at Spitsbergen and Bear Island the temperature has gradually decreased somewhat, evidently because the air now being supplied, though of Atlantic origin, has remained over the sea north of Russia and Siberia long enough to distinctly change its character. The southwesterly wind observed at the station on Jan Mayen is probably a purely local phenomenon (due to the formation of eddies on the leeside of the highest mountain of the island, cf. p. 24).

The anticyclone over Greenland had now assumed entirely exceptional dimensions; at Myggbukta the pressure amounted to 1065 mb (799 mm). Over South and West Greenland, also, the barometer showed unusually high values (Godthaab 1054 mb at 11 h).

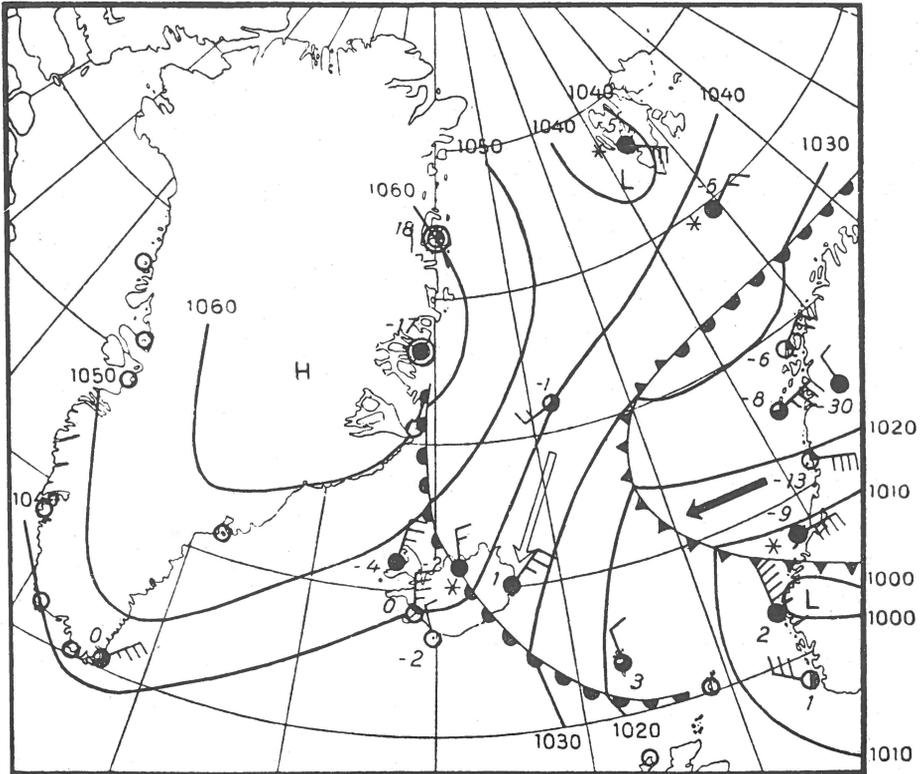


Fig. 48. January 15th, 1940, 07 h.

Just as we may imagine a connection between the warm air advection from the Barents Sea to Greenland and the formation of the well developed Greenland anticyclone, there is possibly a close connection between this air transport and the exceptionally vigorous outbreak of continental arctic air which took place over Scandinavia and the Baltic regions on the 14th—16th: on the south side of the warm air the prevalent strong easterly wind in the upper air may have given rise to advection of Siberian arctic air in the intermediate layers of the troposphere, provoking—through labilisation from above—a considerable cooling of the lower layers also.

February 1932.

The barograms for February 1932 (Fig. 49) show:

- 1) the abnormally high mean value and the slight variations of the pressure at the Faroes;
- 2) the rapid and irregular variations of the pressure at Ivigtut, Umanaq, Myggbukta, and Spitsbergen (mean variability at Myggbukta 12 mb);

3) the travelling of the pressure waves towards the northeast on the northwest side of the high pressure over western Europe, the corresponding points (a, b, c, ...) appearing first at Ivigtut (a_1, b_1, c_1, \dots), then successively at Umanaq (a_2, b_2, c_2, \dots) and Myggbukta (a_3, b_3, c_3, \dots), and finally at Spitsbergen (a_4, b_4, c_4, \dots); only in a few cases may there be some doubt about the coordination of the individual maxima and minima, only a single flat wave (maximum l and minimum m) disappears along the way, and it is only in some few cases that a station exhibits distinct irregularities which cannot be traced back to the preceding stations;

4) the approximate intervals between the occurrence of coherent extremes at Ivigtut and Spitsbergen were as follows:

a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	
2	$2\frac{1}{2}$	$2\frac{1}{2}$	2	$2\frac{1}{2}$	2	4	3	$1\frac{1}{2}$	$1\frac{1}{2}$	2	-	-	$3\frac{1}{4}$	$2\frac{3}{4}$	2	2	2	$1\frac{1}{2}$	days

Thus the mean is c. 60 and the extremes c. 36 and 96 hours; the corresponding values for the velocity of propagation of the waves (provided that the "crests" of the waves are at right angles to the line connecting Ivigtut and Spitsbergen, which is approximately correct) are c. 55, c. 80, and c. 30 km per hour respectively.

February 2nd, 1932.

On the northern side of a strong anticyclone centred near Ireland mild maritime air flows northward across Iceland and the northern seas. This maritime air forms the warm sector of an eastward-moving depression, which, judging from the observations reported from the stations in Greenland, has passed across Greenland approximately from Disko to Shannon, and whose centre now lies c. 500 km north of Jan Mayen. In the afternoon of February 1st, when the depression was centred near Disko, Umanaq reported a pressure of 977 mb with a SE gale and a temperature of 9° C. In the rear of the depression fairly mild air was flowing across West Greenland from the southwest, and it seems to be this air which now arrives at Myggbukta with northwesterly wind of force 5 (foehn) and only 2 degrees of frost. The low temperature at Scoresbysund must be regarded as a local phenomenon (a ground inversion).

The weather situation described here represents the type of weather—not particularly frequent, but fairly well defined and easily recognisable—which was described on pp. 101—02, viz.: a stationary anticyclone over the northern part of the North Atlantic, very mild weather on the northern side of this high pressure, and a depression track across

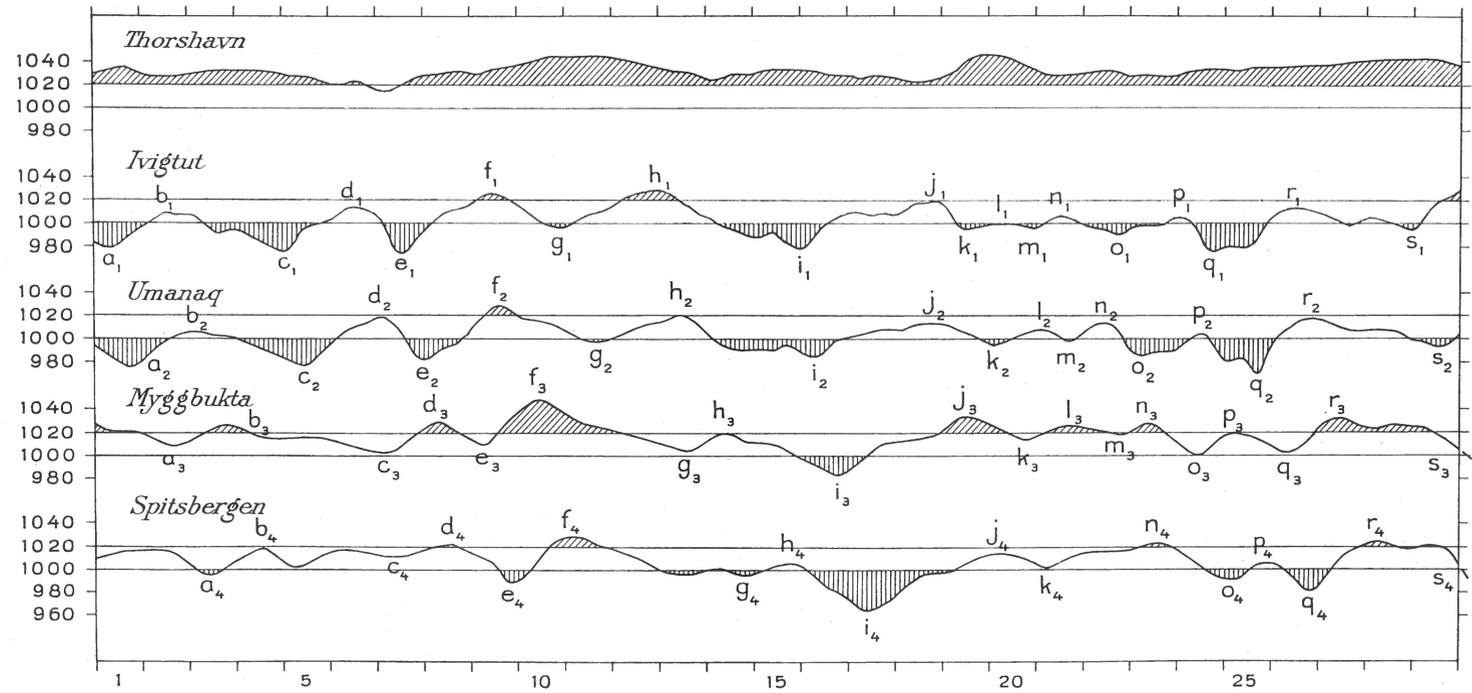


Fig. 49. Barograms for the month of February, 1932, showing the movement of pressure waves from Greenland to Spitsbergen on the northern slope of a stationary anticyclone centred near the Faroes.

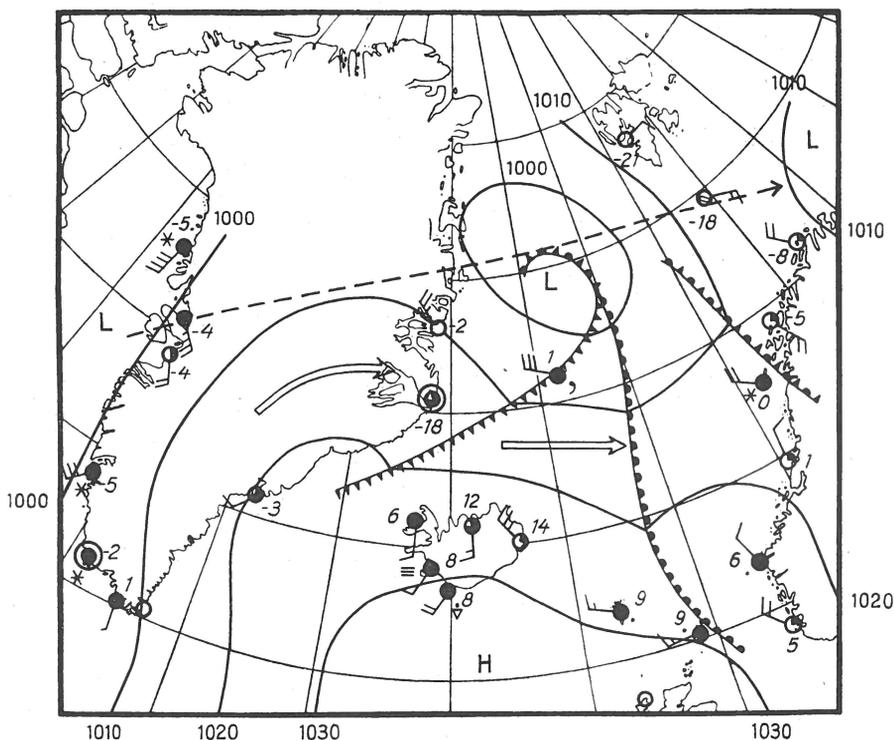


Fig. 50. February 2nd, 1932, 16—18 h.

central Greenland and onwards to the sea between northern Norway and Spitsbergen.

February 10th, 1932.

An unusually strong anticyclone extends from the central part of East Greenland to southern Scandinavia. A low east of Spitsbergen moves off in an easterly direction followed by a considerable rise of the barometer (Myggbukta at 7 h. on Febr. 9: 1009 mb, 24 hours later: 1046 mb; Spitsbergen (Svalbard Radio) at 18 h. on Febr. 9: 990 mb, 24 hours later: 1024 mb); the rise can be traced back to West Greenland (Jakobshavn at noon of Febr. 8: 991 mb, 24 hours later: 1024 mb); the low is probably identical with (or perhaps arisen by division of) a deep depression whose centre passed Disko Bay in the night before the 8th; at that time the high pressure extended from southeastern Europe to the Denmark Strait.

The air which flows southeast between the low and the high pressure is fairly mild at Myggbukta and Jan Mayen—possibly it has been moving north over the Atlantic on the western side of the high pressure; the air at Spitsbergen, however, is evidently of polar or arctic origin

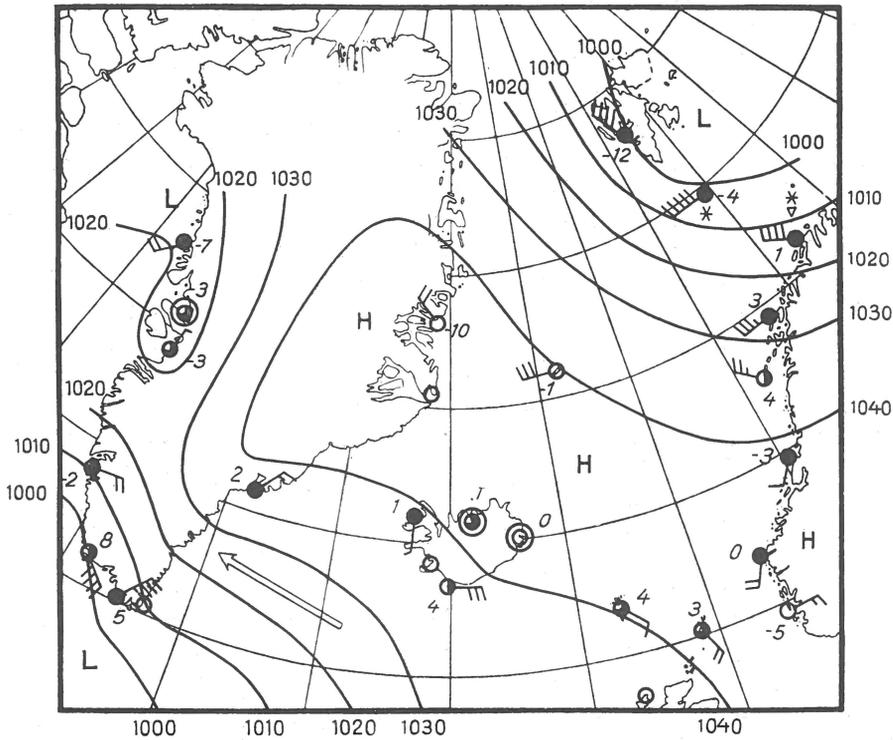


Fig. 51. February 10th, 1932, 07—11 h.

(fall of temperature from 1° to -12° in the course of the night before the 10th).

On the southwestern slope of the high pressure the advection of mild air to southern Greenland continues (Ivigutut SE 8, 8° C.).

February 24th, 1932.

The map for February 24th, 1932, shows the same type of weather as the other two maps for the same month, and the pressure distribution resembles in a remarkable degree the highly abnormal average distribution for the whole month (see Fig. 4a). On the western and northern slopes of the strong anticyclone centred off West Scotland very mild air is flowing northward over Greenland and the northern seas. A depression west of Spitsbergen and Bear Island is moving southeastward, and another, deeper, depression approaches southwestern Greenland from the south. Not only within the warm sectors, but also in front of and in the rear of the depressions the temperature far exceeds the normal; the greatest temperature anomaly—c. $+25^{\circ}$!—is found at Myggbukta, which has a fresh northwesterly wind with bright weather, a relative

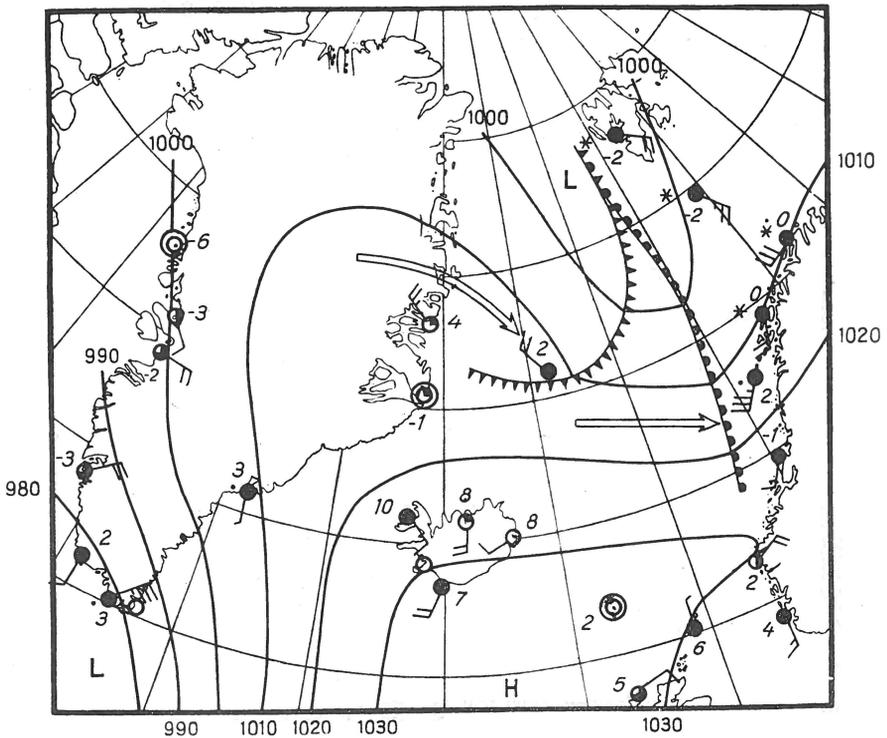


Fig. 52. February 24th, 1932, 16—18 h.

humidity of 50 per cent, and a temperature of $3\frac{1}{2}^{\circ}$ C.; evidently we are not here concerned with warm sector air, but with maritime polar air which has followed the depression from the western part of the North Atlantic and onwards across Greenland, where it has been foehned. The temperature is the highest ever measured at Myggbukta in the winter.

February 10th, 1933.

The figure shows a fairly strong high pressure west of Scotland, an almost stationary, rather deep depression north of the North Cape, and a northward-moving extraordinarily deep depression (c. 950 mb) off the west coast of Greenland, near Holsteinsborg. (The track of the last-mentioned depression can be traced back to the St. Lawrence River, the centre lying near Montreal on February 8th; it deepened very rapidly until reaching eastern Labrador, then more slowly.) Between the anticyclone and the Greenland depression mild air is transported northward; by climbing above the cold air it gives snowfall at Angmagssalik and Kangerdlugssuak. The warm front seems to extend approximately from Angmagssalik to Umanaq, which has 0° ; Upernavik reports -21°

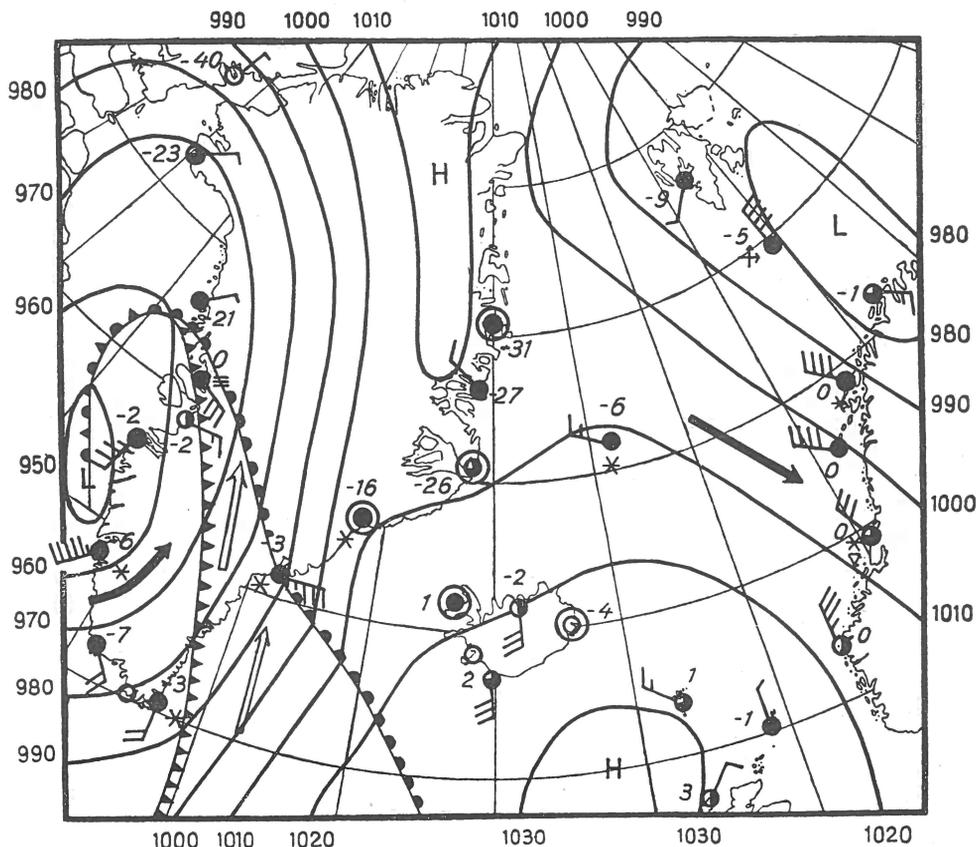


Fig. 53. February 10th, 1933, 10—13 h.

at 11 h., but later on the temperature here rose to -6°C . for a short period. In the rear of the depression colder air from Labrador has invaded southwestern Greenland, Godthaab thus reporting SW 11 and a temperature of -6°C .

February 11th, 1933.

On comparing the map for the 11th with that for the 10th of February it will be seen that the British high has only changed slightly during the intermediate twenty-four hours, while both the depression north of Norway and that situated off the west coast of Greenland have filled up considerably. The lowest pressure, c. 970 mb, is now found near the east coast of Greenland off Myggbukta. A closer inspection shows that this depression has developed near Angmagssalik on the east coast of Greenland, probably at the occlusion point of the frontal system of the West Greenland depression; orographic conditions have probably been of importance on its formation. The cold front has now passed Iceland and Jan Mayen; although the air behind this front—originating from La-

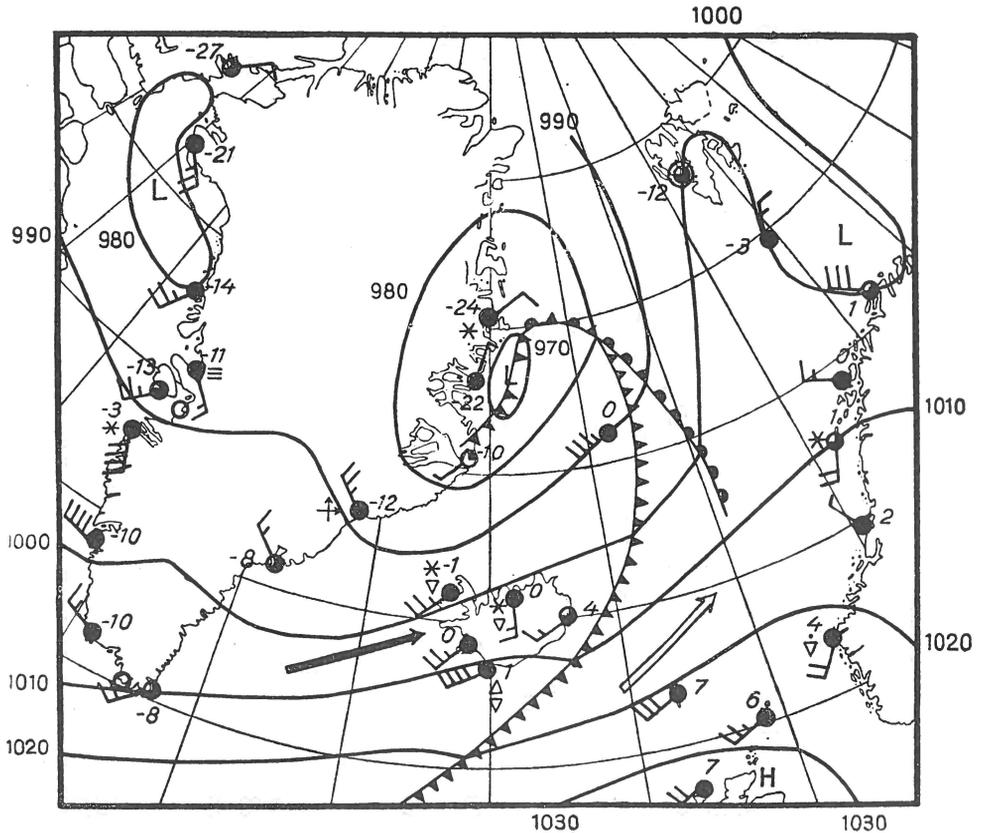


Fig. 54. February 11th, 1933, 10—13 h.

brador—has been heated on its way to c. 0° in the lower layers, its arctic character is revealed by the showers of hail and snow in Iceland.

February 13th, 1933.

The depression between Myggbukta and Jan Mayen referred to on the preceding page moved slowly eastward, and on the 13th reached the sea northwest of the Lofoten. On its southwestern side arctic air is flowing south towards western Europe; on the coast of Northeast Greenland the temperature has risen considerably, evidently because milder air has moved around the northern side of the depression. Simultaneously with and after this rise of the temperature there was a rapid and prolonged rise of the barometer—at Myggbukta totalling 40 mb in twenty-four hours. A fresh depression, on the 11th February centred off the east coast of the United States, has, while deepening, pushed as far north as Davis Strait; its centre (below 970 mb) is situated west of Godthaab. Like the previous low (p. 128) it gave rise to very violent pressure variations in eastern Labrador (c. 50—60 mb in twenty-four hours).

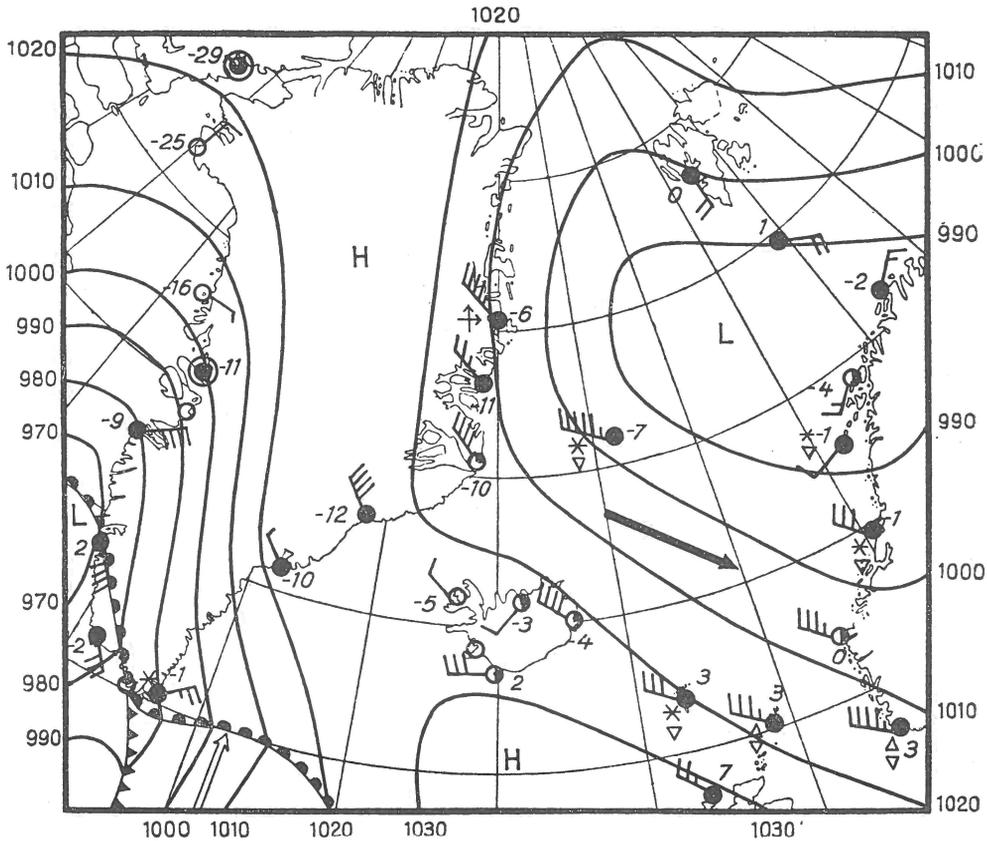


Fig. 55. February 13th, 1933, 10—13 h.

Between this depression and the high centred south of Iceland a current of mild air again flows across South Greenland. The resemblance with the map for February 10th is striking, but it is worth noticing that in this case there did not follow a cyclogenesis off the coast of southeastern Greenland.

February 17th, 1933.

As regards the pressure distribution over Greenland this map shows great resemblance to the preceding one, although the pressure is somewhat higher over East Greenland. The deep depression situated off Godthaab has its centre near the extreme southeastern part of Baffin Land, where an unusually low pressure value (950 mb) is registered; just as exceptional is the pressure difference between Angmagssalik and Godthaab (54 mb; distance between the two stations not quite 700 km). From the sea near the Azores mild air is flowing rapidly north-westward to Southwest Greenland, where Godthaab has a temperature of 4° C., and onwards to the west; a station on Baffin Land north-west of the centre of the low (Pangnirtung, c. 66° N., 66° W.) has only

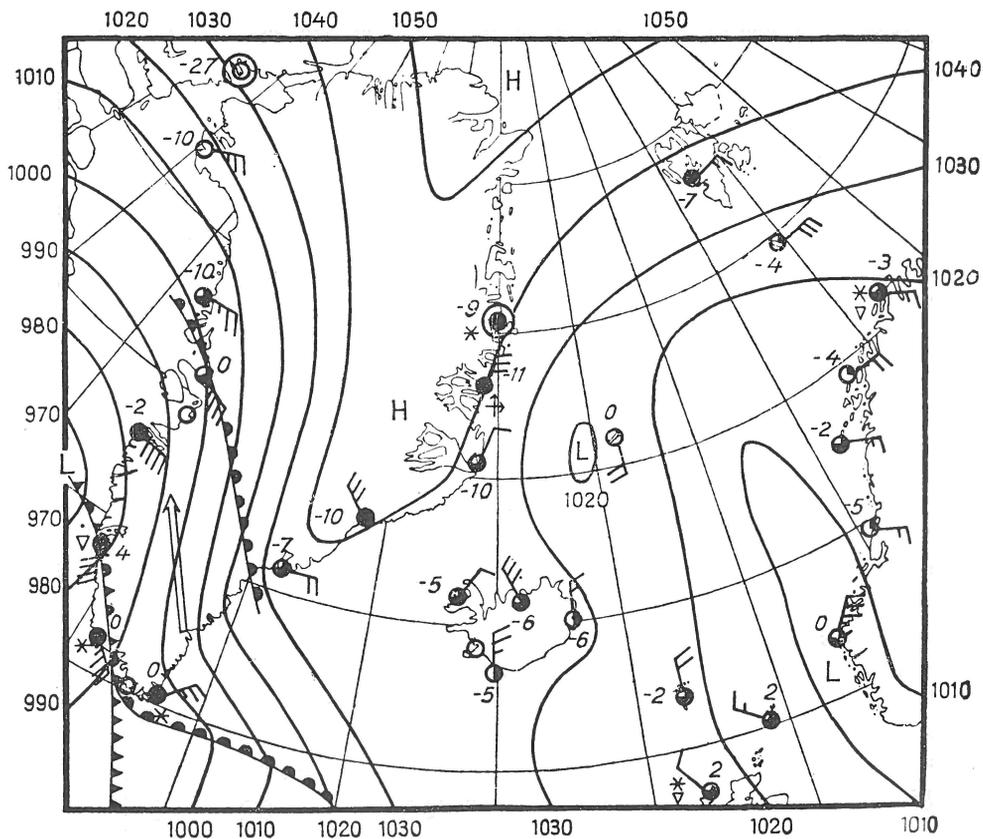


Fig. 56. February 17th, 1933, 10—13 h.

—2°, while another station situated 400 km farther southwestward (Lake Harbour, 63° N., 70° W.) reports —27° C. In accordance with this highly asymmetrical temperature distribution the depression moved westward to Boothia Felix, at the same time filling up so rapidly that the pressure at the southeastern part of Baffin Land rose c. 60 mb in twenty-four hours.

Along the coast of Northeast Greenland these violent events were not much felt; here the advection of fairly mild air from the sea north of Norway continued.

February 5th, 1934.

The deep storm centre seen in the figure north of the Lofoten about twelve hours earlier passed just north of Jan Mayen. The accompanying cold front passed Jan Mayen at the beginning of the day (at 1 h.: —0.2°, at 7 h.: —5.1° C.) and has now reached the Faroes and central Norway. On the northern side of the depression fairly mild air has flowed westward to Jan Mayen, which has now a very strong northerly gale (force 11)

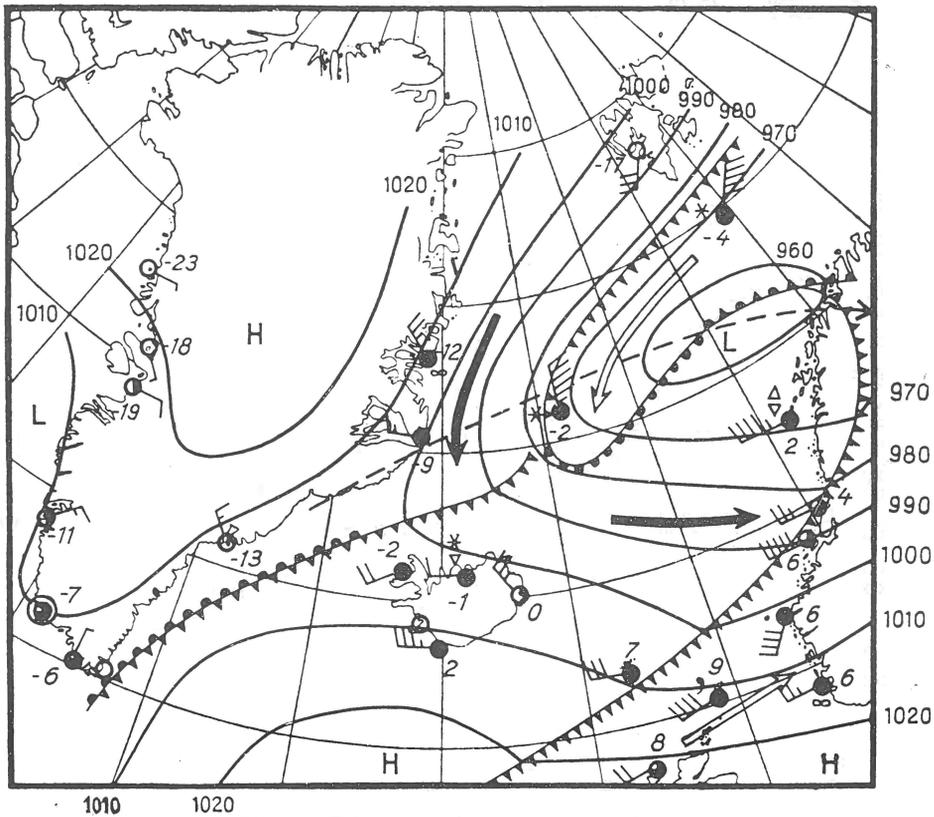


Fig. 57. February 5th, 1934, 15—18 h.

with a temperature of only -2°C . The arctic air between Northeast Greenland and Spitsbergen, however, moved southward in the course of the night; at Jan Mayen the barometer rose 25 mb in 7 hours (44 mb in 18 hours), and at 7 h. next morning the temperature was -8°C .

In the morning of the 5th Myggbukta had northwesterly gale. In the night before the 6th the wind dropped entirely and the weather cleared with the result that the temperature fell to -20°C .

A fresh, less strongly developed depression passed southern Iceland in the afternoon of the 6th, moving east; its influence was felt in Scoresbysund, but not at Myggbukta or Jan Mayen. A third depression, following the same track twenty-four hours later, on its way to southern Scandinavia developed into a storm centre, which i. a. brought an exceptionally violent westerly gale over Denmark on February 8th.

February 9th, 1935.

On the northwestern slope of an anticyclone over the European continent mild maritime air flows northward over the northern seas.

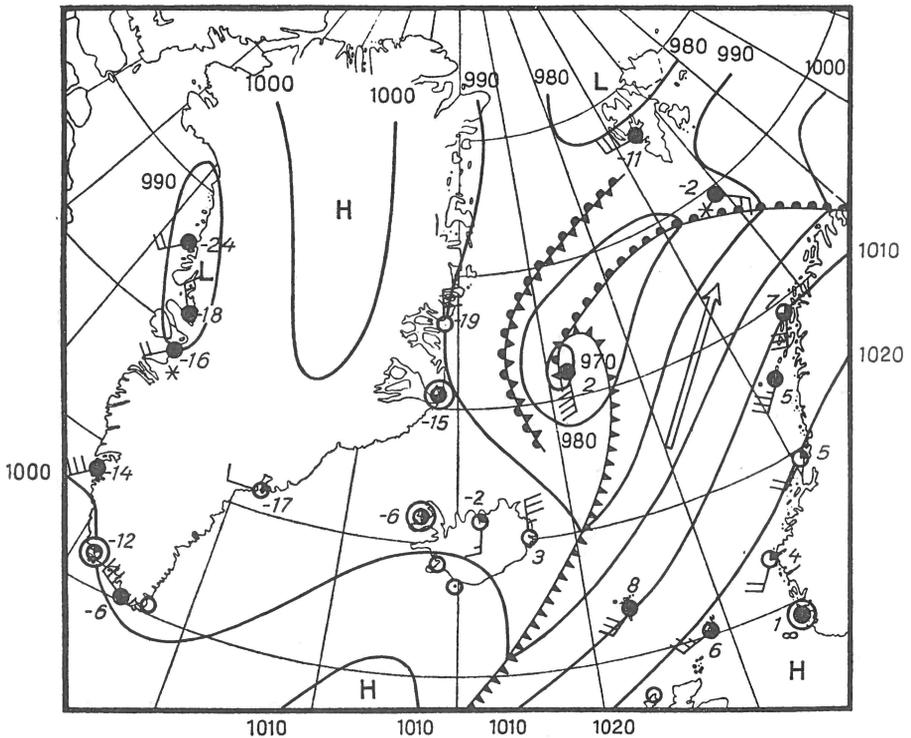


Fig. 58 a. February 9th, 1935, 07—11 h.

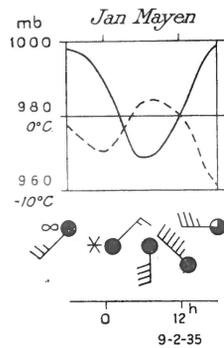


Fig. 58 b. (Cf. Fig. 40 b, p. 112).

On the well-defined front separating this mild air from the arctic air over Greenland and near Spitsbergen, a wave, which has already developed into a cyclone, has formed north of Iceland; the centre of this cyclone is situated just west of Jan Mayen and is moving rapidly towards the east-northeast, reaching Bear Island at 18 h.

The accompanying diagram shows the extremely rapid pressure variations and the great temperature variations experienced at Jan Mayen during the passage of the low.

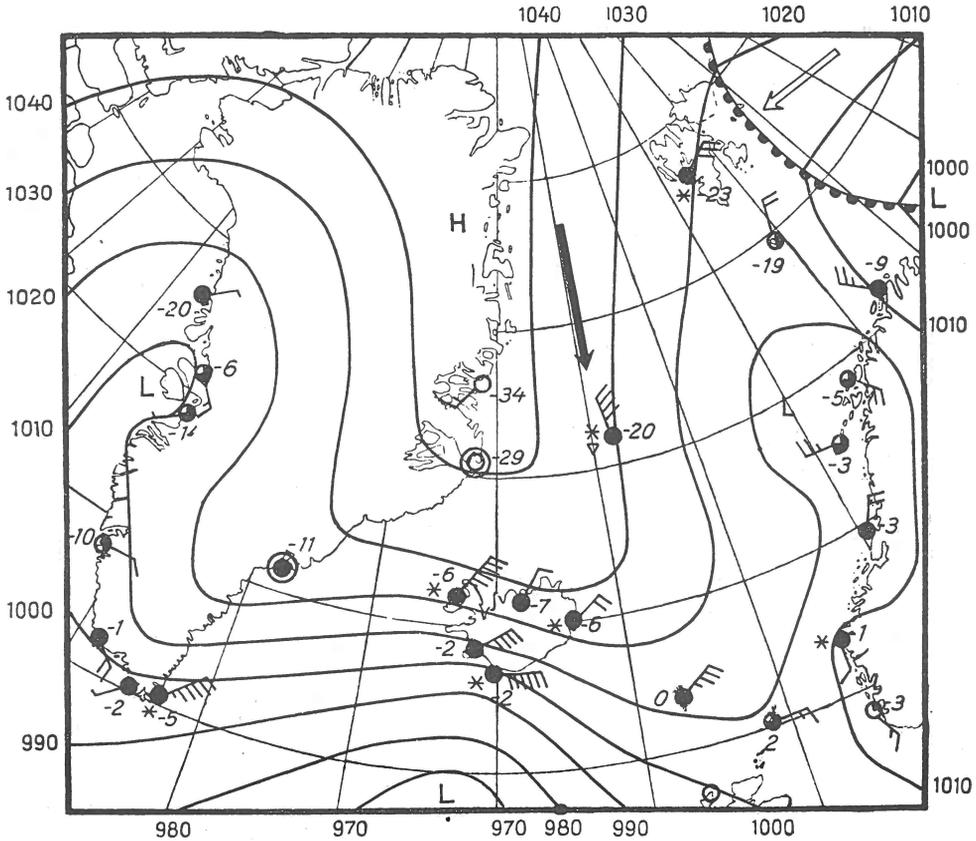


Fig. 59. February 25th, 1937, 07—11 h.

The development described here is, on the whole, typical of the cases, especially frequent during the winter half-year, in which a wave forms on a front which separates mild (in some cases subtropical) maritime air over the southern part of the northern seas from arctic air (at the height of the summer: polar air) over the sea between Northeast Greenland and Spitsbergen.

February 25th, 1937.

The weather situation is characterised by a strong stationary anticyclone over Northeast Greenland and a deep, likewise stationary, depression situated c. 1000 km west of Scotland. On the eastern side of the high, arctic air invades the area near Jan Mayen, which during the whole day and night had a temperature of -20 — -21°C .—the lowest temperature registered at Jan Mayen in the years 1922—38¹⁾. At Spitsbergen and Bear Island, also, the temperature on February 25th ranges

¹⁾ On Dec. 30., 1882, a temperature as low as -30°C . was measured here. On this occasion the winds were light and the weather almost cloudless.

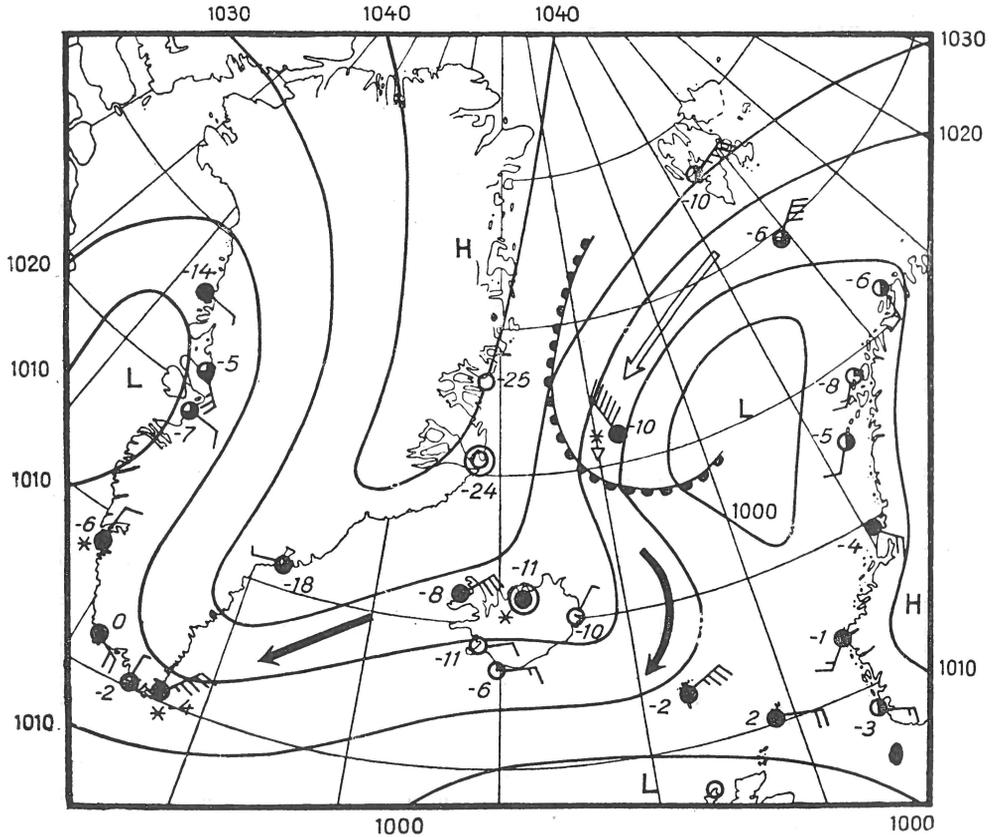


Fig. 60 a. February 26th, 1937, 07—11 h.

about $-20^{\circ}\text{C}.$, but here the frost has begun to decrease; on the preceding evening Spitsbergen had -28° , while Bear Island had $-23^{\circ}\text{C}.$ in the night.

Remarkable is the very steep pressure gradient and the corresponding very high force of the wind in Iceland (Akureyri 1027 mb, Vestmannaeyjar—barely 300 km farther south—997 mb; Bólungarvík NE 11, Vestmannaeyjar E 12); the gradient and the force of the wind culminated about the time for which the map was drawn.

February 26th, 1937.

The high pressure over Northeast Greenland is almost unaltered, while the depression south of Iceland has filled up somewhat; the gradient and the force of the wind near Iceland have decreased considerably. The rise in the temperature which had commenced at Spitsbergen and Bear Island on the previous morning has continued and in the course of the night has advanced as far as Jan Mayen. The accompanying curves show that at the station on Spitsbergen (Isfjord radio) the rise amounted

to c. 19° in twenty-four hours and at Jan Mayen to 11° in thirteen hours and subsequently further 5° in five hours. At the same time Fig. 60b shows that the pressure remained fairly constant at Spitsbergen, while a considerable fall set in at Jan Mayen in the night before the 26th. It will be seen from the weather map that the weak low situated near the Lofoten on the previous day has deepened a good deal and approached Jan Mayen, where the wind has increased to a gale from the NNW. Later on the depression moved southward, amalgamating on the

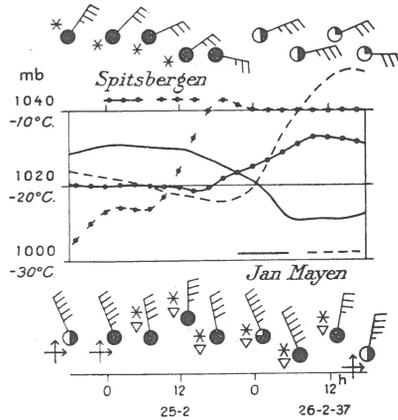


Fig. 60b. Variations of pressure (full lines), temperature (broken lines) and weather at Jan Mayen and Spitsbergen, February 25th—26th, 1937.

following day with the Atlantic depression. The warm front reached Iceland in the night before the 27th; at Seyðisfjörður the temperature rose from -12 to -4° C.; in the course of the 28th thaw set in on the Faroes, with gale from the NNE.

By means of a retrograde analysis the air behind the warm front can be traced back to Franz Josefs Land (-31° at 1 h. of the 24th, -12° at 1 h. of the 25th). It seems to have come there from the south, for on the 23rd—24th a strong southerly wind blew over most of Russia.

March 23rd, 1938.

Within a low pressure trough extending from Spitsbergen to the western part of the North Atlantic and forming the boundary between arctic air and mild maritime air, a northeastward-moving deep storm centre developed near Iceland on the 22nd March; on its front Jan Mayen had a north-northeasterly gale reaching hurricane force with a rather heavy fall of snow. Although the centre passed south and east of Jan Mayen, the temperature here rose to the freezing point for a short time. The lowest pressure, 956 mb, occurred at about 1 h. of the 23rd; a still lower pressure has been registered some few times in the months Novem-

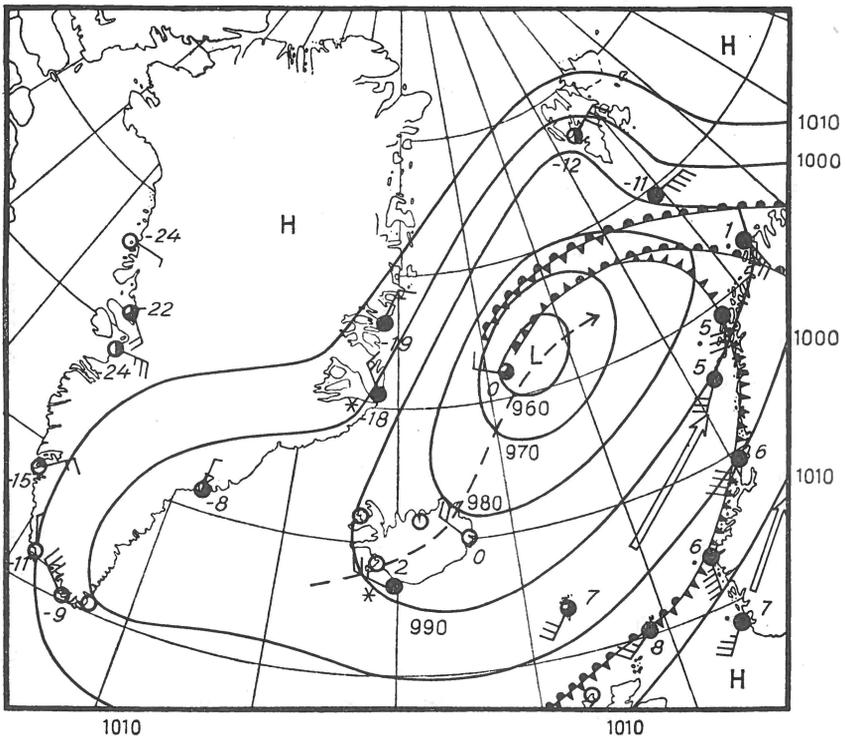


Fig. 61. March 23rd, 1938, 10—13 h.

ber—February. In the rear of the storm centre, arctic or polar air advanced as far as northern Scotland and central and northern Scandinavia; the occlusion front became stationary a short distance south of Bear Island.

March 1st, 1940.

The deep depression seen in the figure off the coast of Northeast Greenland developed off the southern part of the east coast on February 29th at the same time as a very deep depression moved northward along the west coast of Greenland.—A narrow warm sector is still seen between the Faroes and Norway, but apart from this the frontal system of the depression has occluded, and the occlusion front has passed Bear Island in the course of the forenoon. The cyclone gave rise to great pressure variations at Scoresbysund (a fall of 40 mb in twenty-four hours succeeded by a rise of 33 mb in twenty-four hours), whereas the temperature at the ground did not vary very much and did not rise above -9°C . At Jan Mayen the temperature rose, as the depression approached, from -14°C . to 0° in the course of twenty-four hours, but after its passage fell 11° in fifteen hours, as the North Greenland arctic air invaded these regions.

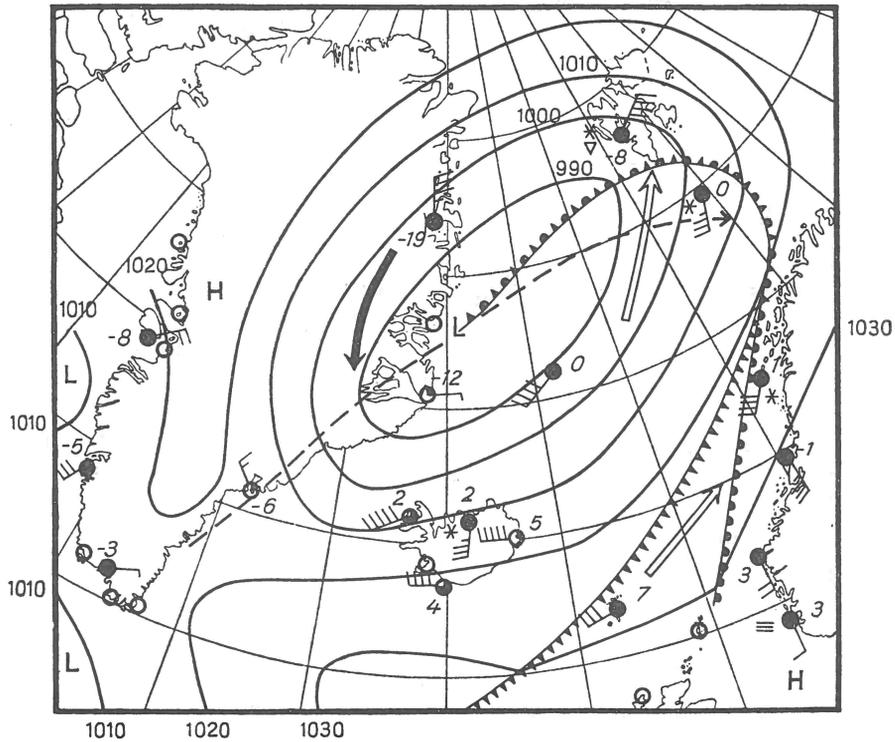


Fig. 62. March 1st, 1940, 13—17 h.

April 10th, 1933.

The figure shows a rather strong anticyclone over Baffin Bay and an intense, though not particularly deep, northeastward-moving depression between Jan Mayen and northern Norway. In the rear of the depression there is a strong northerly gale; at 7 h. Jan Mayen reported N 12, and the highest velocity of the wind registered is stated to be 84 m/s, a quite exceptionally high value.

The determination of the gradient field over the northern seas by means of the scanty material of observations that is available is, of course, attended with a considerable uncertainty. Apart from the very high force of the wind recorded from Jan Mayen, there is no indication that the gradient was steeper in the case here described than in many other similar situations. It may be imagined that the velocity of the wind has for some reason or other been exceptionally high in relation to the gradient.

May 22nd, 1936.

On the northern side of a high pressure over the North Atlantic mild air is flowing up over southeastern Greenland. A depression, which

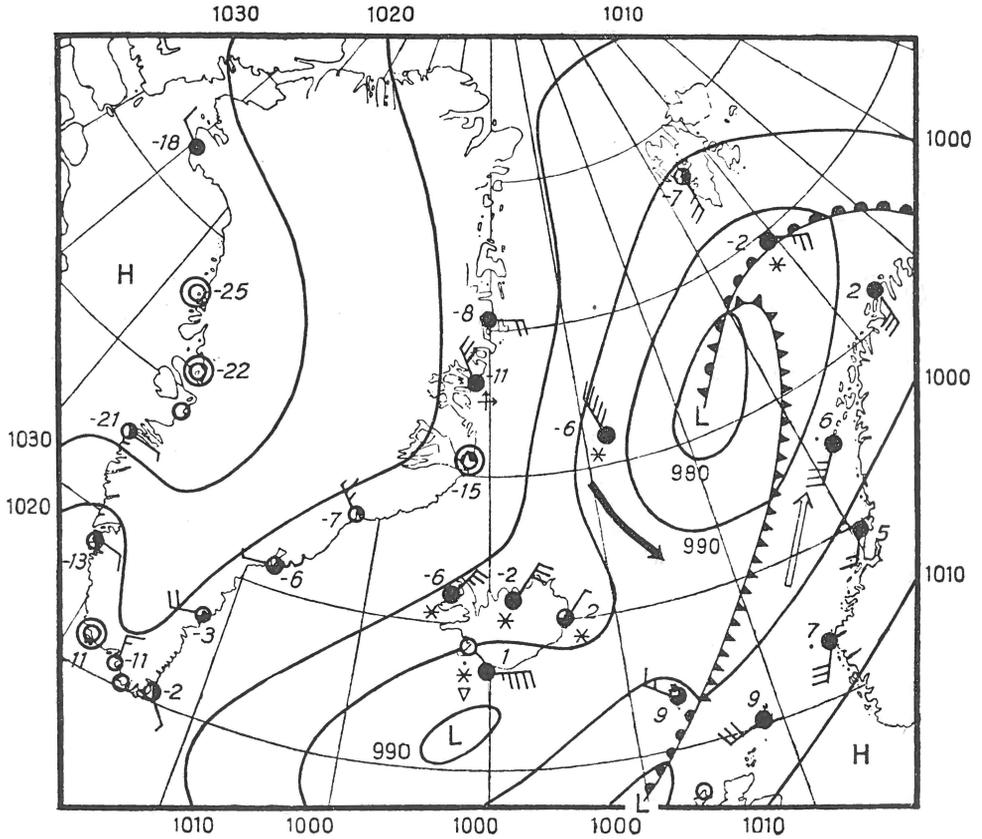


Fig. 63. April 10th, 1933, 10—13 h.

on the previous evening was situated near Disko, seems to have moved northeastward in the course of the night; the barometer is falling at Myggbukta and Scoresbysund, but rising at Jakobshavn, Umanaq, and Upernavik.

May 23rd, 1936.

The depression mentioned on the preceding page has now almost reached the east coast of Greenland near Myggbukta. The warm front of the depression seems to have passed Iceland, and the cold front probably extends from the centre of the depression through the Denmark Strait to Kap Farvel. The bright weather at Scoresbysund and Myggbukta is remarkable; the explanation is probably that the air within the warm sector has been foehn'd during its passage over the inland ice.—At East Iceland a temperature of 18°C . was registered late in the evening; here, also, we are concerned with the effect of a foehn.

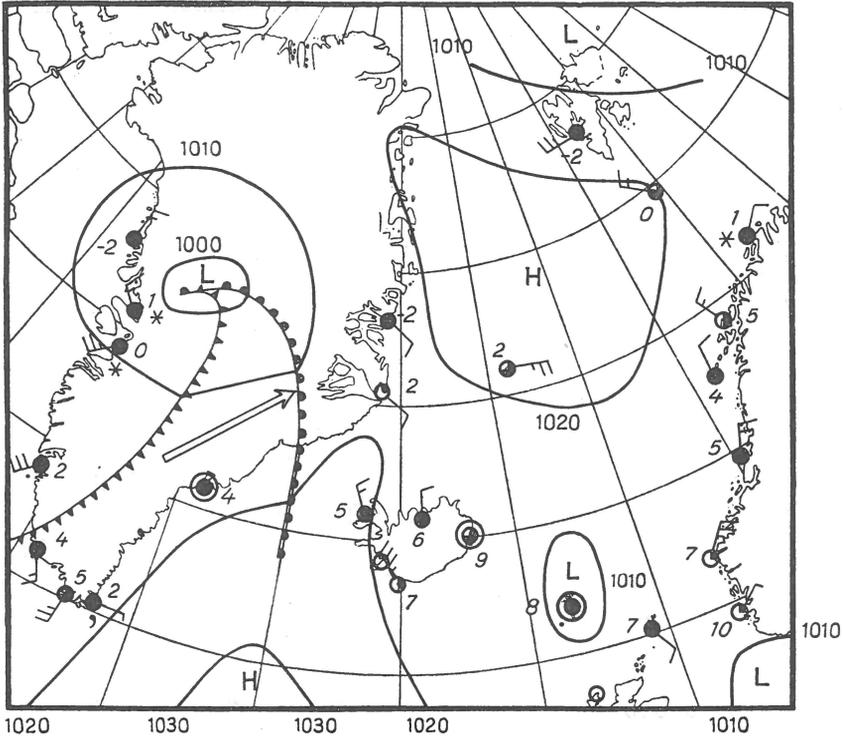


Fig. 64. May 22nd, 1936, 07—11 h.

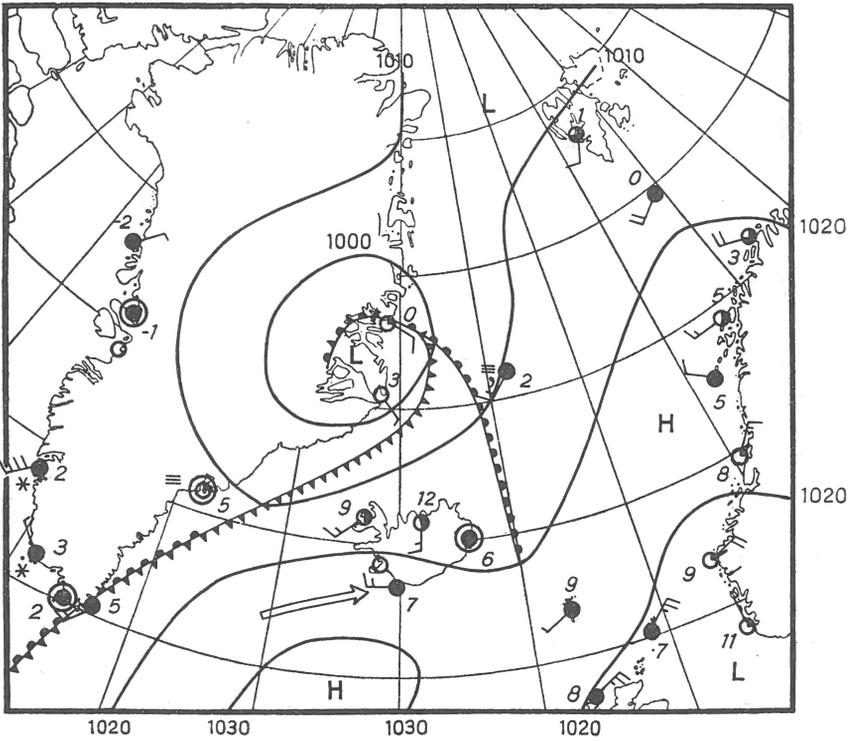


Fig. 65. May 23rd, 1936, 07—11 h.

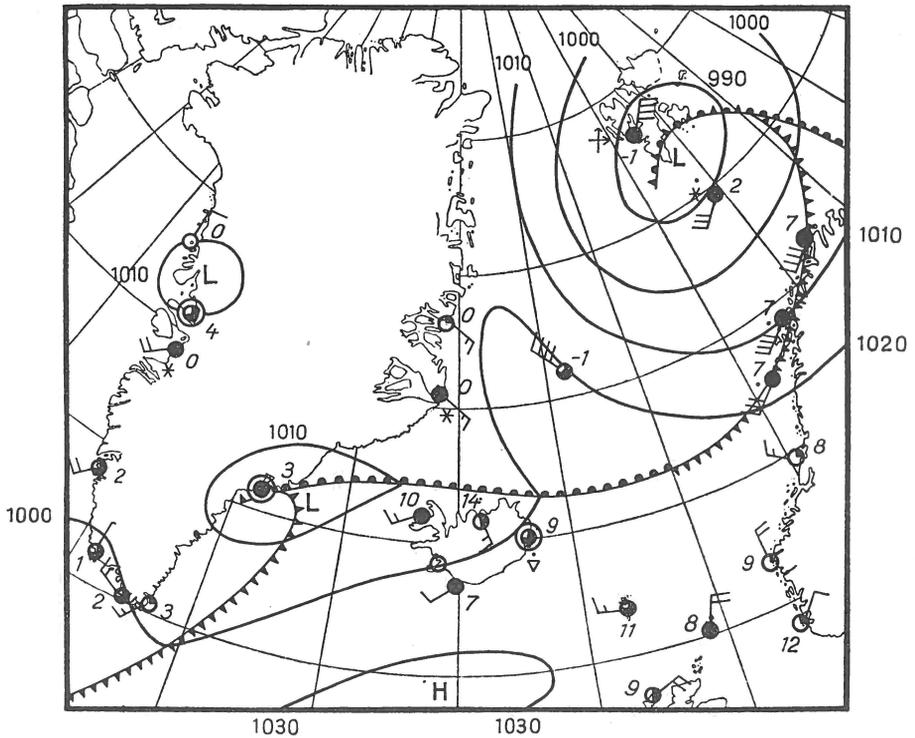


Fig. 66. May 24th, 1936, 07—11 h.

May 24th, 1936.

The depression which passed the east coast of Greenland a little north of Scoresbysund on May 23rd has now reached Spitsbergen; meanwhile it has deepened to c. 985 mb, and in its rear cold air has pushed as far as the coast of northern Norway. The southern limit of the cold air mass extends from northern Norway off the north coast of Iceland to Angmagssalik, where it bends southward. As on the preceding day the temperature rose to 18° C. at Seyðisfjörður in East Iceland.

June 16th, 1932.

The weather map for June 16th, 1932, shows a typical quiet summer situation. The pressure is high from the North Atlantic over Scotland to Norway, while several slightly developed lows are situated along the coasts of Greenland. The map has been included here owing to the very high temperature at Myggbukta, viz. 19° C.; this is probably due to an interaction of several factors: advection of mild air from the south or southwest (except in the lower air layers), a rise of the temperature owing to foehn influence during the passage of the air across part

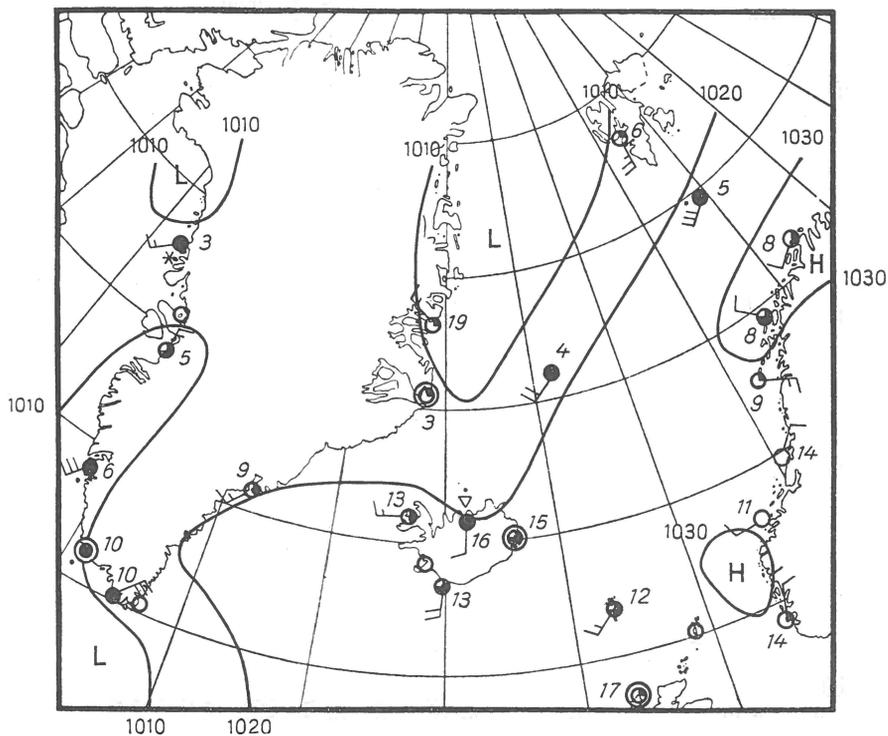


Fig. 67. June 16th, 1932, 16—18 h.

of the inland ice, e. g. from Angmagssalik to Myggbukta (the relative humidity is stated to be 26 per cent), and an intense irradiation during the whole day and night. Only once has a still higher temperature been measured at Myggbukta (see p. 145).—Twenty-four hours previously Myggbukta had easterly wind with fog and a temperature of only 1° C.

Some few days earlier, on June 6th, a similar sudden rise of temperature was registered in the same place; at 13 h. the temperature was -0.3° , with a light easterly wind and cloudy weather, but at 18 h. it was 13.6° C. with a fresh northwesterly wind and clear weather. Weather changes of this kind (as also changes in the opposite direction) are characteristic of the summer months in these coastal tracts, though they are rarely so intense as those mentioned here. In winter and spring the setting in of a foehn wind may cause still greater rises of temperature (see p. 68).

June 25th, 1937.

The map shows a very intense cyclone (c. 965 mb) which has developed over the Denmark Strait and is now situated northeast of Jan Mayen. Noticeable is the low temperature at this station (0° , while none

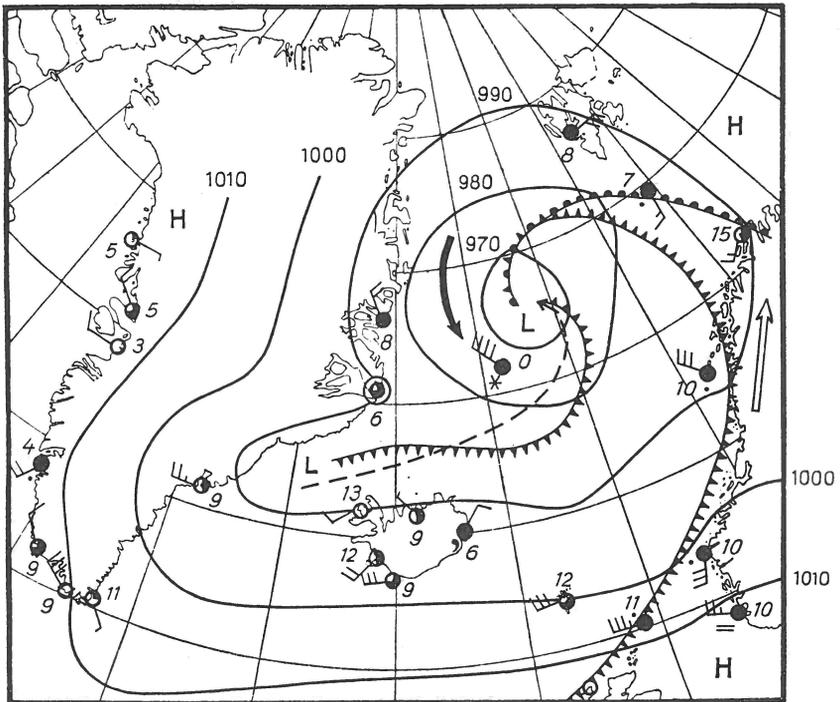


Fig. 68. June 25th, 1937, 18—24 h.

of the nearby stations have less than 6°); the great force of the wind and the snowfall indicate that we are not concerned with a thin bottom layer beneath an inversion, but with a layer of no inconsiderable thickness (order of magnitude 1 km) in which the vertical gradient of the temperature is approximably that of the moist adiabatic. The explanation may be that the cold bottom layer over the Arctic Sea is piled up owing to the convergence in the interior of the low-pressure area; to this must be added the adiabatic cooling due to the horizontal movement towards a lower pressure, viz. c. 1° per 13 mb.

As late as in the evening of June 27th the weather situation was almost unaltered; Jan Mayen then reported NW 12 with showers of snow and a temperature of 0° C. It was not till the following twenty-four hours that the depression moved away, slowly filling up, to the northeast.

July 25th, 1929.

The accompanying map, just like Fig. 67, shows a quiet summer situation; over Greenland and the northern seas—apart from a stretch along the Norwegian coast—the pressure differences are very small and the wind conditions very quiet. Along the coast of Greenland the weather

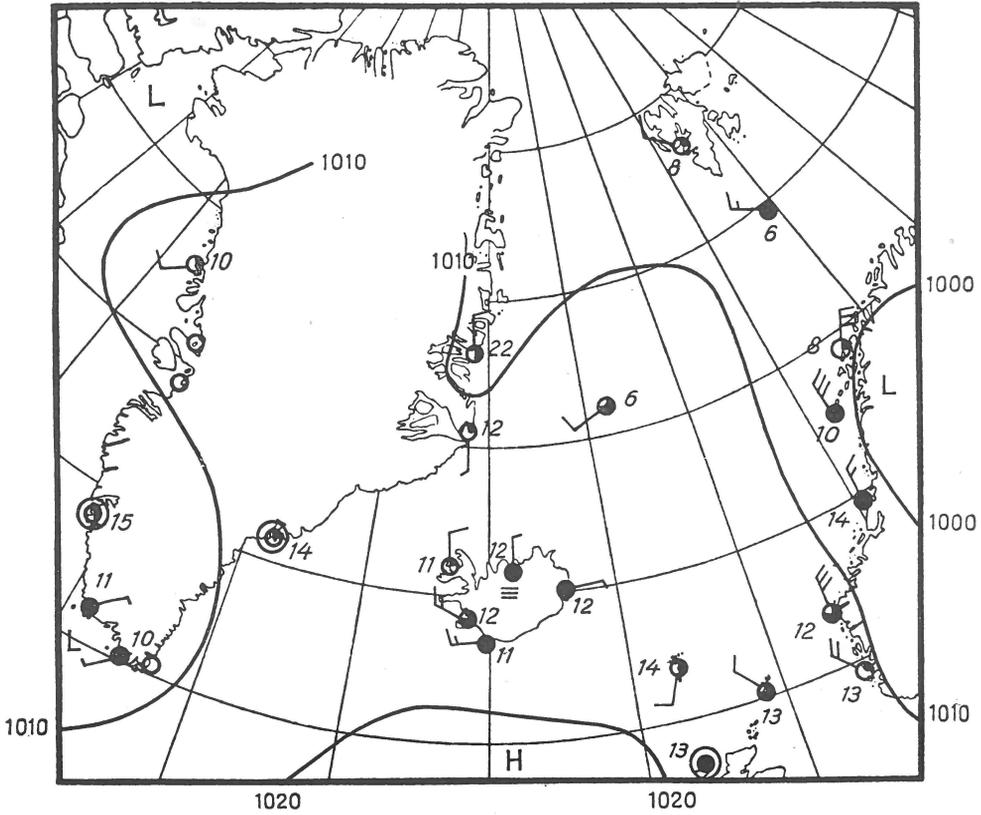


Fig. 69. July 25th, 1929, 13—17 h.

is generally mild; at Myggbukta it is even exceptionally mild, the temperature here being 22°C .; the maximum temperature of the day, 23°C ., is the highest known from this station. The remarks on p. 142 about the causes of the high temperature also apply in this case.

July 8th, 1930.

A well defined, but not particularly deep depression is centred between Jan Mayen and Myggbukta; on its northern side warm continental air from northern Russia (where Archangel had 27°C . on the preceding evening) flows towards the east coast of North Greenland, where it brings a good deal of rain by climbing over the polar air which is still present in the lower layers; the station Sandodden (north of Myggbukta) reported a rainfall of 20 mm in the period 7 h. on the 7th to 7 h. on the 9th, in part accompanied by a strong northerly gale.

The depression is moving westward—in accordance with the air being warmer on its northern than on its southern side; in the morning

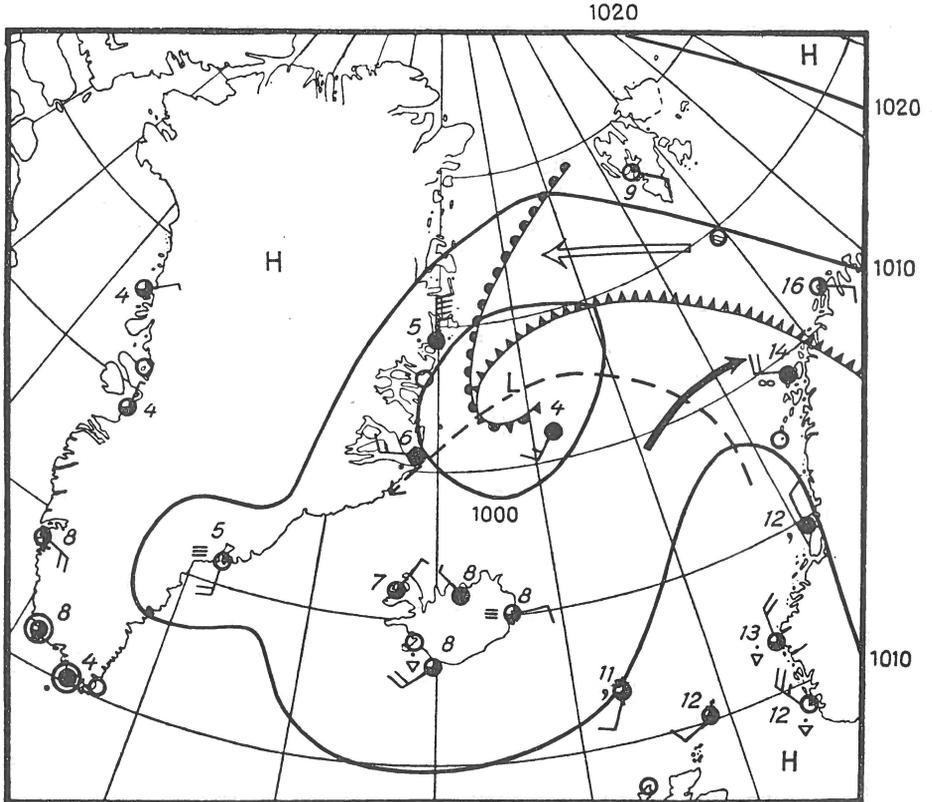


Fig. 70. July 8th, 1930, 07—11 h.

of the previous day it was situated west of the Lofoten, and in the evening of the 8th it passed Scoresbysund. This direction of movement as well as the temperature distribution described are rare or very rare.

July 28th, 1936.

The figure shows an intense depression centred between Jan Mayen and the Lofoten; it developed on the 24th near the Alps and moved over eastern Germany and southern and central Sweden to the sea northwest of the Lofoten, where it is now almost stationary.

Although the depression does not seem to have been accompanied by disturbed weather conditions over large areas, the wind at Jan Mayen increased to hurricane force blowing from the northwest; at the same time there was an excessive rainfall—more than 100 mm in thirty-six hours, 71 mm of which fell in the time from 7 h. to 18 h. of July 28th.

It is natural to assume that on the eastern side of the depression air with a very high absolute humidity has travelled from the Danube

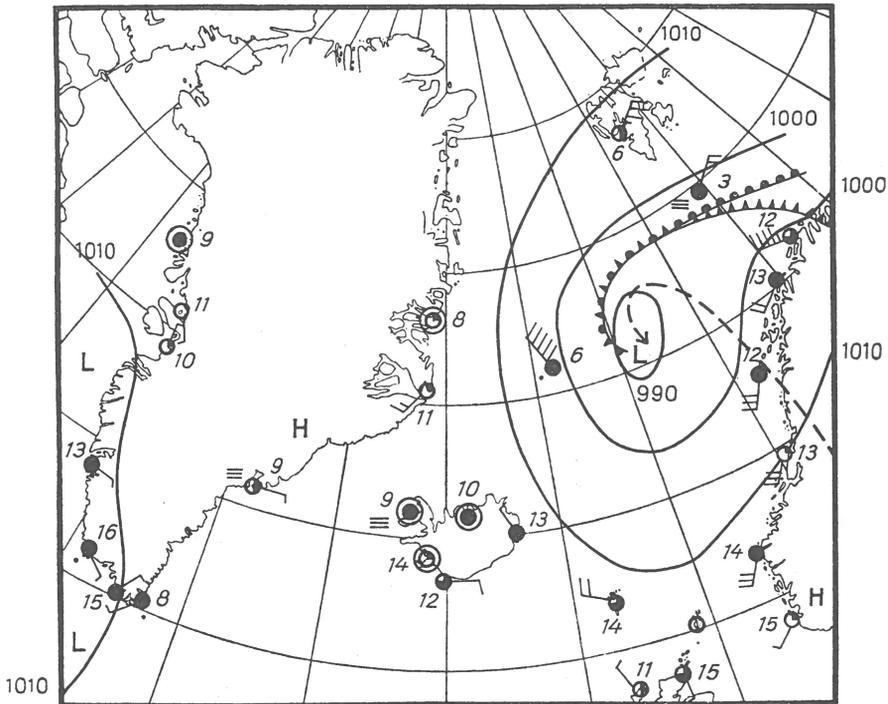


Fig. 71. July 28th, 1936, 07—11 h.

area across the Baltic regions and northern Scandinavia to the sea near Jan Mayen, but orographic conditions may have been a contributive cause of the exceptionally large amount of precipitation at this place.

August 24th, 1929.

A rather intense, almost stationary depression is situated east of Iceland. Warm and rather humid air flows from Scandinavia towards Jan Mayen, where the temperature is 14°C ., though the sky is overcast and some rain has fallen.

A temperature of 14°C . is very rare at Jan Mayen; the absolute maximum in the period 1922—1937 is 15°C . (cf. p. 62). It is natural of ask whether any foehn influence may have contributed to the high temperature in the case dealt with here. The cloudiness is not suggestive of this, but on the other hand the humidity is rather low (68%), so the possibility of the presence of either a local foehn on Jan Mayen proper or a so-called “free foehn” (a rapid flow of air with a well-marked downward component) cannot be entirely excluded.

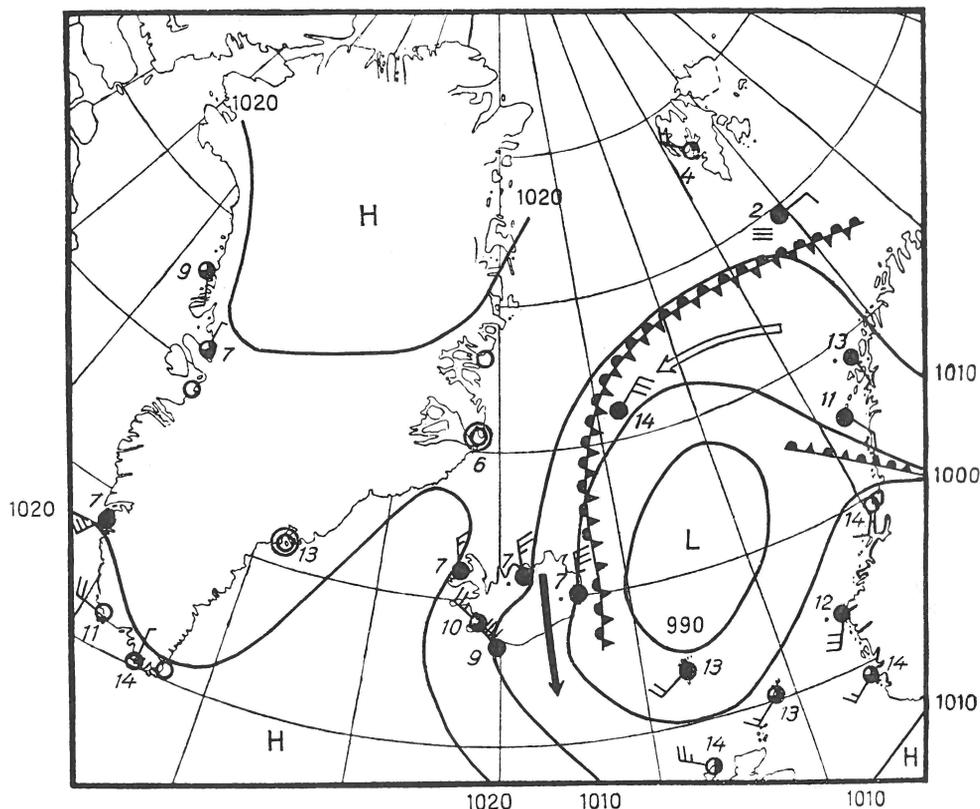


Fig. 72. August 24th, 1929, 13—17 h.

August 24th, 1937.

The figure shows the presence of a well developed northward-moving low over East Iceland. On the eastern side of the depression warm maritime air is flowing towards the north; Jan Mayen, which lies before the warm front, reports heavy rainfall, the total precipitation falling in the course of the night amounting to 8 mm.

August 25th, 1937.

The low mentioned on the preceding page passed Jan Mayen at a short distance in the morning of the 25th and is now situated between Myggbukta and Spitsbergen; Spitsbergen and Bear Island seem to lie within the warm sector; the cold front has passed the Faroes and the Shetlands, but has not yet reached the Norwegian coast. The pressure variations in connection with the passage of the low were very considerable for the season; after a fall of 18 mb in 18 hours there followed a rise of 21 mb in 18 hours.

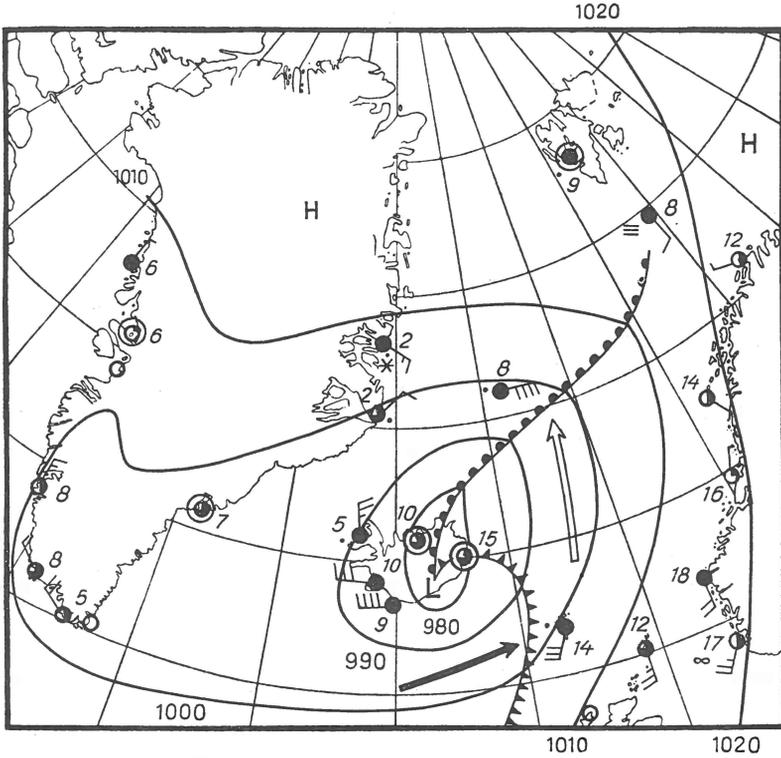


Fig. 73. August 24th, 1937, 18—24 h.

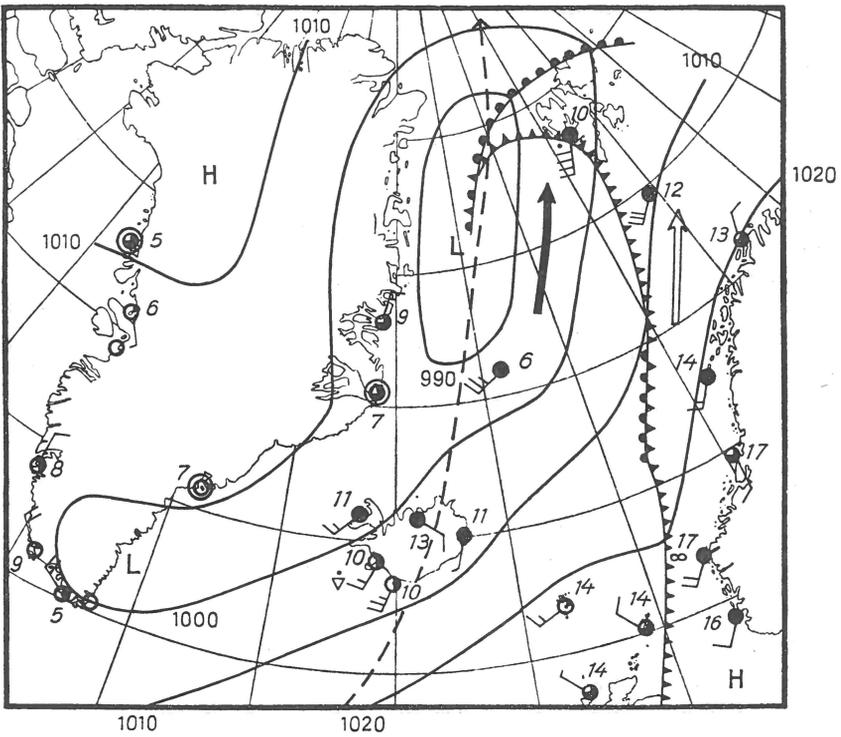


Fig. 74. August 25th, 1937, 18—24 h.

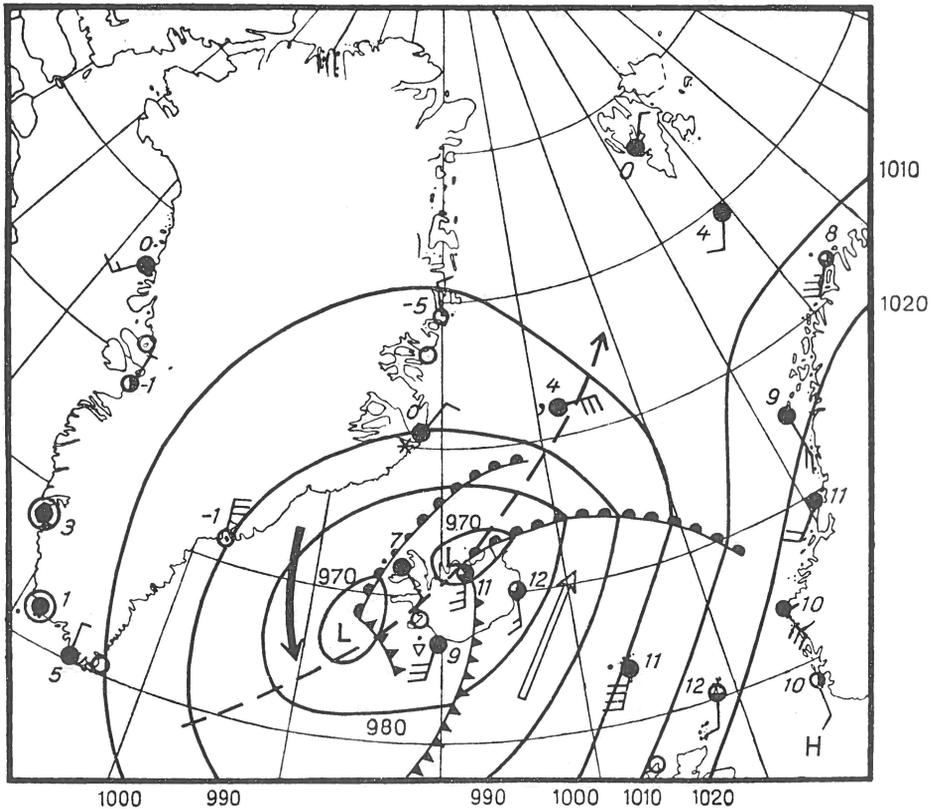


Fig. 75. September 17th, 1929, 07—11 h.

The low continued northward, and, as appears from observations made by the Russian North Pole Expedition, whose position at that time was still 88° N. lat., it passed the North Pole in the night before the 27th; the pressure at its centre was then still as low as c. 990 mb, and the fall of the barometer before the passage of the centre was just as great here as at Jan Mayen.

September 17th, 1929.

The figure shows a depression, very intense for the season and moving northeast, near Iceland; there seem to be two almost equally deep centres, one west of Reykjavik and another near Akureyri. The frontal system of the depression is somewhat problematic, but there seems to be a broad warm sector, comprising East Iceland and the sea between Iceland and the British Isles. In advance of the warm front a very rapid fall of the barometer was registered at Jan Mayen, and the

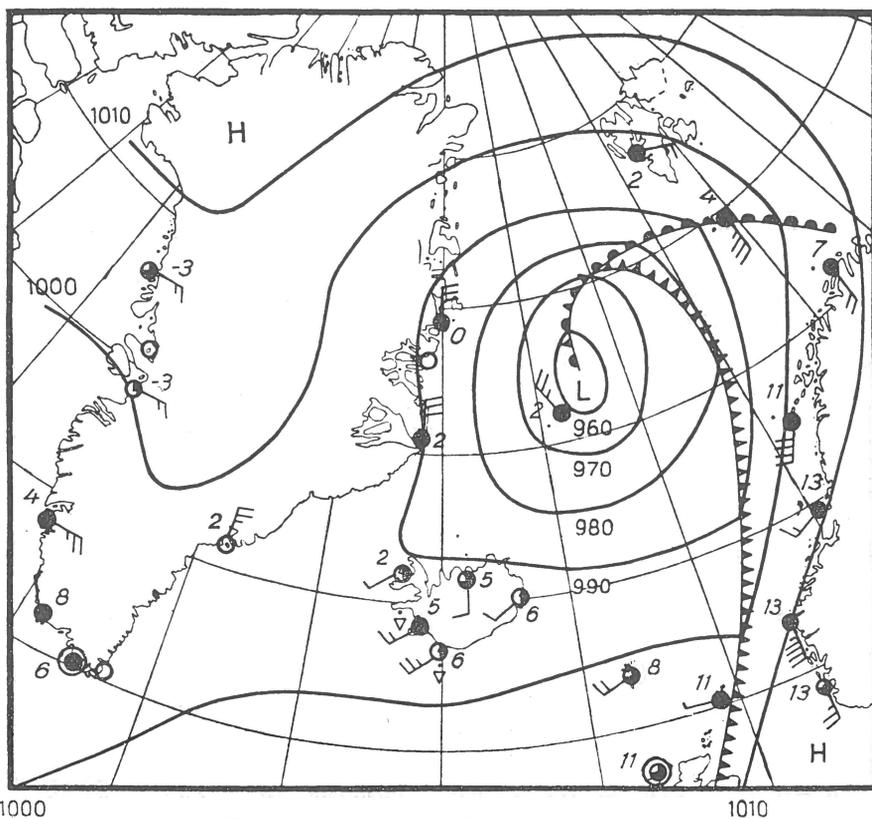


Fig. 76. September 18th, 1929, 07—11 h.

fall continued after the passage of the front; altogether the fall amounted to 26 mb in eleven hours and 38 mb in twenty-four hours. In the afternoon and evening the temperature rose to 6—7° C. At Scoresbysund there was a fresh northerly gale in the evening.

September 18th, 1929.

The cyclone which in the morning of the 17th was situated over Iceland has deepened to c. 955 mb and moved northeastward; its centre has passed Jan Mayen a short time before. The accompanying frontal system has occluded near the centre; the warm front seems to have reached Bear Island and Vardø, while the cold front runs from the sea northwest of the Lofoten to Scotland. The rise of the barometer at Jan Mayen in the rear of the depression was only rapid for a short time; then followed a slow rise, the cyclone remaining between Jan Mayen and Bear Island, and as late as the 21st it had only filled up to c. 980 mb. In

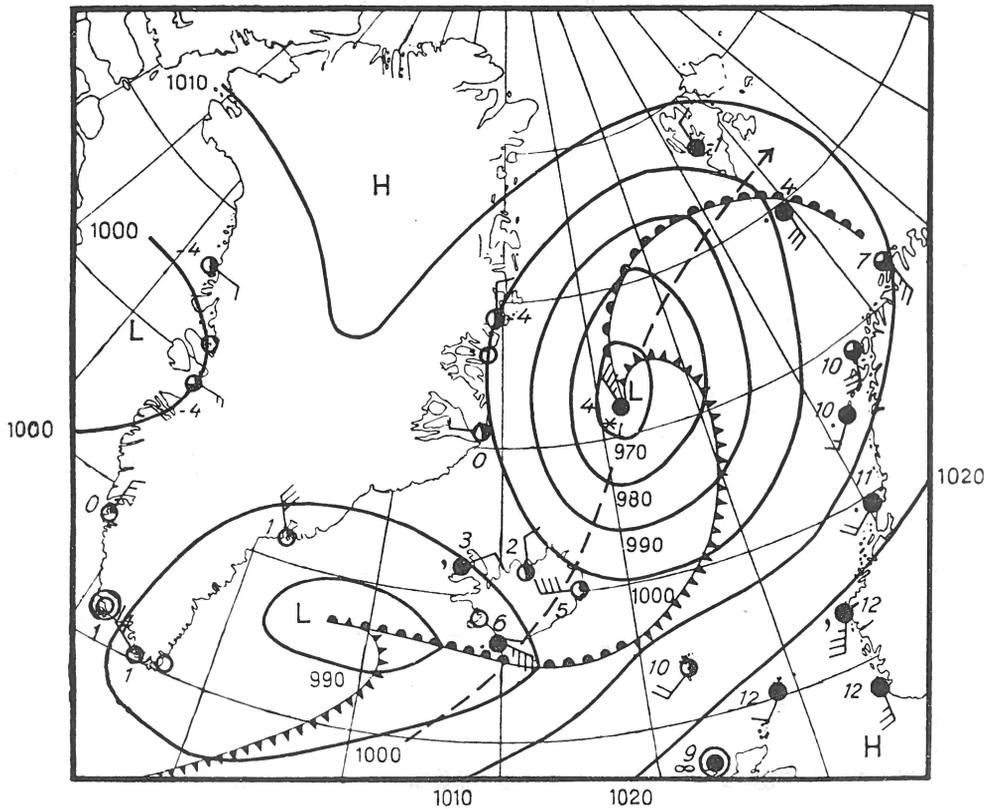


Fig. 77. September 24th, 1929, 07—11 h.

the rear of the depression cold air pushed south and southeast from Northeast Greenland to northwestern Europe, where the weather conditions in the days about the 20th were rather disturbed and showery.

September 24th, 1929.

The figure, like the preceding one, shows a deep and intense cyclone near Jan Mayen. The two maps also show a rather close agreement in regard to the track of the depression, but the cyclone dealt with here passed Iceland and Jan Mayen at almost twice as rapid a rate (c. 70 km/h) as the preceding one; accordingly, the pressure variations during its passage were exceptionally great (see Pl. 1 and the accompanying text). Thus at Jan Mayen the barometer fell, in front of the depression, 24 mb in 7 hours, while in its rear it rose 23 mb in 6 hours and subsequently further 13 mb in 5 hours; these pressure variations are by far the greatest that are known for the summer half-year, and even in the winter variations matching these have only occurred a very few times. In the same place the force of the wind rose to NE 12 on the front side of the

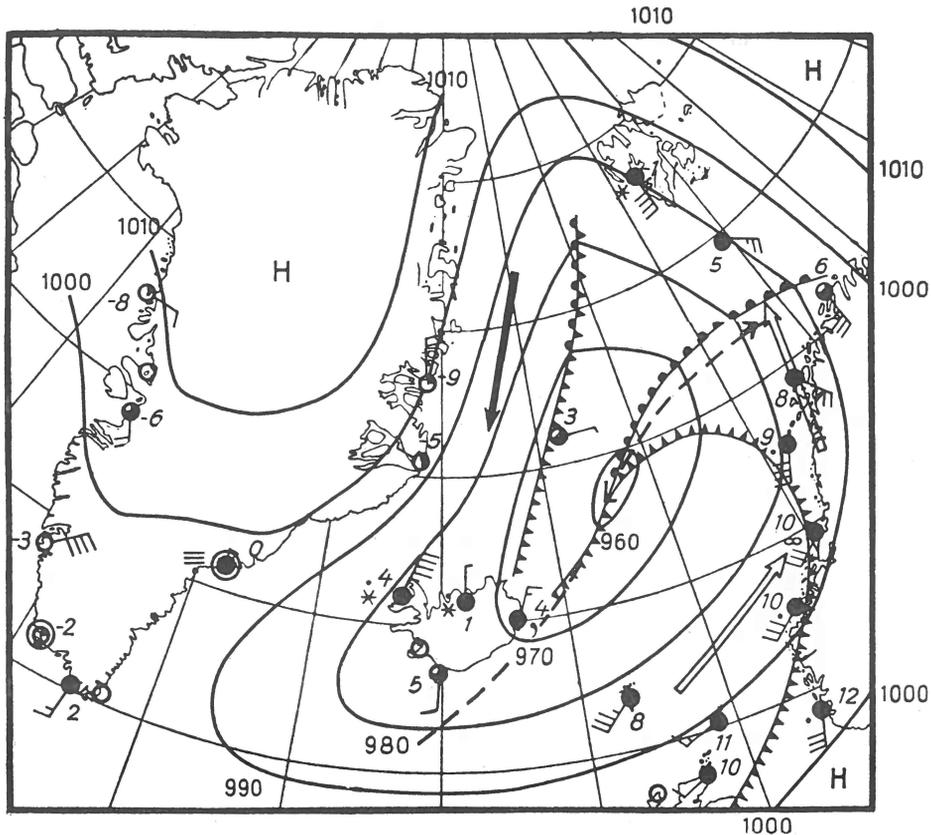


Fig. 78. October 2nd, 1931, 07—11 h.

depression and to NNW 10 in its rear; the temperature variations were rather inconsiderable, the temperature attaining a maximum of c. 4° C. almost simultaneously with the passage of the centre, but otherwise remaining about 0° . The most probable position of the fronts of the depression will appear from the figure; it will be seen that the cold front turns into a warm front again between Iceland and the Faroes, the top of a succeeding front wave being situated between southern Greenland and Iceland. This second front wave passed Isafjörður in the evening of the same day and reached Jan Mayen next morning, but in the meantime it had filled up to c. 1000 mb.

October 2nd, 1931.

The figure shows a northeastward-moving deep depression (c. 960 mb) southeast of Jan Mayen. The warm front of the depression seems to have passed northern Norway, while a primary cold front has advanced to the coast of central Norway and Scotland. However, the air behind this cold front is not much colder than the air within the warm sector,

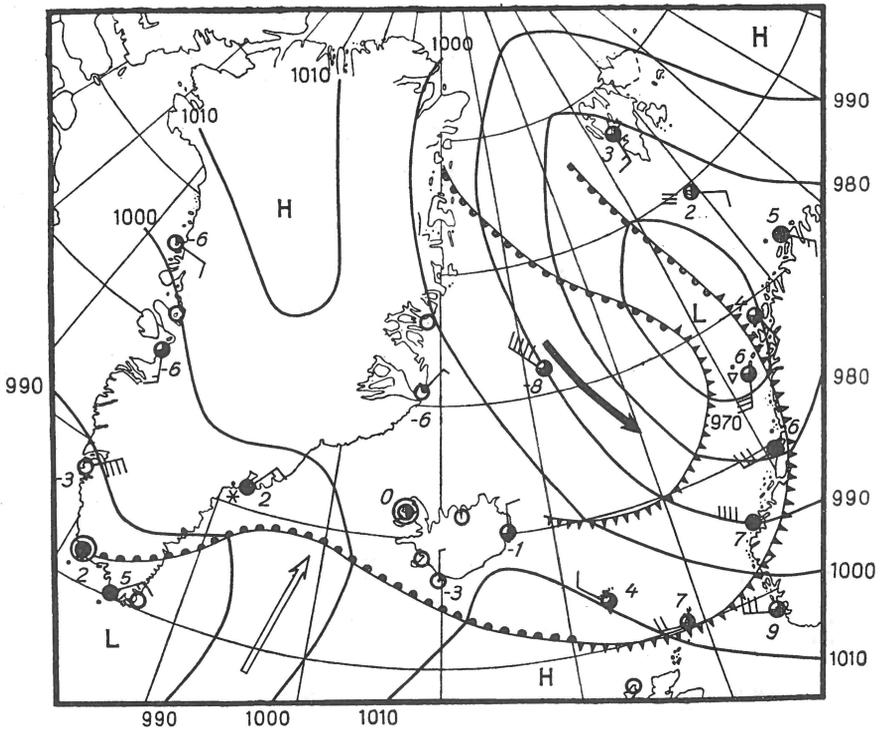


Fig. 79. October 3rd, 1931, 07—11 h.

whereas much colder air flows down along the east coast of North Greenland to Iceland. The almost stationary eastern boundary of the arctic air lies immediately west of Jan Mayen. During the previous days (from September 29th) the weather had been unusually quiet here, with winds of force 1—2 blowing from varying directions and a temperature of a few degrees above the freezing point; the barometer was falling from the night before October 1st, at first slowly, but later rather rapidly. However, as early as 13 h. on the 2nd a very strong gale (force 11) blew from the NNW, and the temperature fell gradually until the next morning, when the thermometer registered -8°C . No less than 47 mm of rain and snow came down between 7^h on the 2nd and 7^h on the 3rd. Judging from the wind conditions the cold front proper must have passed before 13 h. on the 2nd, but that part of the arctic air which was nearest the front was heated considerably during its passage over the open water north of Jan Mayen.

October 3rd, 1931.

The depression which was situated southeast of Jan Mayen on the previous morning has moved in an east-northeasterly direction (which agrees with the fact that the air behind the primary cold front of the depression is almost just as warm as the air within the warm sector).

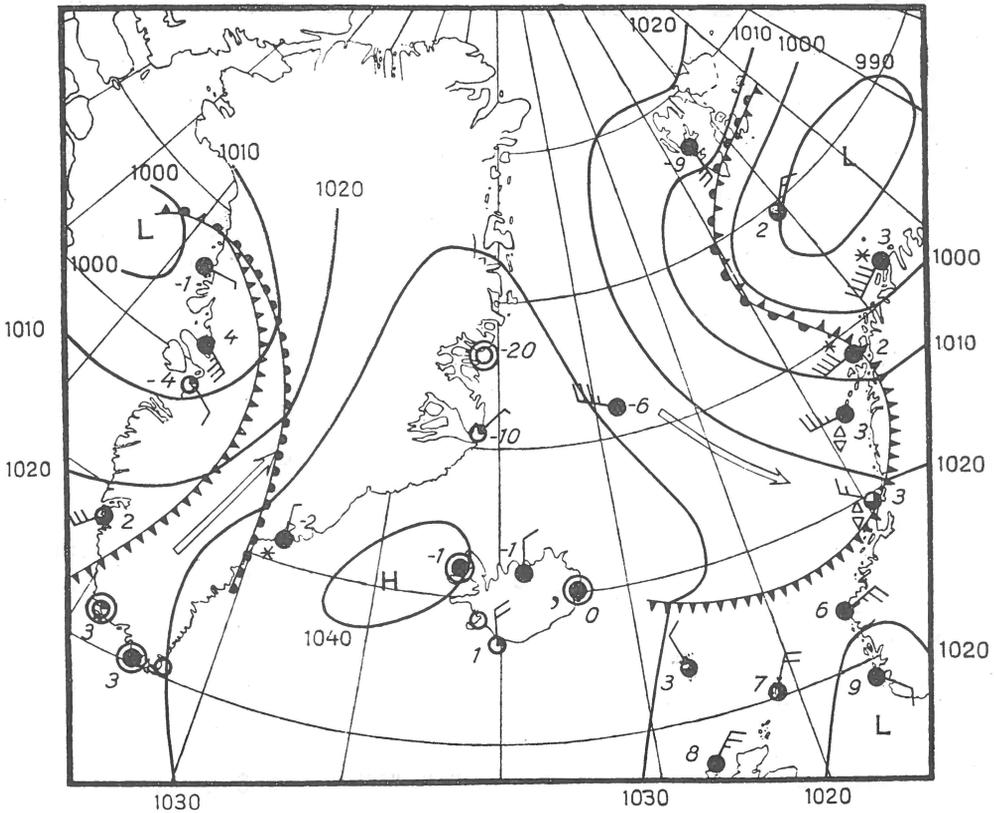


Fig. 80. October 24th, 1933, 18—24 h. The arrow to the right should be black.

The arctic air is flowing from Northeast Greenland southward over the northern seas; at Jan Mayen the force of the wind was from the NW or NNW of force 10—12 during twenty-four hours. The lowest temperature measured, -8°C ., was unusually low for the season and all the more remarkable since the lowest temperature registered up to then in the autumn of 1931 was -1°C .. In the course of the day, however, the temperature rose somewhat, to about -4°C ., and at the same time the wind veered west, decreasing a good deal; the rise of the temperature may possibly be due to a heating of the arctic air, under the influence of a foehn, during its passage across northeastern Greenland (humidity at 7 h.: 71 %, at 18 h.: 59 %).

Over Iceland there was in the course of the day and the next night a fresh advance of mild maritime air on the front side of a depression centred near the southernmost point of Greenland.

October 24th, 1933.

The figure shows a strong anticyclone (c. 1040 mb) over the Denmark Strait and Iceland. The air within the southern part of the high

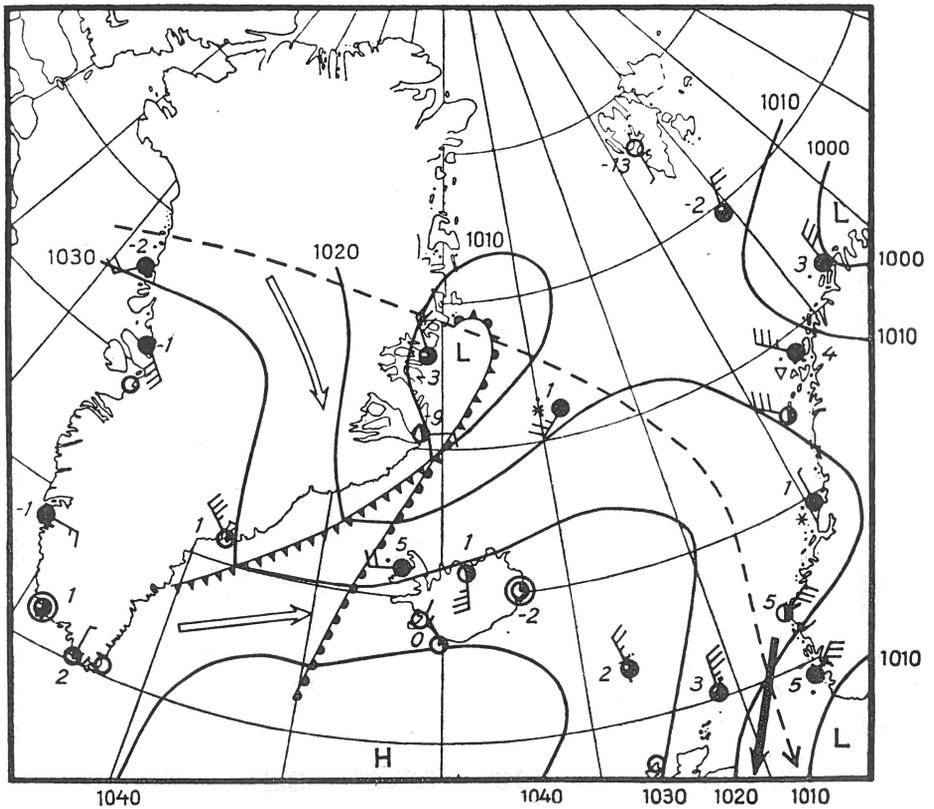


Fig. 81 a. October 25th, 1933, 18—24 h.

pressure area is mild maritime air, while in the northern part it is polar or arctic air, which had pushed down in the rear of the almost stationary depression situated north of Norway. The distribution of the air masses gives ground for assuming that a strong flow of air from the west prevails in the upper air layers north of Iceland.

A depression centred off Upernavik has hitherto moved in a north-easterly direction. Both the air in its warm sector, which is probably almost occluded, and the air behind the cold front are fairly mild.

In the twenty-four hours preceding midnight before October 24th 85 mm of rain fell at Ivigtut, the mild maritime air being forced to rise on meeting the steep coast.

October 25th, 1933.

The high pressure off Iceland has been displaced some distance southward; it is now chiefly that part which is built up of warm air that is left, while only a remnant of the northern cold part is still present in the form of an anticyclonic ridge extending northeast to the Lofoten.

The depression now centred over the sea off Myggbukta may without much doubt be identified with that situated over Baffin Bay twenty-four hours before; the accompanying barograms (Fig. 81 b) for Upernavik, Myggbukta, and Jan Mayen exhibit fairly good agreement, apart from the phase difference, which between the two first-mentioned stations amounts to 19 and between the two last-mentioned stations to 15 hours. The diagram also shows the rapid rise of temperature at Myggbukta

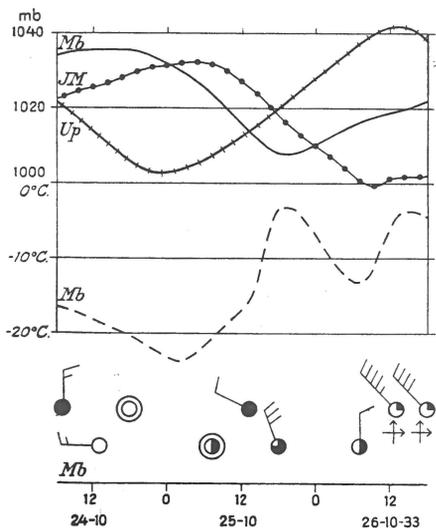


Fig. 81b. Barograms for Upernavik, Myggbukta, and Jan Mayen (October 24—26, 1933); thermogram and symbols showing weather development during the same period at Myggbukta.

during the 25th October. It is hardly probable that the warm sector in the evening of the 25th extends as far north as Myggbukta; more probably it is the rear air, which, as shown by the observations made in West Greenland, is fairly mild, and the cooling of which through its contact with the inland ice is almost compensated by the foehn effect (relative humidity at Myggbukta at 18 h.: 60 %).—It is noticeable that no precipitation at all fell at Myggbukta in connection with the passage of the depression; on the front side Jan Mayen had only 4 mm, but in its rear 7 mm. These figures confirm that the warm air of the depression has lost much of its moisture during its passage over the inland ice. Similar conditions are regularly found in such cases in which other facts, too, indicate that a depression has moved across the inland ice.

October 26th, 1933.

The large anticyclone seen in the figure may be divided into a southern relatively warm and almost stationary part situated over the

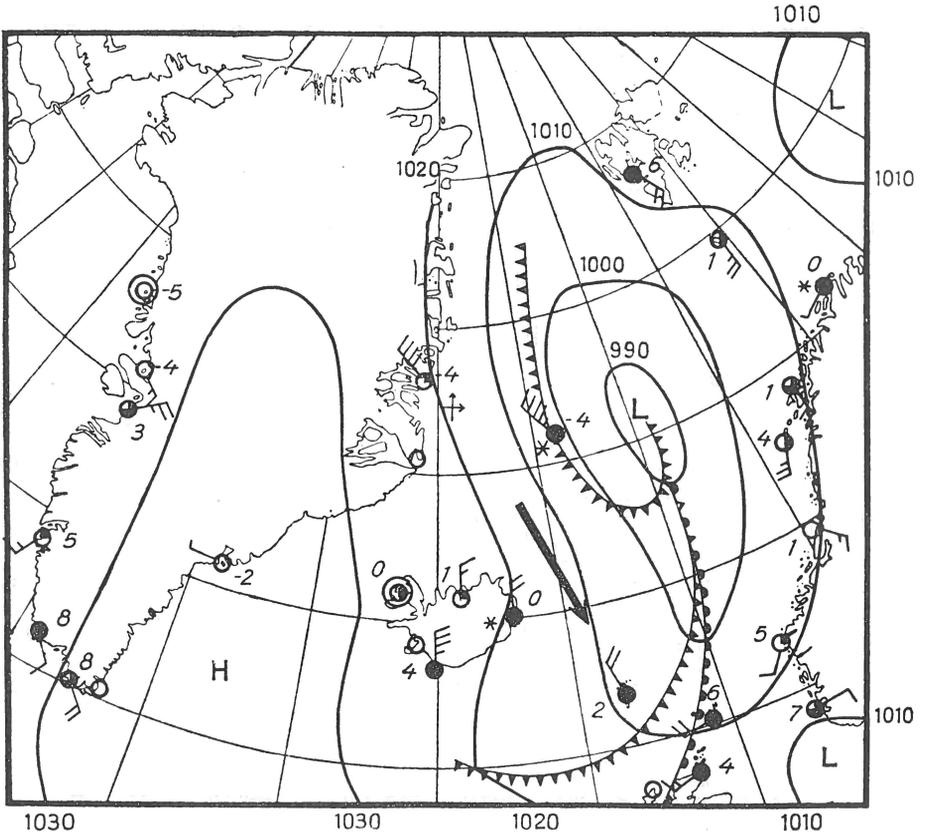


Fig. 82. October 26th, 1933, 18—24 h.

Atlantic and a northern part which is built up of somewhat colder air and is displaced from West to East Greenland. However, even in the northern part the temperature is fairly high considering the place and the season, thus Jakobshavn reports 3°C . and Myggbukta (with wind of force 8 from the NW) -4°C . While the flow of upper air over Greenland is probably westerly, it is northwesterly over the greater part of the northern seas; the depression which passed Myggbukta on the previous day is now situated between the Faroes and the Lofoten, continuing towards SSE; its cold front has passed the Faroes but has not yet reached Scotland. In the course of the night and the following day the cyclone advanced to the central part of the North Sea, at the same time deepening to below 980 mb. The air which on the 26th flowed southward past Jan Mayen, on arrival at Iceland, the Faroes, and the British Isles on the 27th appeared to be typical arctic air, and its further advance over France and Central Europe to the Alps seems to have given rise to a violent cyclogenesis over Austria on the 29th, with the

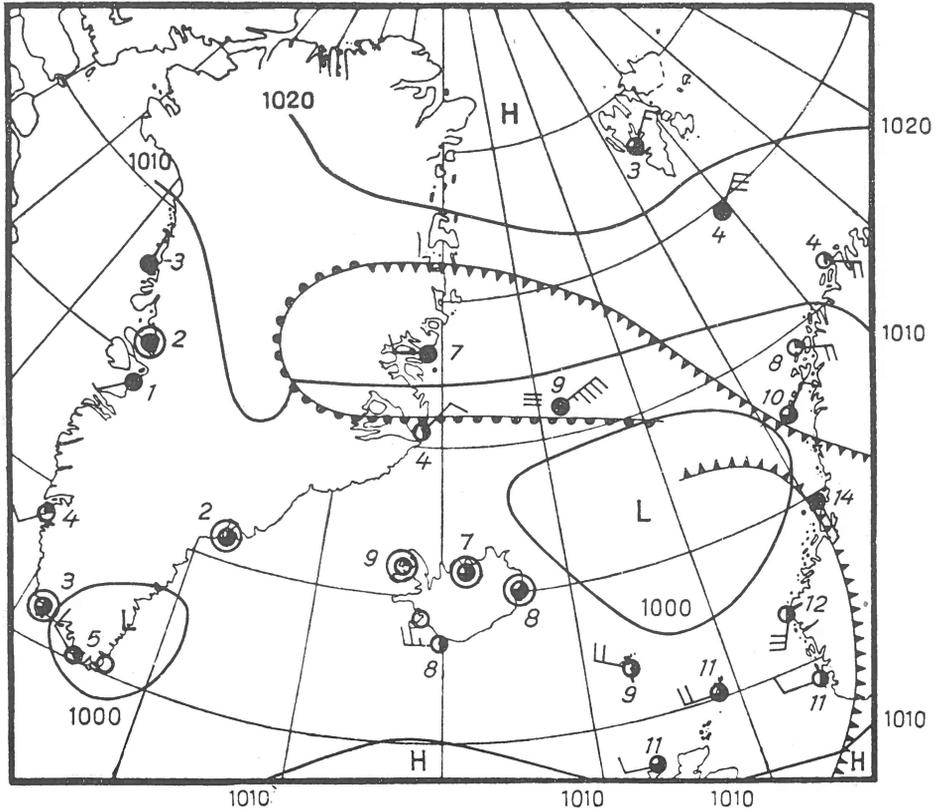


Fig. 83. October 1st, 1934, 15—18 h.

formation of a cyclone which moved rapidly northward to southern Sweden, assuming the character of a deep storm centre.

The development outlined here is described in such detail because it is an example of the close connection which sometimes exists between the development of the weather over Greenland and that over Europe.

October 1st, 1934.

The figure shows a depression situated between Iceland and Norway; on its eastern and northern sides mild humid air has moved from the North Sea or Baltic regions to the sea around Jan Mayen; the warm air has moved onwards, passing the east coast of Greenland in the region of Myggbukta. The separation of the warm air can hardly be determined with any great accuracy; the construction of the position of the front shown in the figure agrees in all essentials with the available observations.

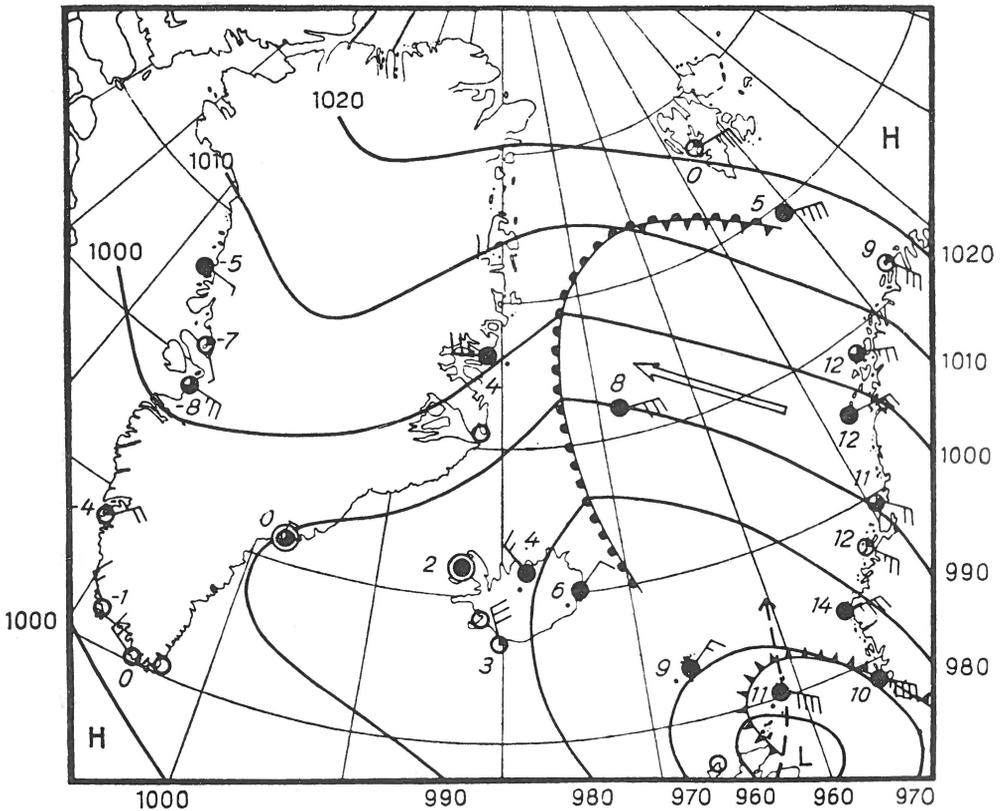


Fig. 84. October 4th, 1938, 07—11 h.

The rainfall at Myggbukta in the period from 7 h. on September 30th to 7 h. on October 1st amounted to 15 and in the next twenty-four hours even to 29 mm. As the temperature culminated in the morning of October 1st ($8\frac{1}{2}^{\circ}$, which is the highest temperature ever measured here in the month of October), the orographically conditioned rising seems to have played a greater role than the climbing over the warm front surface.

Altogether the autumn of 1934 was unusually wet both at Myggbukta and at Scoresbysund; thus Myggbukta had 90 mm in September and 53 mm in October, while Scoresbysund had 140 and 90 mm respectively.

October 4th, 1938.

The figure shows a very deep north-northeastward-moving depression off the east coast of Scotland and a high pressure extending from the Barents Sea to North Greenland. Over the intermediate area mild air from Scandinavia is flowing northward over the northern seas. At Jan

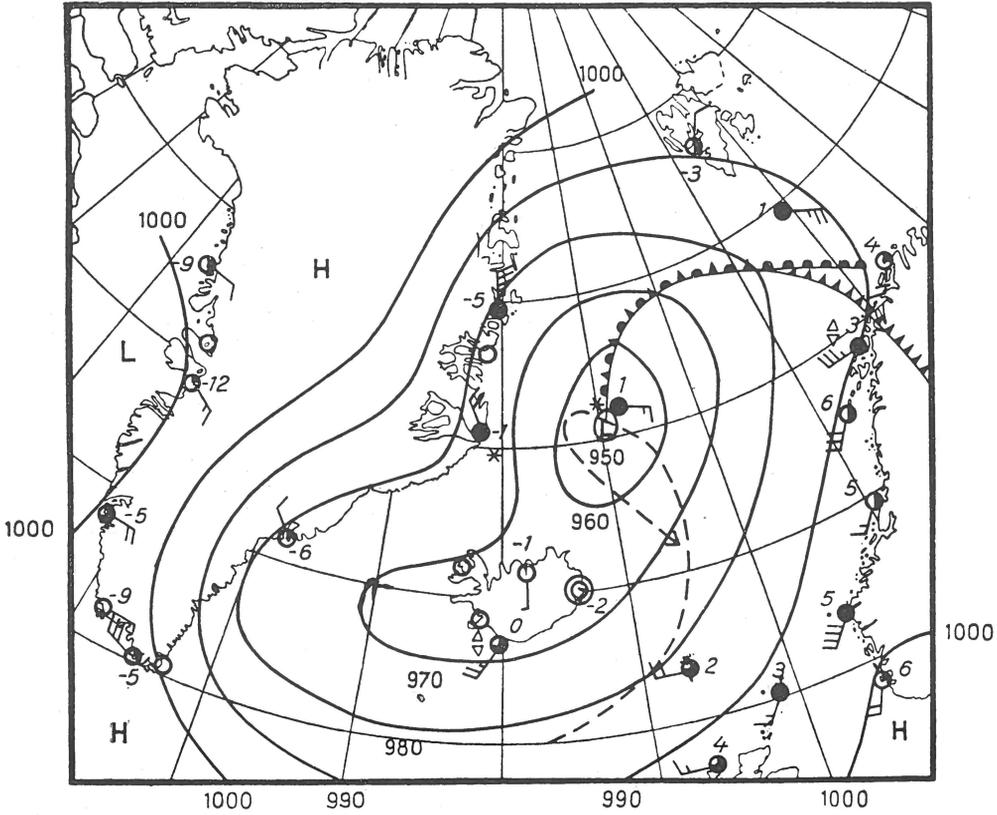


Fig. 85. November 9th, 1929, 07—11 h.

Mayen the temperature rose to 9°C ., which is an unusually high temperature for the season. Myggbukta had rain, partly due to the orography, partly as a consequence of the climbing of the warm air over the frontal surface; in the twenty-four hours preceding 7 h. of the 4th the precipitation amounted to 10 mm and in the next twenty-four hours to 6 mm.

November 9th, 1929.

The figure shows an unusually deep cyclone (c. 950 mb) at Jan Mayen. The frontal system of this depression passed the North Sea and southern and central Norway on the previous day; the occlusion process is far advanced, and at the surface of the ground the temperature contrasts within the area of the low are relatively small (-5° at Myggbukta, $5-6^{\circ}$ at the west coast of Norway). The stippled arrow indicates the track which the centre of the depression would seem to have followed in so far as this track can be determined on the basis of the available

observations, especially the observations from Jan Mayen from November 8th—10th listed below.

			Pressure at sea level, mb	Temperature	Wind	Cloudiness and weather
Oct. 8th	13 h.		964.8	2.2	NNE 6	9
	18 h.		954.8	3.0	NNE 10	10 Rain
Oct. 9th	1 h.		948.5	4.2	N 7	10
	7 h.		950.6	0.6	ESE 3	10 Snowfall
	13 h.		954.1	0.4	S 9	10 Snowfall
	18 h.		963.2	-0.5	SSE 8	10 Snowfall
Oct. 10th	1 h.		971.8	0.8	SE 4	3
	7 h.		976.7	-0.6	E 4	3

The quantity of precipitation at Jan Mayen was remarkably small, being only 4 mm from 7 h. of the 8th to 7 h. of the 10th.

November 13th, 1929.

The weather situation is characterised by a stationary depression, which is filling up but is still rather deep, centred between the Faroes and the Lofoten, and a fairly high pressure over Greenland. The observation from Jan Mayen is noticeable in several respects: the force of the wind seems to be remarkably great in relation to the gradient, the temperature is much higher than might be expected (on the previous day Spitsbergen had c. -10° C. with overcast weather), and the relative humidity is recorded as only 10 per cent, which is an exceptionally low value. Since the preceding observation reported a humidity of 18 per cent with wind from the NNE of force 10 and a temperature of 3° C., it is hardly probable that it is the question of any great error (a minor error may, however, be conceived to have been produced by the exceedingly strong "ventilation" of the psychrometer); the question now suggests itself how such a low relative humidity may have arisen. As it cannot be due to a local foehn only (to 2° and 10 % at the surface of the ground correspond -21° and 45 % (i. e. no saturation) at an altitude of 2250 m (the highest point of the island is 2267 m)), the most reasonable explanation is probably that we are here concerned with a "free foehn", air from an altitude of some few kilometres—possibly remnants of the warm air of the depression over the Norwegian Sea—having penetrated the colder layer near the surface of the sea; this penetration may be supposed to have been rendered possible by the peculiar orography of Jan Mayen.

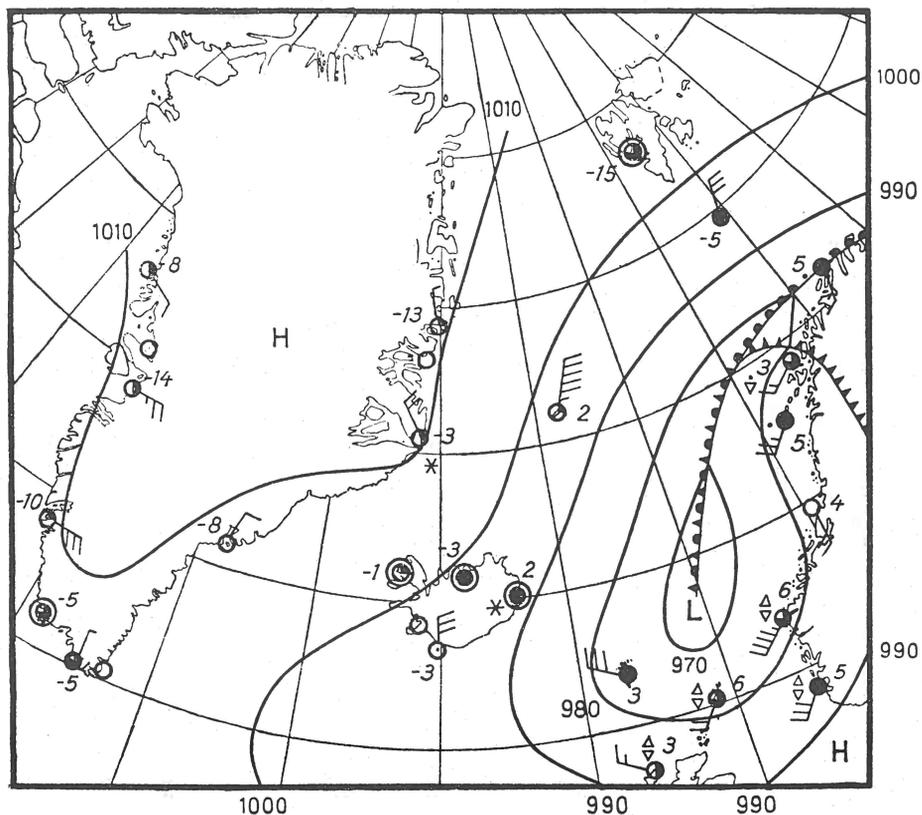


Fig. 86. November 13th, 1929, 07—11 h.

November 12th, 1930.

The figure shows a strong storm centre which has advanced from the Denmark Strait to the sea immediately south of Jan Mayen. Its warm front has passed Scotland and approaches Norway, while the cold front lies between the Faroes and Iceland. Another air mass boundary separating polar air from arctic air behaves as a cold front over Iceland, but as a warm front north of Jan Mayen. The fall of the barometer on the front of the depression was extremely rapid during about twelve hours, thus at 1 h. the pressure at Jan Mayen was 1014 mb, at 7 h. it was 1000 mb, at 13 h. 979 mb, and at 18 h. 971 mb. The highest temperature was almost simultaneous with the lowest pressure (-1°C . at 18 h.).

In the course of the evening and the night the depression moved towards the ESE; it passed the Lofoten next morning. It was accompanied by gales over large parts of northern Europe, i. a. over the Danish waters.

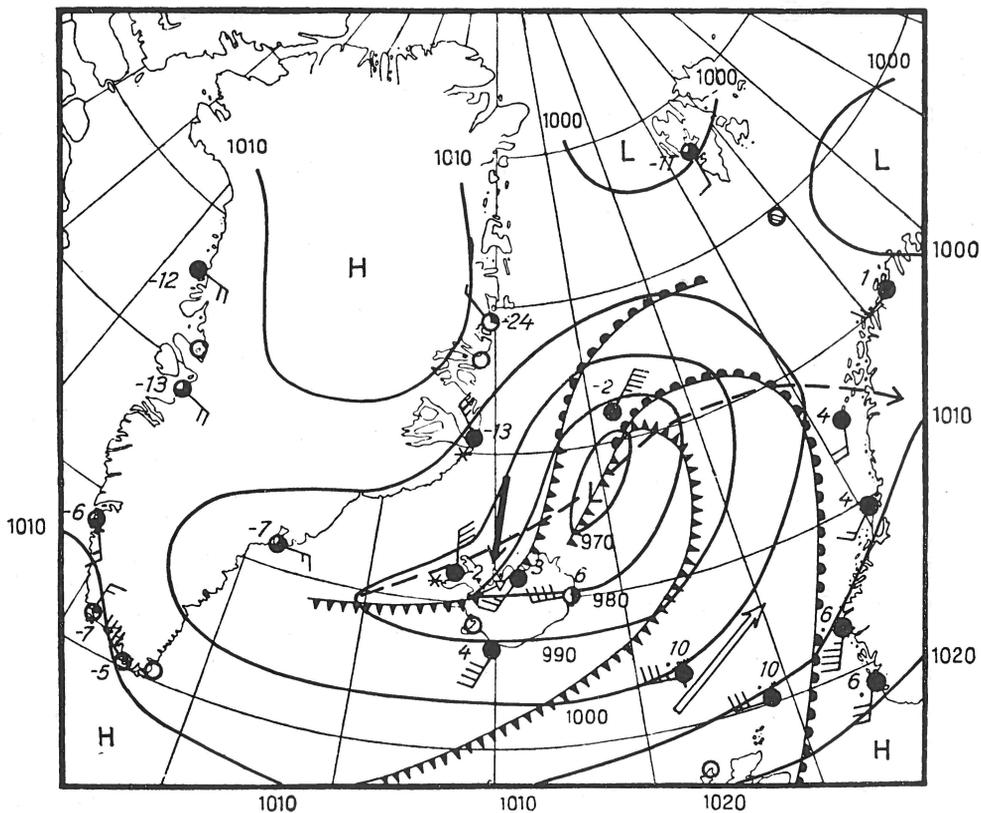


Fig. 87. November 12th, 1930, 13—17 h.

November 7th, 1932.

The figure shows a rather intense depression moving northeast between Jan Mayen and northern Norway; another depression southeast of Kap Farvel is moving towards the northeast. The Greenland high pressure is rather weakly developed; a somewhat stronger anticyclone over Europe is mainly built up of warm air. The positions of the boundaries of the air masses is uncertain; a marked boundary, however, extends through the Denmark Strait, and it is probably this boundary which passed Jan Mayen as a marked cold front shortly before the afternoon observation was made. The fall of the temperature after the passage of the front was unusually rapid, the temperature being -2° at 13 h and -11° C. at 18 h. The severe cold lasted only for a little more than twelve hours, the warm air again pushing northward in front of the succeeding depression; on the 8th, at 7 h., the temperature was -9° , with NW wind of force 4, but at 13 h. it was -6° , with E wind of force 8, and at 18 h. even -2° C. with E wind of force 4.

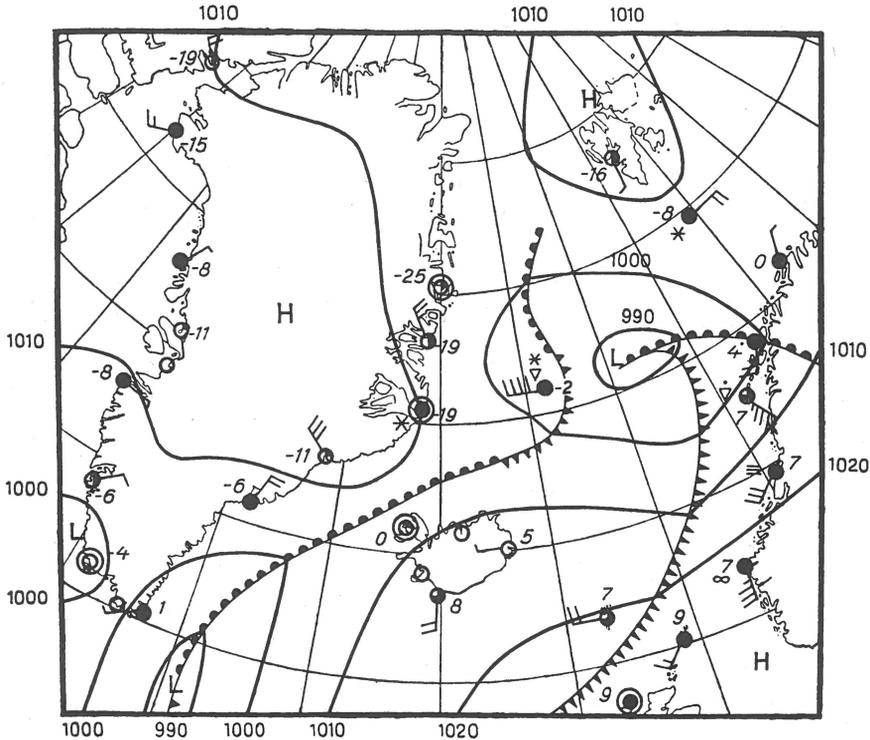


Fig. 88. November 7th, 1932, 11—13 h.

November 19th, 1934.

A deep depression (below 970 mb) near the east coast of Greenland is moving northeast. Mild air flows across the Norwegian Sea from the southwest, but a cold front with a southwesterly to westerly gale in its rear has passed the Faroes and Iceland; the air behind this front probably originates from Labrador.

The cyclone at Myggbukta developed near Kap Farvel on the previous day; at that time a deep northward-moving depression was centred near Disko (Umanaq at 11 h. 960 mb), remnants of which are still seen near Melville Bay. The cyclogenesis near Kap Farvel may be due to the constellation of the air masses, since evidently there has been an occlusion point near this place, but it may be assumed that orographic conditions have also played a part. Until reaching Scoresbysund, the cyclone moved at a great velocity, and the fall of the barometer at Myggbukta was very rapid (40 mb in twenty-four hours); during its continued movement towards the northeast the depression slowed up and began to fill.

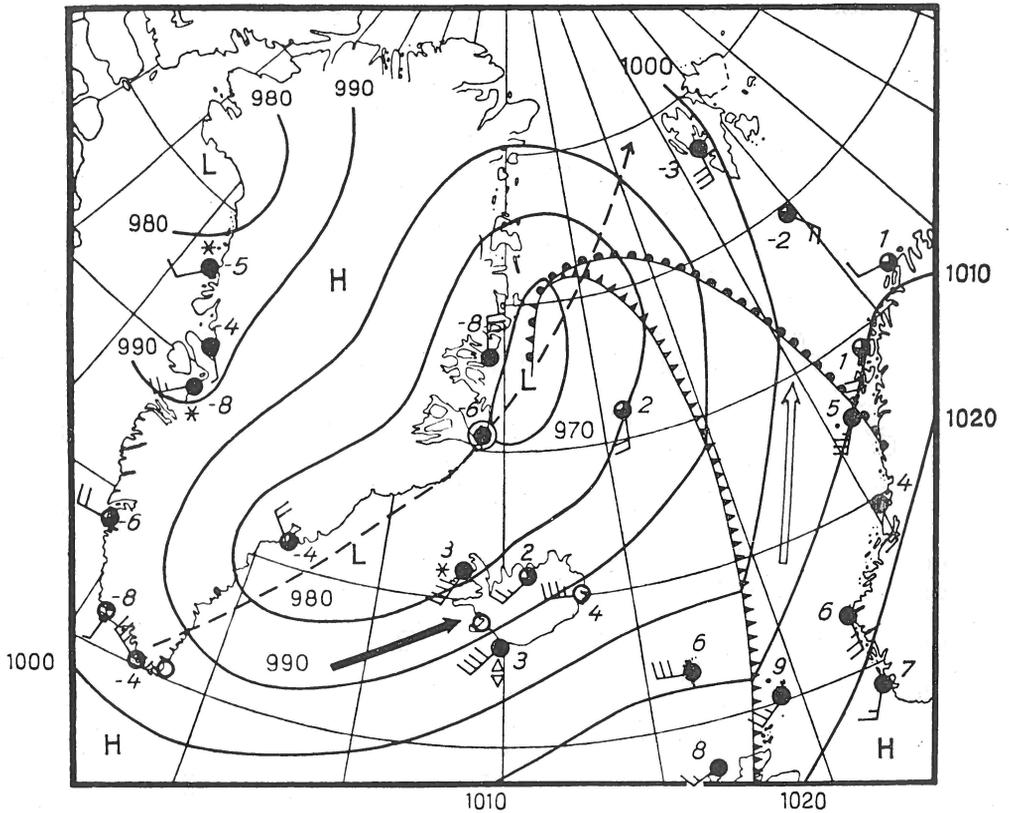


Fig. 89. November 19th, 1934, 07—11 h.

December 22nd, 1929.

Between a strong anticyclone over Russia and a deep depression over the North Atlantic mild air is pushing northward across the Norwegian Sea and Scandinavia to Spitsbergen, which has just been passed by a cyclone moving northeast. The air circulation of the Atlantic depression extends as far as Scoresbysund, but not as far as Myggbukta, where the temperature fell rapidly (at 7 h.: -20° , at 18 h. -36°) in the course of the day, the weather being clear and calm.

December 23rd, 1929.

The advection of mild air from the south continues over the northern seas; the warm front seems to have passed Jan Mayen and to have reached the coast of Greenland between Angmagssalik and Scoresbysund. Although the warm air itself has not reached Myggbukta, a very great rise of temperature (26°) has taken place here during the night because the wind has freshened and the cloudiness increased.

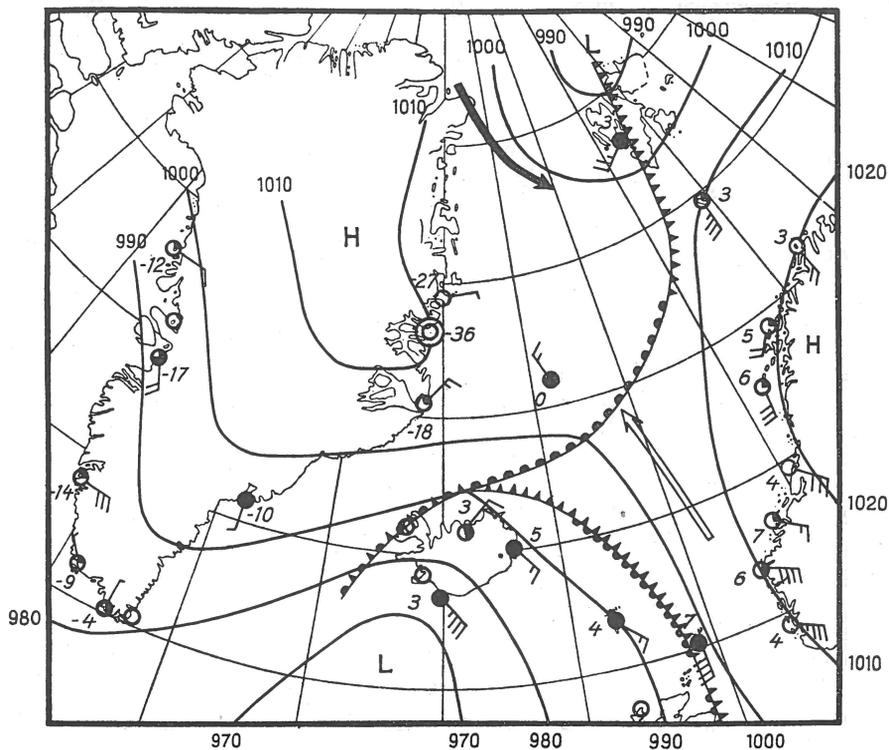


Fig. 90. December 22nd, 1929, 16—18 h.

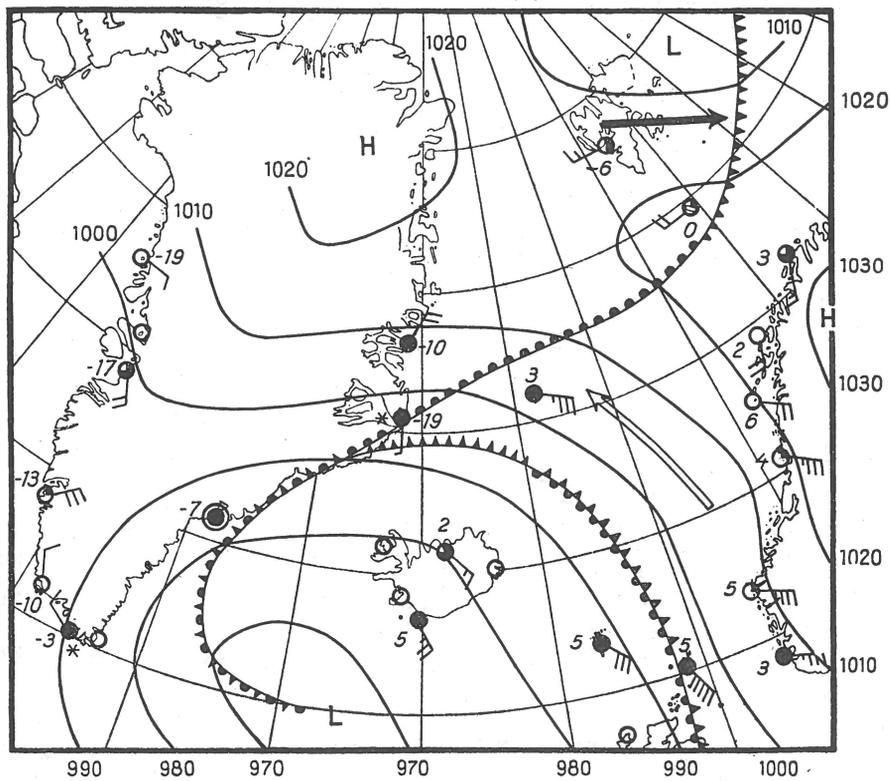


Fig. 91. December 23rd, 1929, 07—11 h.

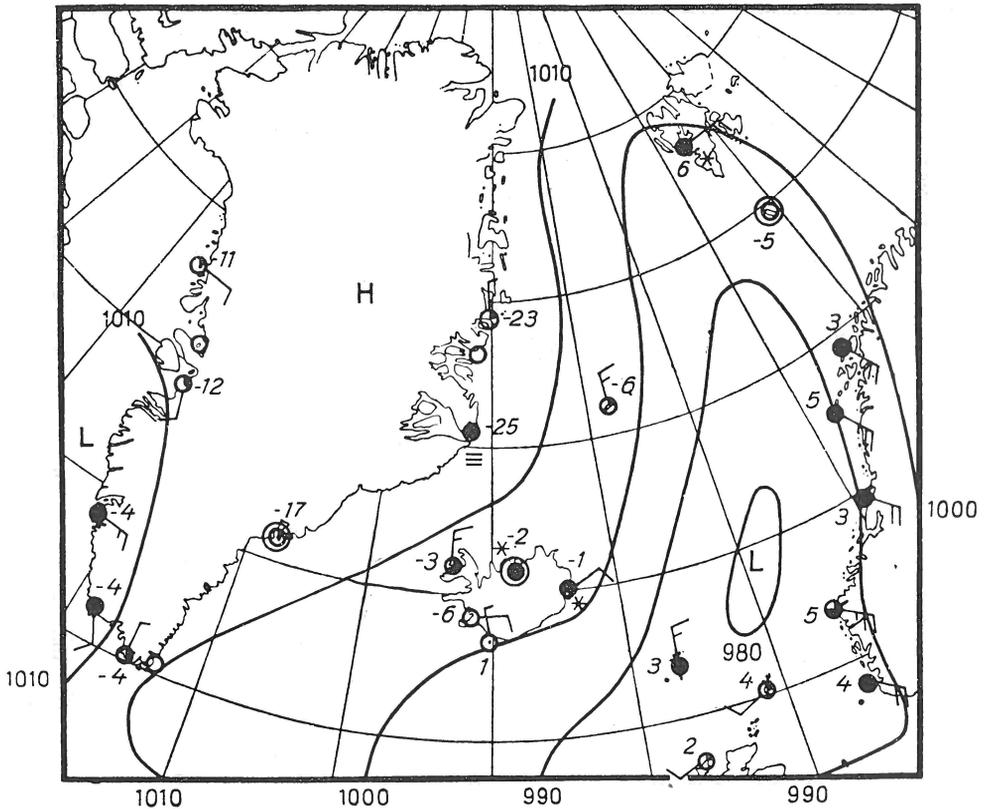


Fig. 92. December 30th, 1930, 15—18 h.

December 30th, 1930.

While an almost stationary depression is situated over the sea between the Faroes and Norway, the pressure is moderately high and fairly uniform over Greenland. On the east coast of Greenland the weather is calm and the temperature is low, in part very low; radiation fog is observed at Scoresbysund. The ascent of a balloon from this place gave the result that the temperatures at altitudes of 2 m and 50 m differed no less than 20° , being -34° and $-13\frac{1}{2}^{\circ}$ C. respectively. The presence of a marked ground inversion, according to the investigations of the WEGENER expedition, is a frequent, not to say a normal, phenomenon in Greenland. This also appears indirectly from observations made at the ground, e. g. the temperature in winter often falls rapidly in the course of a very short time when the weather is clear and calm. However, of all the inversions observed at Scoresbysund this one was the most strongly developed.

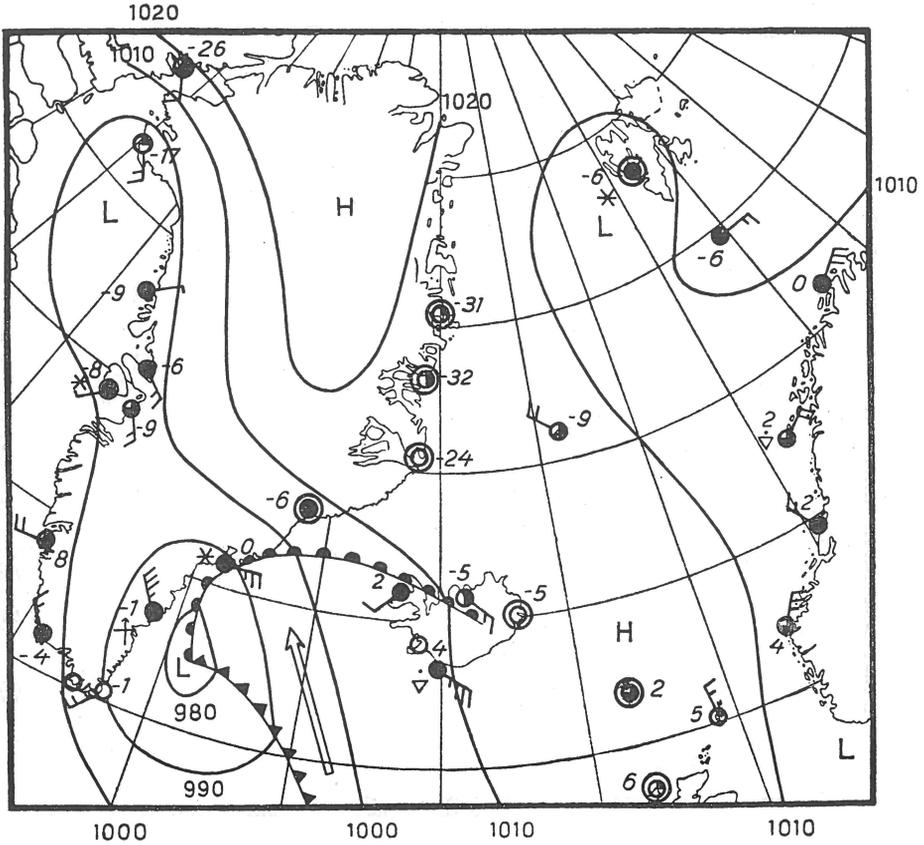


Fig. 93 a. December 5th, 1932, 10—13 h.

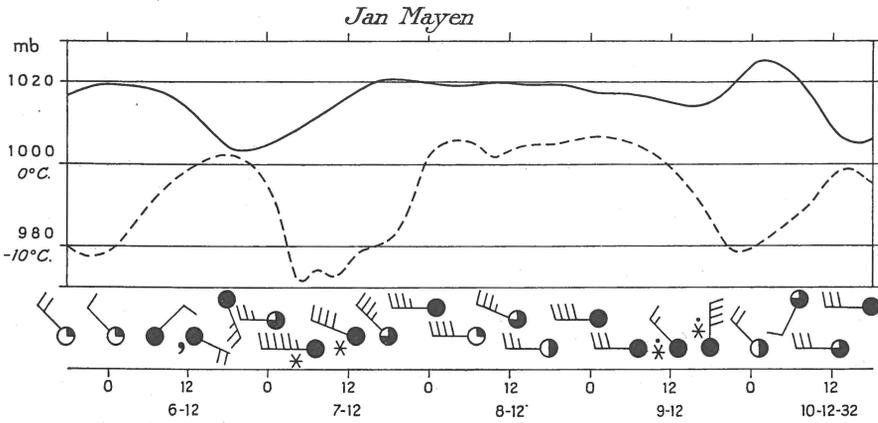


Fig. 93 b.

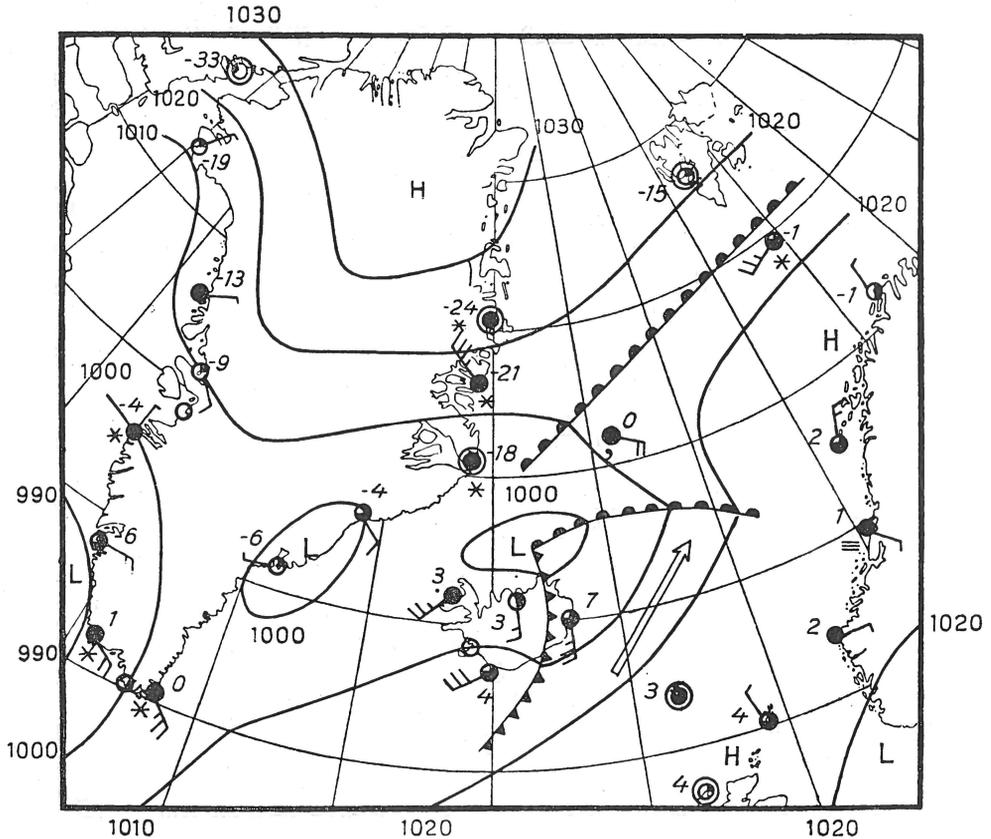


Fig. 94. December 6th, 1932, 10—13 h.

The weather map gives no explanation why the inversion was so unusually strong on that day; that this was the case must be assumed to be due to local causes—possibly the snow covering on the ground was especially thick and powdery.

December 5th, 1932.

The weather map shown in Fig. 93a together with the five succeeding ones forms a series which supplies several examples of a frontologically interesting weather development over the sea off the east coast of Greenland.

On December 5th a ridge of high pressure extends from northern Greenland to the British Isles, while a northward-moving cyclone is situated off the east coast of southern Greenland. On its eastern side mild maritime air flows northward over the Denmark Strait; at Scoresbysund and farther northward the weather is quiet, clear, and very cold.

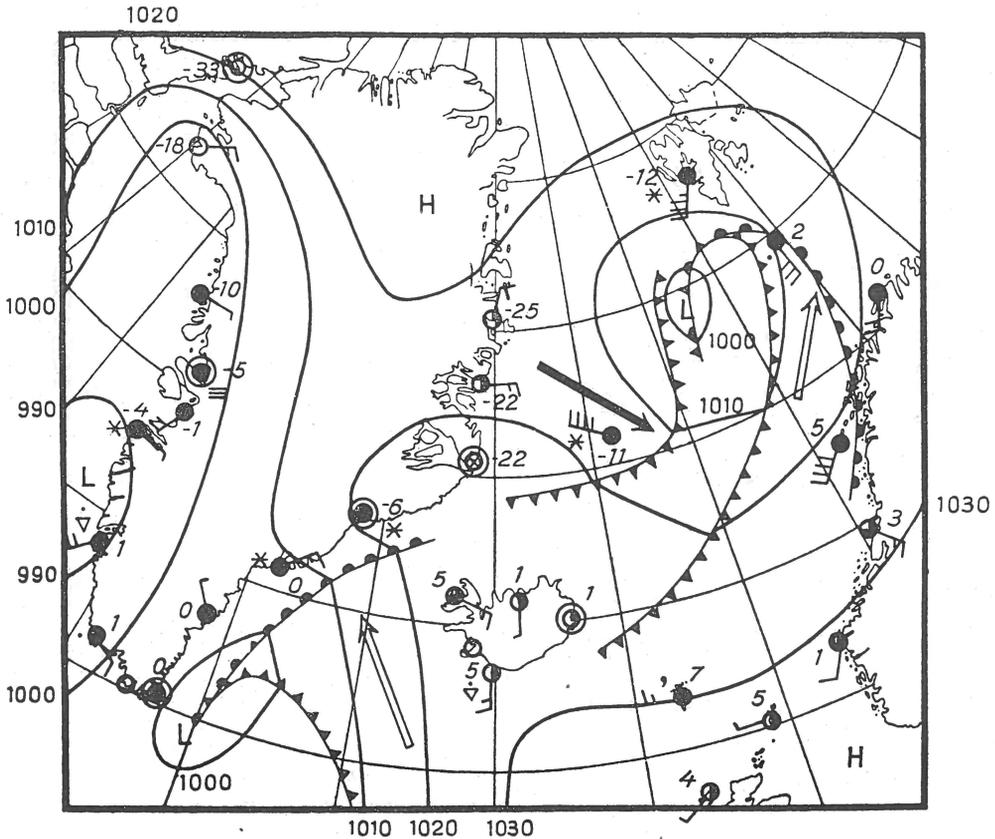


Fig. 95. December 7th, 1932, 10—13 h.

December 6th, 1932.

The anticyclone over North Greenland has increased somewhat in intensity. The depression off Southeast Greenland has reached Angmagsalik, but has now almost filled up; a newly formed northeastward-moving depression, on the front side of which the temperature at Jan Mayen has risen from -10° to 0° C. in the course of twelve hours, is seen off the north of Iceland. At Myggbukta the temperature is low in spite of the high force of the wind, which indicates that here the arctic air has a considerable vertical extension.

December 7th, 1932.

The depression situated near northern Iceland on the previous day has, while deepening, advanced to the sea between Jan Mayen and Bear Island. In its rear arctic air from Northeast Greenland is flowing southeastward; at 18 h. on the 6th Jan Mayen had a temperature of 4° C.

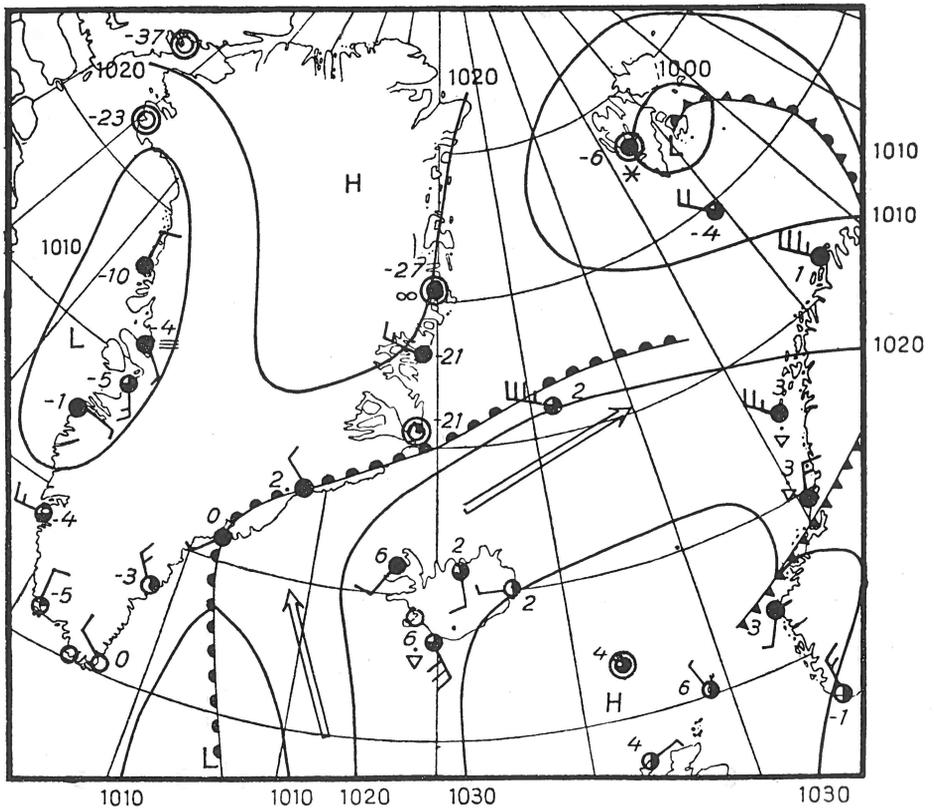


Fig. 96. December 8th, 1932, 10—13 h.

with a fresh southerly wind, but in the morning of the 7th -14° C. was registered with a very strong westerly gale; this is the most rapid fall of temperature in twelve hours observed at this station in the years 1929—39. On the western slope of an anticyclone, which extends from Scotland to the White Sea, mild maritime air is again flowing northward to the Denmark Strait.

December 8th, 1932.

The depression has now advanced as far as Spitsbergen. The European anticyclone has moved northwest, being now centred near the Faroes. Between this anticyclone and the somewhat less intense high over Northeast Greenland a marked air-mass boundary extends from Angmagssalik over Scoresbysund to Jan Mayen; south of this boundary there is mild maritime air, while north of the boundary the air is of arctic origin. East of Scoresbysund the two air masses are flowing almost parallel to each other; at 13 h. of the 7th Jan Mayen

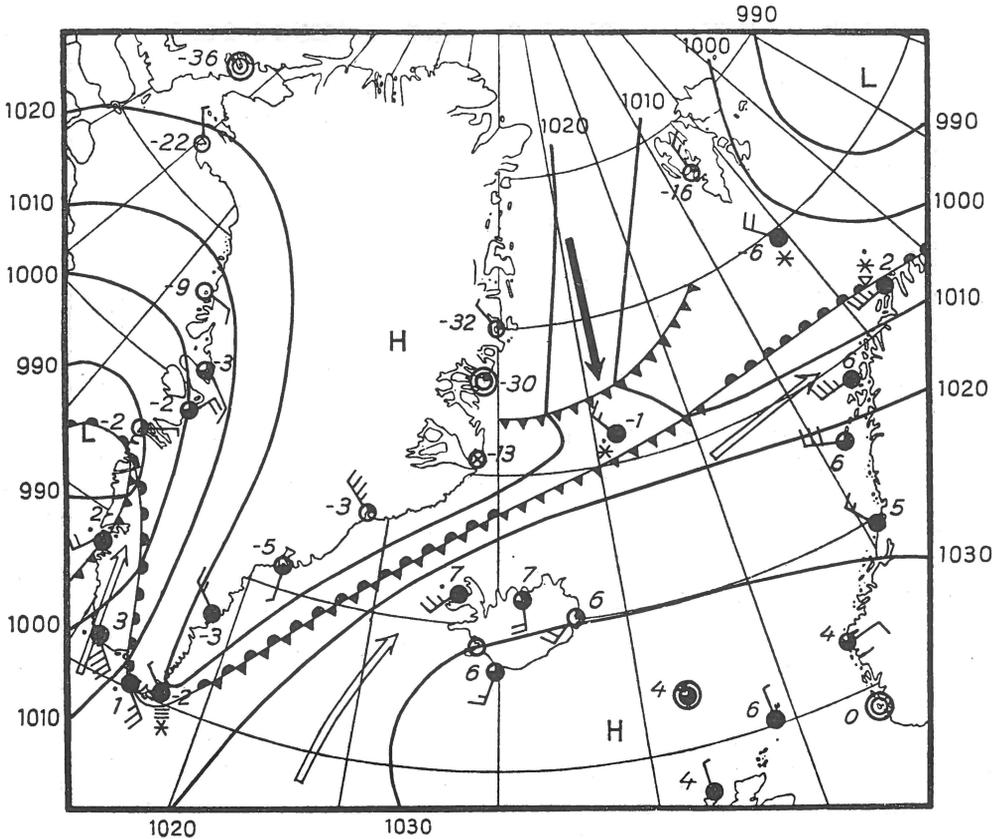


Fig. 97. December 9th, 1932, 10—13 h.

had a temperature of -11° with wind from the WNW of force 8, and as late as 18 h. -9° with NW wind of force 7, but during the whole day and night of the 8th (from 1 h.) c. 2° C. with wind from the W of force 5—8.

December 9th, 1932.

The air mass boundary between the cold anticyclone over North and East Greenland and the much warmer anticyclone north of the British Isles can now be traced from Kap Farvel over Jan Mayen to the North Cape; while Iceland has a temperature of $6-7^{\circ}$ C., Scoresbysund has -13° and Myggbukta -30° C. The boundary has just passed Jan Mayen, and the temperature has fallen from $+3$ to -1° C. in the course of six hours with decreasing wind veering from the W to the NW. In the course of the afternoon the wind veered north, increasing to a fresh gale, and the temperature fell to $-6\frac{1}{2}^{\circ}$ C. (at midnight -10°); this development of the weather suggests that two cold front passages may have taken place at an interval of some few hours.

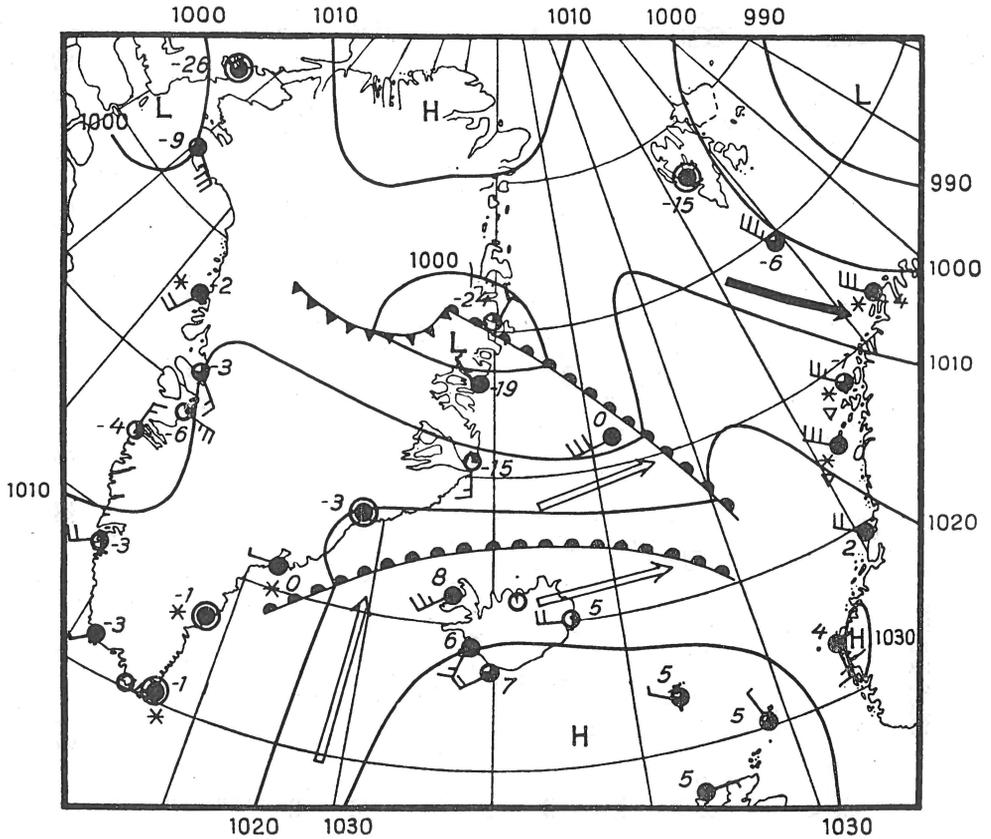


Fig. 98. December 10th, 1932, 10—13 h.

An intense depression is pushing northward over the Davis Strait, and on its eastern side mild air is flowing north across southwestern Greenland.

December 10th, 1932.

While the pressure and air-mass distribution over northwestern Europe has not changed materially, a very rapid development of the weather has taken place over Greenland. The East Greenland high has practically disappeared, and the low, which was situated over Davis Strait on the previous day, seems to have moved right across Greenland and to have reached the east coast between Myggbukta and Danmarks Havn. On the southern side of the depression mild air (which, however, is not as mild as the air mass over Iceland) has pushed as far eastward as Jan Mayen, where the temperature has risen c. 10° in twelve hours. A cold bottom layer persists over the coast-land of Northeast Greenland; at Myggbukta this ground layer was removed later in the evening, evidently in connection with the passage of a masked cold front; at

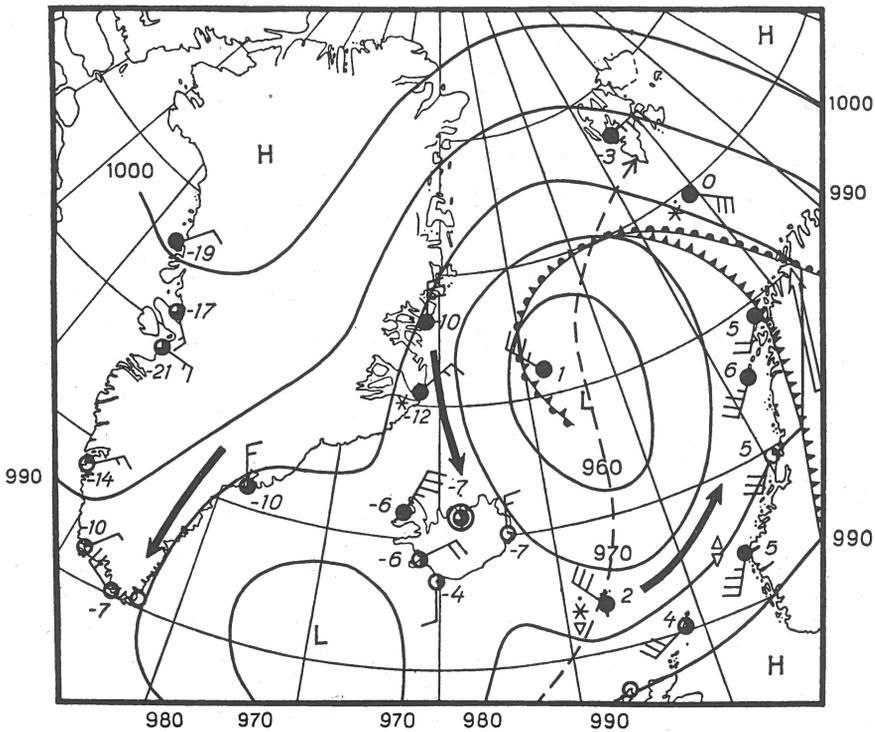


Fig. 99. December 15th, 1936. 13—17 h.

18 h. Myggbukta reported a temperature of -2°C . with northwesterly wind of force 5 and a rising barometer.

It is characteristic that no precipitation fell at Myggbukta in connection with the passage of the depression (see p. 157). However, Jan Mayen had some snow shortly before the passage of the warm front.

December 15th, 1936.

A very deep storm centre is found east of Jan Mayen; its track will appear from the figure: it passed the Faroes at noon of the 14th, arriving at the southern part of Spitsbergen in the afternoon of the 16th. On the eastern side of the depression mild air from Central Europe flowed northward across Scandinavia, while on its western side arctic air was moving south across Iceland and the surrounding waters; from these regions, part of the arctic air flowed east towards Norway. At Jan Mayen the highest temperature (slightly above 2°C .) was registered on the front side of the cyclone, with an easterly wind; after the passage of the cyclone the wind was northwesterly, and a fall of the temperature set in, though not particularly great (-4°C . at 7 h. of the 16th.).

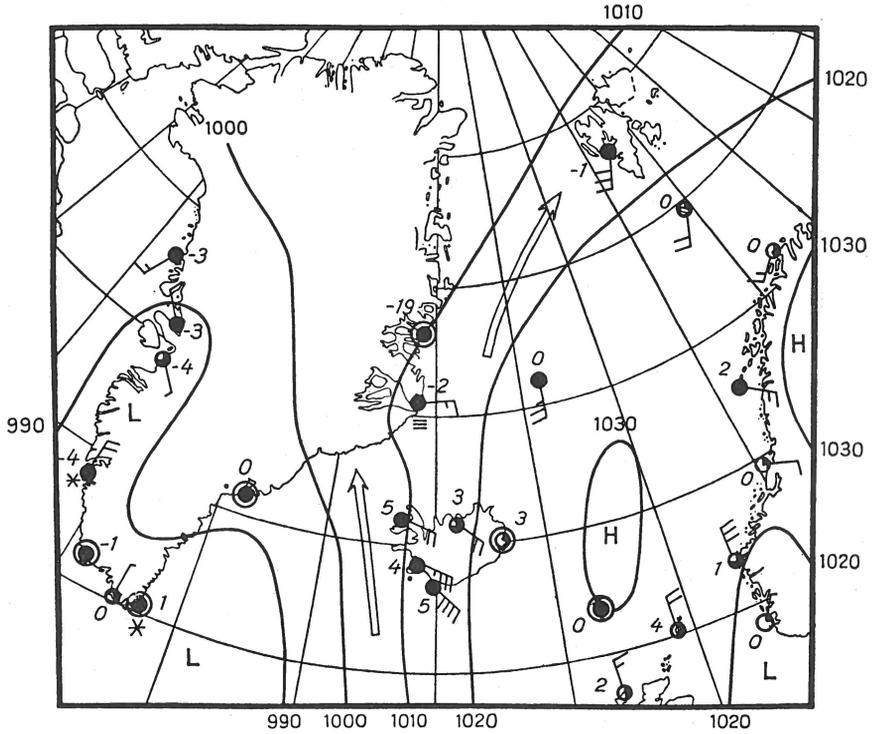


Fig. 100. December 17th, 1937, 07—11 h.

December 17th, 1937.

On the western slope of a strong anticyclone extending from Madeira over Ireland and the Faroes to northern Scandinavia, mild maritime air is flowing north across Iceland towards the east coast of Greenland. On the previous days the weather in Northeast Greenland had been calm, clear, and in part very cold, thus on the 16th, 13 h., a temperature of -29° C. was registered at Scoresbysund. About this time the advection of warm air in the upper layers would seem to have begun; at 18 h. the weather was calm and cloudy, with a temperature of -22° C., and as the wind increased somewhat in the course of the night, blowing from the east, the cold ground layer was destroyed, with the result that the temperature rose 23° in the course of 13 hours.

III. EXPLANATION OF PLATES 1—11

The atmospheric pressure in the months June—September in each of the years 1929—1939 along the stretch Thorshavn—Myggbukta is illustrated by Plates 1—11. Each plate contains

- 1) a barogram for each of the points A, B, C, and D,
A indicating Myggbukta (73.5° N., 21.6° W.),
B — a point in 70.0° N., 17.1° W.,
C — - - - 66.0° N., 12.0° W.,
D — Thorshavn (62.0° N., 06.8° W.)

- 2) a diagram showing the pressure along the stretch Thorshavn—Myggbukta as a function of the time and the geographical latitude. “Areas” with a high pressure (above 1015 mb) are marked with a blue, and areas with a low pressure (below 1005 mb) with a green colour.

Plate 1.

June—September 1929.

In June 1929 the mean pressure was high, 1021 mb, at Myggbukta and moderately high, 1011 mb, at East Iceland and the Faroes. The mean variability of the pressure was almost normal (c. 4—5 mb). Along the coast of Northeast Greenland the wind blew almost exclusively from northerly and northeasterly directions; near East Iceland and the Faroes winds from northerly directions were prevalent from the 1st to the 7th and from the 20th to the 26th, while the remainder of the month had variable winds.

During nearly the whole month the pressure was high near North-east Greenland; at Myggbukta it was above 1010 mb all the time, at the beginning of the month and during the last half even above 1020 mb. The high pressure culminated on the 1st—2nd and on the 23rd—24th, when the height of the barometer at Myggbukta amounted to 1035 mb. The high pressure sometimes extended southeastward to the Faroes or the British Isles, thus on the 1st, the 21st, and notably on the

24th—28th, when the pressure near the Faroes was c. 1020—25 mb. Otherwise Iceland and the Faroes were passed by several cyclones of slight or moderate intensity in the course of the month. Thus on the 6th a southward-moving cyclone of c. 990 mb was found east of the Faroes, on the 8th—9th an almost stationary depression of 1000 mb over Iceland; on the 13th—14th a depression of 990—95 mb moved from N. Scotland to S. Iceland, on the 16th the pressure was less than 1000 mb between Scotland and Jan Mayen, and in the night before the 20th a depression of 1000 mb passed the Faroes moving east. A peculiar development of the weather situation took place on the 21st—22nd, when a low pressure of 1000 mb moved westward from the Lofoten Islands to the sea south-east of Jan Mayen, accompanied by rather disturbed weather conditions.

In July the pressure was moderately high, 1010—13 mb, near E. Iceland and the Faroes, and a little higher, 1015 mb, at Myggbukta. The mean variability was almost normal ($3\frac{1}{2}$ —4 mb). On the first five days of the month the wind was chiefly northerly, but after that time the direction of the wind changed frequently; near E. Iceland and the Faroes southwesterly winds prevailed from the 11th to the 17th.

On the first days of the month the pressure was high, c. 1025 mb, over Northeast Greenland; on the 6th—7th it was high, above 1020 mb, near the Faroes. A considerable fall of the barometer set in on the following days; the deepest and most violent cyclone of the month (c. 990 mb) passed East Iceland in the evening of the 10th, moving northeast; in the Jan Mayen area it gave rise to high winds from northerly directions from the 10th to the 12th. Some days later, about the 15th, the weather situation was dominated by a well developed anticyclone (1020—30 mb) over the North Sea area; a few depressions of c. 1000 mb moved in an east-northeasterly direction past Jan Mayen during this period. From the 18th to the 20th the pressure was again highest over Northeast Greenland; on the 22nd—23rd a deepening depression moved from Scoresbysund to the sea east of Jan Mayen. Then followed some days with uniform and quiet pressure conditions (see p. 144 f.); at the end of the month the pressure was high, c. 1025 mb, at Myggbukta and low near Scotland.

In August the mean pressure was high, 1016 mb, at Myggbukta and rather low, 1007—09 mb, near East Iceland and the Faroes. The mean variability of the pressure was fairly great, 5 mb, near the Faroes, but otherwise rather small, 3— $3\frac{1}{2}$ mb. Northerly and north-westerly winds were predominant; however, a southerly wind blew near the Faroes and East Iceland for some days around the 20th.

At the beginning of the month the pressure was fairly high over Greenland and low from the North Sea over Scandinavia to Spitsbergen. From the 5th to the 10th a low of c. 995 mb moved slowly northward from

Shetlands to the sea between Northeast Greenland and Spitsbergen. During the second third of the month the pressure was moderately high, c. 1005—15 mb, along the stretch Thorshavn—Myggbukta; from the 14th to the 18th a low of 1000 mb occurred between Jan Mayen and the Lofoten Islands. About the 20th a considerable fall of the barometer took place near the Faroes and Iceland; the deepest depression of the month, c. 985 mb, on the 22nd—24th moved slowly from Southwest Iceland to the sea between the Faroes and the Lofoten, partially accompanied by rather high winds (see p. 147 f.); near East Iceland and the Faroes the passage of the depression was followed by a considerable rise of the barometer. On the 28th a new depression (under 1000 mb) passed the Shetlands, heading towards the north-northeast; otherwise the weather situation during the last days of the month was mainly dominated by a well-developed anticyclone (c. 1020—25 mb) over Greenland.

September had very disturbed pressure and wind conditions. The mean pressure was low (1001 mb) near East Iceland, somewhat higher (1006 mb) near the Faroes, and moderately high (1010 mb) at Myggbukta. The mean variability of the pressure was moderate (5 mb) at Myggbukta and otherwise very high (7—8 mb). Off the coast of Northeast Greenland the wind most frequently blew from directions between northeast and northwest; near East Iceland and the Faroes it blew from the north from the 1st to the 5th, from the southwest from the 8th to the 18th, being altogether rather variable.

At the beginning of the month a rather deep depression (c. 990 mb) approached the Faroes from the south; subsequently it moved slowly towards central Scandinavia and was filled up in the course of the 2nd. Over Northeast Greenland the pressure was high, 1025—30 mb, during the first six days of the month; on the 6th a ridge of high pressure extended from Northeast Greenland to the British Isles, but as early as the 7th—8th a depression of less than 1000 mb made its way across Iceland, moving towards the east-northeast. Subsequently the weather was fairly quiet until the night before the 12th, when a northward-moving cyclone between East Iceland and Jan Mayen suddenly deepened from 995 to less than 980 mb; in its rear Jan Mayen on the 13th had a northwesterly gale. Another, likewise fairly well-developed depression (985 mb) passed Iceland on the 13th, moving northeast; on the 15th—16th the pressure was high over the British Isles, while a depression of 995 mb moved through the Denmark Strait towards Spitsbergen. In the night before the 16th a low of 995 mb occurred near Kap Farvel; it moved towards Iceland, developing at the same time into a violent depression (see p. 150 ff.); by Northeast Iceland, after a fall of 30—35 mb in twelve hours, a pressure as low as 960 mb was registered on the 17th, an

exceptionally low value for the time of the year. The centre of the storm passed Jan Mayen in the morning of the 18th and during the following days remained northwest of the Lofoten Islands, where it slowly filled up; as late as the 20th Jan Mayen had a strong northwesterly gale. At this time several secondaries moved from Southwest Greenland to Southwest Norway, with the result that the force of the wind at Iceland and the Faroes was not especially high at the rear of the storm centre.

In the course of the 23rd the weather, however, again became highly disturbed. On the north side of a well-developed anticyclone, whose centre lay over the Channel region on the 23rd and over southern Scandinavia on the 24th, a deep and violent storm centre moved rapidly from the North Atlantic over East Iceland and Jan Mayen to Spitsbergen, accompanied by quite exceptionally great pressure variations (see p. 152 f.). At Seyðisfjörður the barometer fell 38 mb (to 959 mb) in the course of twelve hours, after which it rose no less than 43 mb in twelve hours; even in the middle of the winter such great pressure variations are very rare.

As early as the 24th a fresh depression reached Northwest Iceland; however, it was much less intense than the previous one. On its south side a low pressure of under 990 mb developed in the night before the 26th, which passed Iceland in the morning of the 26th, accompanied by rather high winds.

The last deep cyclone of the month developed on the 27th southwest of Iceland and on the next day passed northeastward between the Faroes and Iceland, accompanied by great pressure variations; midway between Thorshavn and Seyðisfjörður the barometer fell 30 mb (to 970 mb) in the course of twenty-four hours, to rise subsequently nearly 20 mb in twelve hours.

Plate 2.

June—September 1930.

In June 1930 the mean pressure was low, c. 1005 mb, near Northeast Iceland, and moderately high both near the Faroes (1009 mb) and at Myggbukta (1012 mb). The mean variability of the pressure was fairly high, c. 5—6 mb,—highest near East Iceland.

Off Northeast Greenland northeasterly and easterly winds prevailed during the first four days of June and from the 19th during the rest of the month, while from the 6th to the 13th the wind mostly blew from directions between the west and north. Near East Iceland and the Faroes the wind was most frequently southerly or southeasterly.

At the beginning of the month the pressure was very high near Spitsbergen, whence a broad ridge of high pressure extended as far as

Scotland. The anticyclone was replaced towards the east already on the 3rd—4th, when a low of c. 995 mb passed Iceland, moving in a north-easterly direction; on the 5th another, equally deep depression followed almost the same track. Then there was a short rise of the barometer on the front side of a ridge of high pressure, which on the 7th extended from an anticyclone west of Ireland northward across the northern seas; already in the night before the 8th another rapid fall of the barometer set in near Iceland and the Faroes, where the pressure in the course of the 9th fell to below 990 mb. Within the area of the depression, which moved slowly onwards, there were, up to the 10th, several centres, but on the 11th only one, midway between the Faroes and Jan Mayen, exhibiting a pressure of c. 975 mb—an unusually low value for the season. In the rear of the depression, partly strong northerly winds were blowing off the coast of Northeast Greenland on the 9th—11th.

During the next few days the barometer rose considerably; as early as the 14th it rose above 1020 mb along the line Myggbukta—the Faroes; the centre of the anticyclone, with a height of the barometer of c. 1030 mb, lay over or near southern Norway from the 13th to the 17th. Near Iceland and the Faroes a considerable fall of the barometer took place on the front side of a depression (995 mb) which passed Myggbukta on the 17th moving towards the northeast. From the 18th to the 20th a deep depression (c. 980 mb) was found southwest of Iceland; at the same time the barometer rose to c. 1025 mb near Northeast Greenland, and along the stretch Jan Mayen—Scoresbysund an easterly gale blew on the 20th—21st.

During the rest of the month the pressure remained between 1010 and 1020 mb near Northeast Greenland and between 995 and 1008 mb near the Faroes; the gradient was as a rule rather uniform over the intermediate area, except on the 25th—26th, when a low of c. 990 mb occurred east of Iceland; on the 26th a strong easterly wind blew near Jan Mayen and, probably, strong northerly winds off Scoresby Sund.

In July the mean pressure was high, 1017 mb, but the mean variability of the pressure rather high, $4\frac{1}{2}$ mb, at Myggbukta; near East Iceland and the Faroes the mean pressure was almost normal, 1009—10 mb, and the mean variability rather small, c. $3\frac{1}{2}$ mb. Easterly and northeasterly winds were predominant off the coast of Northeast Greenland; near East Iceland and the Faroes the wind was chiefly southwesterly from the 2nd to the 9th but during the rest of the month winds from the northeast quadrant were highly predominant. The force of the wind was generally light or moderate.

On the 2nd a depression of 995 mb moved across Iceland towards the north. Another depression which on the 3rd—4th lay over the Denmark Strait, moved slowly in an easterly direction; it was deepest,

below 990 mb, on the 5th—6th, when it passed Iceland. A rather unusual weather development took place on the 8th, when a depression of 995 mb moved in a westerly direction close past Jan Mayen and Scoresby Sund (see p. 145 f.). Already next day a high pressure of c. 1025 mb developed near Northeast Greenland, and on the 10th—11th the height of the barometer was generally 1015—25 mb along the whole stretch Thorshavn—Myggbukta. During the rest of the month the pressure was almost constantly 1015—25 mb at Myggbukta and 1005—15 mb near the Faroes, the pressure difference being greatest, c. 20 mb, on the 15th—16th and on the 21st.

In August the mean pressure was high, above 1018 mb, and the mean variability fairly small, c. $3\frac{1}{2}$ mb, at Myggbukta; on the other hand, the mean pressure was low, under 1007 mb, and the mean variability great, nearly 7 mb, near the Faroes. The wind was almost constantly northeasterly or northerly off the coast of Northeast Greenland; near East Iceland and the Faroes it ranged about northeast and north until the 17th and then mostly between east and south.

In the first week of the month the pressure was high, 1022—27 mb, near Northeast Greenland. Near the Faroes the barometer during the first five days fell gradually from 1013 to 995 mb; on the 5th—6th a depression of c. 990 mb moved slowly from Southwestern Norway to the Shetlands. From the 4th to the 6th a partly high northeasterly wind blew between the Faroes and Iceland.

During the following days the pressure differences were levelled out; on the 9th the height of the barometer at Myggbukta was c. 1018, near East Iceland and the Faroes c. 1012 mb. On the 10th—11th a rather weakly developed depression (below 1000 mb) moved in an easterly direction just south of the Faroes. It was succeeded by another, more strongly developed depression (c. 985 mb)—the deepest depression of the month—which moved close past the south of Iceland on the 13th and already next morning was found over the North Sea; however, this depression did not, either, give rise to disturbed weather conditions along the stretch Thorshavn—Myggbukta. A depression of less than 1000 mb, which arrived from the North Atlantic on the 14th, became stationary near the south of Iceland. A peculiar development of the weather took place on the 19th—20th, when a low pressure moved from Scotland to Iceland and at the same time deepened from 997 to 990 mb; it was repeated on the 21st—23rd, merely with the difference that in this case the lowest pressure was 985—990 mb all the time. At Myggbukta the pressure ranged between 1010 and 1025 mb during the last two weeks of the month; it was highest about the 22nd, and the steep gradient (pressure difference between Northeast Greenland and the Faroes up to 35 mb) gave rise to easterly or northeasterly gales from the 20th to the 24th over the sea north of Iceland.

During the last week of the month the pressure and wind conditions were fairly quiet. A slightly developed low of 1000 mb passed Iceland on the 28th, moving north, and on the 30th the height of the barometer reached 1025 mb near the Faroes.

In September the mean pressure was high, 1015 mb, near the Faroes and very high, 1024 mb, at Myggbukta. The mean variability of the pressure was less than that which is normal for the month, and fairly uniform ($4-4\frac{1}{2}$ mb). The wind direction was mainly between north and east off the coast of Northeast Greenland; near East Iceland and the Faroes it was chiefly about east from the 5th to the 22nd and about northwest during the last week of the month.

Nearly throughout the month the pressure was high near Northeast Greenland, and with the exception of a few scattered days and the period from the 18th to the 24th it was likewise high near East Iceland and the Faroes. The barometer was especially high, c. 1030—35 mb, on the 3rd within an area extending from Northeast Greenland over the Faroes to Belgium, on the 8th—9th over Northeast Greenland, and on the 29th—30th, when the pressure even exceeded 1035 mb at Myggbukta and south of Iceland.—In the first half of the month no depressions of any importance occurred over the area the Faroes—Northeast Greenland, the lowest reading of the barometer being only a little below 1010 mb, and the wind conditions were mostly quiet. On the 19th—20th, when a deep storm centre was found over the British Isles, in part high east-northeasterly winds blew near the Faroes. The lowest height of the barometer during the month, 992 mb, occurred near the Faroes on the 24th on the north side of an eastward-moving cyclone; after the passage of the cyclone the barometer rose about 32 mb in thirty-six hours, and at the same time a northerly gale was blowing. On the 26th—27th, when the highest pressure (above 1030 mb) was found south of Iceland, a cyclone, deepening fairly much, moved from Northeast Greenland to the North Cape.

Plate 3.

June—September 1931.

In June 1931 the mean pressure was high, c. 1015 mb, near the Faroes and East Iceland, and exceptionally high, 1023—24 mb, at Myggbukta. The mean variability was very small, c. 4 mb, at the Faroes and East Iceland and extraordinarily small, c. $2\frac{1}{2}$ mb, at Myggbukta.

In the first twenty days of the month the wind almost exclusively blew from the northeast and north; in the last ten days winds blowing from northerly directions were prevalent off the coast of Northeast Greenland, while westerly winds prevailed near East Iceland and the Faroes.

During the first ten days of the month and, though to a decreasing extent, also during the next ten days the weather was characterised by a stationary anticyclone which had its centre over North Greenland; at Myggbukta the pressure varied during the first thirteen days between 1028 and 1038 mb, falling slowly during the following week to 1020 mb. The high pressure culminated about the 5th, when the height of the barometer reached 1030 mb also near the Faroes. From the 7th to the 11th the Faroes, influenced by a low pressure area over the British Isles, had easterly wind with an atmospheric pressure of 1011—14 mb.

About the middle of the month the cyclonic activity over the British Isles began to a somewhat greater extent than hitherto to make itself felt over the southern and eastern parts of the northern seas; about the 20th a deep depression (c. 990 mb) travelled from central Norway towards the northwest to the sea east of Jan Mayen, an abrupt fall of the barometer thus terminating the long quiet anticyclonic period near Northeast Greenland. Immediately afterwards another, equally deep, depression pushed eastward close past the south of Iceland. After the passage of a high pressure ridge (1024 mb at the Faroes on the 24th) there followed a fresh depression, which reached Iceland on the 26th and then continued slowly towards the east-northeast.

In July the mean pressure was high, 1017 mb, at Myggbukta and low, c. 1004 mb, at the Faroes. The average pressure difference between these two places was thus exceptionally great; in accordance with this, northerly and northeasterly winds were highly predominant during the whole month.

The mean variability of the pressure was fairly great, nearly 5 mb, at the Faroes, but otherwise small, 3—3½ mb.

During the first days of the month a depression of c. 995 mb moved from South Greenland eastward to the Shetland Islands. On the 3rd a fresh, deeper depression (below 980 mb) reached the sea south of Iceland, where it filled up during the following days. On the 6th the barometer rose to c. 1015 mb near the Faroes; next day the pressure was almost 1025 mb at Myggbukta. About the 9th the pressure was fairly high, c. 1015—20 mb, and the wind conditions quiet near Iceland and Northeast Greenland. In the second third of the month the pressure varied generally between 1010 and 1020 mb near the coast of Northeast Greenland, while near the Faroes it decreased to 1000 mb in two instances, viz. on the 13th and 18th; on the whole the wind conditions were quiet until the 19th, when the wind was freshening from the north-northwest on the west side of a cyclone centred between Jan Mayen and northern Norway.

On the 21st—23rd a fresh depression of c. 990 mb moved slowly northeastward to Southeast Iceland; it was only accompanied by mod-

erately strong winds. During the following days the depression filled up, and an anticyclone was built up over the Northeast Greenland area, where the pressure amounted to c. 1025 mb from the 25th to the 28th; at the same time the pressure was low, c. 1000 mb, near the Faroes, and a rather strong northeasterly wind blew over parts of the intermediate area. On the 29th—30th a depression of c. 995 mb lay north of the Faroes, and at Myggbukta the barometer fell to c. 1000 mb during the last few days of the month.

In August the mean pressure along the stretch Northeast Greenland—the Faroes was somewhat above the average, being c. 1014 mb at Myggbukta, 1010 mb near East Iceland, and 1015 mb at Thorshavn. The mean variability of the pressure was almost normal (4—5 mb)—least near the Faroes.

At the beginning and the end of the month the direction of the wind was most frequently southwest to northwest; from the 7th to the 16th the wind was rather variable, and from the 17th to the 24th northerly winds prevailed.

From August 1st to the 5th a ridge of high pressure extended from the Azores across Scotland to the Baltic regions; north of this ridge some depressions moved northeastward or eastward—one of these, of c. 995 mb, passed Myggbukta on the 3rd. In the period from the 6th to the 14th the pressure along the stretch from Northeast Greenland to the Faroes was calm and fairly uniform, 1010—20 mb, except for a low pressure of c. 1000 mb which passed Scoresbysund on the 11th, moving east-northeastward. From the 15th to the 23rd the pressure was generally high, 1015—25 mb, near Northeast Greenland, and moderately high, 1005—15 mb, near the Faroes; in this period, also, the weather was on the whole quiet.

A period of more disturbed weather set in on the 24th with a rather considerable fall of the barometer over Greenland; a depression of c. 990 mb passed Angmagssalik on the 25th and Jan Mayen on the 27th—on its south side a high southwesterly wind blew on the 26th—27th. During the following days a strong high pressure spread from the North Sea area to Iceland; the highest pressure of the month, 1031 mb, was registered at Thorshavn on the 29th. An eastward-moving and deepening depression would seem to have passed Myggbukta on the same day, after which the barometer here also rose to over 1025 mb; in the night of the 31st Jan Mayen had a strong northwesterly gale.

In September, until the 12th, the general character of the weather was very quiet but subsequently the weather conditions were disturbed, in part highly disturbed.

The mean pressure for the whole month was high: about 1015 mb, at Thorshavn even 1019 mb. The mean variability of the pressure was

small, c. 4 mb, near the Faroes, but great, 6—6½ mb, near the coast of Northeast Greenland.

During the first, quiet, period of the month northerly winds prevailed; during the part of the month with disturbed weather conditions the wind was almost constantly southerly to westerly near the Faroes and East Iceland, while it repeatedly changed its direction off the coast of Northeast Greenland.

Up to the 12th the pressure was almost without exception between 1015 and 1025 mb along the whole stretch from Thorshavn to Myggbukta, and the variation of the pressure from day to day was very small. On the 1st Jan Mayen had high northwesterly wind and the Faroes a northerly gale on the 4th, but otherwise the wind conditions, also, were quiet.

On the day (September 13th) on which the disturbed weather set in the pressure conditions were as follows: a well-developed anticyclone (c. 1035 mb) southwest of the British Isles, with a ridge extending over Scotland to central Norway; a well-developed low (c. 995 mb) over Baffin Bay and another well-developed cyclone (c. 990 mb), which pushed rapidly north-eastward along the coast of Southeast Greenland. The last-mentioned depression passed Jan Mayen in the night before the 15th. During the following days a number of cyclones followed almost the same track, viz. through the Denmark Strait and onwards towards the east-northeast, moving close past Jan Mayen. Several of these depressions were accompanied by rather high winds, and the last one, which passed Northwest Iceland in the evening of the 17th and Jan Mayen next morning, had the character of a violent storm centre; at Isafjörður the lowest reading of the barometer was c. 976, at Jan Mayen 979 mb, and the pressure variations experienced in connection with the passage of the cyclone were very great (falls and rises of c. 20 mb in the course of twelve hours).

On the 20th, only two days after the passage of the centre of the depression, a ridge of high pressure extended from a very well-developed anticyclone (nearly 1040 mb) near West Ireland northward across Iceland to Northeast Greenland, where the pressure (at Myggbukta) amounted to 1027 mb. But already next day a depression, moving from the south along the western slope of the aforementioned high pressure, began to push northeastward along the east coast of Greenland; it continued to Spitsbergen, where, on the 23rd, the pressure fell to c. 985 mb.

The centre of the anticyclone, with a pressure of mostly 1035—40 mb, was lying over the British Isles from the 23rd to the 28th. On the 24th—25th and the 27th (just as on the 20th) a ridge of high pressure extended from here northwestward to Northeast Greenland; in the meantime (on the 26th) a deepening depression of c. 1005 mb moved

east-northeast around the north of Iceland. During the last days of the month another, more violent, cyclone (c. 990 mb) moved slowly from South Greenland to North Iceland.

Plate 4.

June—September 1932.

In June 1932 the mean pressure was high, c. 1015—18 mb, over the whole area Thorshavn—Myggbukta (lowest off Northeast Iceland and highest at Myggbukta). The mean variability of the pressure was moderate and fairly uniform (4—4½ mb).

On the first days of the month and in the period from the 12th to the 21st the weather situation was dominated by large anticyclones; the highest reading of the barometer, somewhat above 1030 mb, was registered on the 2nd near Northeast Greenland and on the 15th and the 17th—18th near the Faroes. A depression of 990 mb passed East Iceland on the 10th, moving northeast. On the last five days of the month the pressure was fairly high near Northeast Greenland, while a northeastward-moving low of 990 mb passed the Faroes in the night before the 27th, and a deep depression approached Scotland from the west on the 30th.

The wind conditions were as a rule quiet (see p.142f.); however, strong northerly winds were experienced off the coast of Northeast Greenland on the 10th—12th and near the Faroes on the 27th.

In July the mean pressure was high, c. 1017 mb, near Northeast Greenland and much lower, c. 1009 mb, near the Faroes and East Iceland. The mean variability only amounted to 3 mb at Myggbukta and c. 4½ mb near East Iceland and the Faroes. Northeasterly winds were predominant north of Iceland during the first ten days of the month and along the whole stretch from Myggbukta to Thorshavn from the 23rd to the 29th; with these exceptions the wind was rather variable and generally light.

Near Northeast Greenland the pressure ranged between 1010 and 1020 mb almost throughout the month, the highest value, c. 1025 mb, being registered on the 13th. On the 1st a deep depression (below 980 mb) was centred southwest of the Faroes, it moved north and later northwest and reached South Iceland on the 2nd; it gradually filled up, but right up to the 9th the pressure was generally below 1000 mb near South Iceland.—From the 11th to the 18th the pressure was mostly 1010—22 mb, and from the 19th to the 23rd c. 1005—15 mb along the whole stretch from the Faroes to Northeast Greenland. Then followed some days (24th—28th) on which the pressure was lowest, 1000—05 mb, near the Faroes; at the end of the month it was moderately high and fairly uniform along the whole stretch.

In August the mean pressure was low, c. 1007—09 mb, near North-east Greenland and East Iceland and relatively high, 1013 mb, near the Faroes. The mean variability ranged about the normal (c. $3\frac{1}{2}$ —5 mb). Between the Faroes and Iceland the wind was southwesterly or westerly during almost the whole month, but otherwise it was variable and as a rule rather light.

In the first twenty days of the month several—mostly eastward-moving—depressions of c. 995—1000 mb occurred, thus at Myggbukta on the 1st, near Iceland on the 2nd—4th and the 6th—8th, and north of Iceland on the 16th. From the 10th to the 26th the pressure was constantly high (generally 1025—30 mb) near the Faroes, while it was somewhat lower, 1005—15 mb, near Northeast Greenland. At the end of the month there was a rather deep depression (below 990 mb) at Angmagssalik, and on the 31st the barometer fell considerably near Iceland.

In September the mean pressure was low, c. 1004 mb, and the mean variability very great (9 and 7 mb respectively) near the Faroes and East Iceland; near Northeast Greenland, however, conditions were almost normal (mean pressure at Myggbukta 1011 mb, mean variability 4 mb). Northerly winds prevailed north of Iceland, while the wind was variable between Iceland and the Faroes; high wind forces occurred on several occasions during the month.

At the beginning of the month a very deep depression (below 975 mb) was found near West Iceland; a pressure of 978—80 mb was read near East Iceland on the 2nd and near the Faroes on the 3rd. Then followed, from the 4th to the 9th, the calmest period of the month. On the 10th a cyclone, moving east, passed just south of the Faroes, and another, deeper depression (c. 980 mb) moved from Northwest Iceland to the North Cape on the 14th—15th, followed by a very great rise of the barometer. In the morning of the 17th a weak depression was situated south of Iceland; it moved eastward, gradually deepening, and in the evening reached the Faroes, after which it deepened so much that next morning it had assumed the character of a storm centre of c. 980 mb; the centre then lay 200 km east of the Faroes. On the 20th the pressure rose above 1030 mb west of Scotland, but on the same day the cyclonic activity near Iceland started again; a depression of 1000 mb passed the Faroes in the night before the 22nd, moving east, and in the night of the 25th a depression of 980 mb occurred near the Hebrides, which in connection with a less deep depression between Jan Mayen and the Lofoten Islands dominated the weather conditions over the northern seas and the whole northwestern part of Europe. On the west side of the depression near Scotland a strong anticyclone gradually developed; on the 27th a high pressure wedge extended from its centre

north of the Azores to the Faroes; at the same time a violent cyclone (c. 990 mb) moved from South Greenland to the sea northeast of Iceland. This cyclone was followed by another, less intense depression, which passed Northeast Iceland on the 29th and reached central Norway on the 30th. In the night before the 30th the pressure was high, c. 1030 mb, from the coast of Southeast Greenland southward to c. 50° N. lat., while a deep depression (980 mb), hitherto moving in a northerly direction, was centred over Baffin Land (in c. 65° N. lat.); a fall of the barometer, in the circumstances great (from c. 1025 to c. 998 mb), which took place at Myggbukta in the course of twenty-four hours from 8 h. of the 30th September to 8 h. of the 1st October, seemed to be associated with this depression, but the observations from the intermediate area are too sparse to enable us to decide whether the depression itself or the fall of the barometer on its front side had crossed the inland ice.

The barogram for Thorshavn shows four deep, almost equidistant minima in the course of the month (on the 3rd, 11th, 18th, and 24th).

Plate 5.

June—September 1933.

In June 1933 the mean pressure was fairly uniform, c. 1010 mb, along the whole stretch Myggbukta—Thorshavn; the mean variability was comparatively small, 4—5 mb, farthest northward and farthest southward, while it was somewhat greater, c. 6 mb, near Northeast Iceland. The wind direction was rather variable.

In the first week of the month a depression was found south or southwest of Iceland. On the 7th—10th a cyclone moved in a northerly direction across Iceland and onwards west of Jan Mayen to Spitsbergen; after the passage of the cyclone there followed a great rise of the barometer, and a strong anticyclone developed over the sea west of the British Isles; the greatest height of the barometer, 1028 mb, was reached near the Faroes on the 9th. In the following days winds between the west and south prevailed. From the 14th to the 16th the barometer fell considerably (from over 1020 to less than 980 mb) near the Faroes, a depression approaching from South Greenland and at the same time deepening. The depression moved later, filling up, to East England, and a high developed near Northeast Greenland. Another high, extending from Southeast Greenland and Iceland to the Azores, dominated the weather situation on the 24th—25th.—After a quiet interval of nearly two weeks some cyclonic activity set in again near Iceland in the last days of the month.

Apart from the first five days July had very quiet weather conditions. The mean pressure was moderately high, c. 1011 mb, near

the Faroes and rather low, 1007 mb, at Myggbukta; the variability was small everywhere, c. 4 mb. The wind was southwesterly in the first week of the month, but subsequently it was variable and generally light.

On the northern and northwestern slopes of an anticyclone, whose centre at the beginning of the month was situated southwest of Iceland and later over the British Isles (on the 4th), the North Sea (the 5th), or Scandinavia (the 6th—7th), several depressions moved in a northeasterly direction along the east coast of Greenland; the deepest of them, c. 990 mb, passed Myggbukta on the 4th, and as the pressure at Thorshavn was at the same time 1025 mb, a generally fairly high southwesterly wind blew over the intermediate area.

From the 7th to the end of the month the pressure variations were generally small; the pressure was c. 1005—15 mb, with the exception of the period from the 10th to the 14th, when it was somewhat lower, and the 21st—23rd, when it was a little higher.

August had a rather low mean pressure—lowest near East Iceland (c. 1003 mb), somewhat higher at Myggbukta (1008 mb). The mean variability of the pressure was very small, c. 3 mb, at Myggbukta, but fairly great, 6 mb, near East Iceland and the Faroes. The prevalent wind direction was northeasterly north of Iceland and southwesterly near the Faroes, but the wind was on the whole rather variable in direction and force.

In the first half of the month several rather noteworthy depressions occurred, thus on the 2nd an eastward-moving cyclone of 990 mb north of Iceland, on the 7th—8th another eastward-moving cyclone of 990 mb near the Faroes accompanied by gales, and on the 13th—14th a depression which moved from Iceland towards Spitsbergen, meanwhile developing into a storm centre, gave rise to a strong northwesterly gale at Jan Mayen on the 14th. However, the most disturbed period of the month occurred from the 15th to the 19th: a depression, which on the 16th lay east of Iceland, moved slowly northwest—at first deepening to 980 mb, subsequently filling up—and reached Scoresbysund in the evening of the 17th; next night a deep cyclone (980 mb) passed the Faroes, moving north.

In the days from the 21st to the 26th the pressure and wind conditions were fairly quiet; the pressure varied from 1000 mb (near the Faroes on the 21st) to 1020 mb (at Scoresbysund on the 24th). On the 27th a deep cyclone was found near West Iceland, accompanied by gales. A less intense depression passed just north of the Faroes on the 31st, moving east.

In September the pressure and wind conditions were at times very disturbed. The mean pressure of the month was high, 1018 mb, near the Faroes, but comparatively low, under 1010 mb, at Scoresbysund and

Myggbukta. The mean variability of the pressure was fairly great, c. 6 mb, near the Faroes and very great, nearly 8 mb, north of Iceland. Between the Faroes and Iceland winds from southwesterly directions prevailed, except in the days from the 19th to the 23rd, when the wind was most frequently between southeast and northeast; near Northeast Greenland the wind frequently changed its direction.

During the first week of the month the pressure was generally high over Norway, and several cyclones moved in a northerly or northeasterly direction across the North Atlantic, Iceland, and the Greenland Sea; thus on the 6th a depression moved from West Iceland to Myggbukta, where its passage gave rise to very disturbed weather conditions, and a similar development took place on the 7th—8th, when the pressure at Myggbukta fell to 990 mb. At the same time the pressure near the Faroes was above 1030 mb, and southwesterly winds, partially reaching gale force, were blowing over the intermediate area.

The anticyclone, whose centre in the days from the 8th to the 11th lay over the North Sea region, gradually spread northwestward, so that on the 11th—13th the pressure was c. 1020—30 mb along the whole stretch Thorshavn—Myggbukta. In these days the wind conditions were fairly quiet, but already on the 14th a rather deep depression, moving northeast, advanced as far as North Iceland, thus marking the beginning of the most disturbed period of the month: on the 15th—16th a cyclone developed between Iceland and Jan Mayen, in the centre of which the height of the barometer in the morning of the 16th was very low, c. 975 mb; the cyclone, to some extent accompanied by gales, moved northwest and reached Myggbukta in the night before the 17th, but at that time it had filled up to 980 mb. Another depression arose on the 16th near the Azores and moved northeast, later north, deepening all the while and partially accompanied by high winds; it passed East Iceland on the 18th and twenty-four hours later it reached Myggbukta, where the lowest pressure registered was c. 990 mb.

In the following days the pressure was high over northern Scandinavia and fairly high over the greater part of the northern seas; a pressure of 1020 mb was registered on the 21st north of the Faroes, on the 22nd—23rd at Myggbukta, and on the 25—28th near the Faroes. A depression of c. 995 mb moved on the 24th—26th along the east coast of Greenland from Kap Farvel to Scoresbysund; on the 28th—29th another low moved rapidly and deepening considerably over Southeast Iceland and Jan Mayen, continuing towards Bear Island, which it reached on the 30th as an exceptionally deep and violent storm centre for this time of the year (c. 960 mb); at the same time the pressure had increased to 1025 mb near the Faroes.

Plate 6.

June—September 1934.

June was characterised by quiet pressure and weather conditions. The mean pressure was fairly high and rather uniform along the whole stretch (Thorshavn 1018, Myggbukta 1016 mb); the variability of the pressure was low near the Faroes and East Iceland, but somewhat greater at Myggbukta, especially at the beginning of the month.

The most remarkable occurrence of the month was a well-developed anticyclone, culminating on the 7th—8th, when the pressure northeast of Iceland rose above 1035 mb. At Thorshavn the pressure was almost without interruption above 1015 mb during the first half of the month.

On June 1st a cyclone of c. 1000 mb moved in a northerly direction from Iceland to Northeast Greenland. Otherwise no remarkable depressions occurred: only in two or three cases the pressure fell below 1005 mb over part of the area.

July. In the period from the 1st to the 23rd July the quiet type of weather continued which had characterised the whole previous month; the pressure remained between 1002 and 1025 mb over the whole area. The greatest height of the barometer occurred on the 3rd and the 8th—9th near the Faroes; in both cases the centre of the high pressure lay over the British Isles.

During the last week of the month there was a somewhat more intense cyclonic activity near East Iceland; it commenced on the 24th—25th, when a depression, deepening rather much (to c. 988 mb), moved from the sea southwest of Iceland to the sea north of the Faroes. Near Northeast Greenland the pressure remained above 1005 mb during the rest of the month; the gradient between Northeast Greenland and East Iceland was considerable during the last week of the month, when northeasterly or northerly winds, at times strong, prevailed over this area.

In August conditions were still quiet near Northeast Greenland, where the lowest pressure registered during the month was 1008 mb, while a rather intense cyclonic activity at times prevailed near the Faroes and East Iceland; the mean pressure at Myggbukta was 1013 and at Thorshavn 1004 mb, and the mean variability of the pressure was $2\frac{1}{2}$ and $6\frac{1}{2}$ mb respectively; northeasterly winds prevailed over the intermediate area.

The most strongly developed cyclones occurred on the 9th—11th (pressure below 995 mb near the Faroes), the 15th (below 995 mb near East Iceland), the 22nd (below 990 mb near the Faroes), and the 28th—30th, when a low of 980—90 mb was centred south of Iceland. The most remarkable anticyclone of the month occurred on the 31st, when

the barometer rose above 1025 mb in Northeast Greenland. The pressure difference between Myggbukta and Thorshavn amounted to as much as 20—30 mb several times during the month (on the 10th, 22nd, and 30th); high winds especially occurred on the 28th—30th (from the southeast and east).

In the barograms for Thorshavn and for point C a rather marked symmetry will be noted about August 15th; the symmetry is also found in diagram II (July), in which e. g. the low pressure on the 20th—23rd corresponds to that on the 9th—11th.

September was noteworthy on account of an intense cyclonic activity near the Faroes and Iceland, while the pressure variations remained small near Northeast Greenland. At Myggbukta the mean pressure was 1012 mb, at East Iceland 1000, and at the Faroes 1003 mb, the mean variability being $3\frac{1}{2}$, 8, and $6\frac{1}{2}$ mb respectively. North of Iceland winds were blowing from northeasterly directions almost throughout the month.

Four especially violent cyclones occurred in September: on the 3rd—4th a cyclone moved northward from the sea northwest of Ireland, curving left, to Iceland, at the same time filling up from 975 to 990 mb; on the 8th—9th a cyclone of 985 mb moved rapidly from North Ireland northward across the Faroes to Jan Mayen; on the 19th—20th a deep depression (975—80 mb) occurred off Northeast Iceland, moving slowly east; and on the 26th—27th an almost equally deep depression travelled from the sea south of Iceland northeastward to the sea between the Faroes and Jan Mayen, where it soon filled up.

A pressure of c. 1025 mb was registered in Northeast Greenland at the beginning of the month and on the Faroes on the 6th and the 14th; the centre of the anticyclone lay off the coast of central Norway on the 6th and over central Scandinavia on the 14th.

Rapid variations in the pressure took place in several cases near the Faroes and Iceland, especially in the period from the 3rd to the 10th.

As examples of days with a steep gradient and high wind over part of the area between the Faroes and Northeast Greenland the following may be mentioned: the 1st and the 3rd—4th (northeasterly wind), the 8th—9th (strong winds from variable directions near the Faroes), the 12th—13th (south to southwest winds between the Faroes and East Iceland), the 18th—21st (strong northerly wind along the coast of Northeast Greenland and, at times, near Iceland), and the 25th—27th (strong northeasterly wind near Northeast Greenland and North Iceland).

Plate 7.

June—September 1935.

June 1935 had a mean pressure of 1017 mb at Myggbukta and 1010 mb at the Faroes; the mean variability was 3 and $5\frac{1}{2}$ mb respectively.

During the first half of the month the pressure was constantly high, 1015—30 mb, near Northeast Greenland, while lows of c. 990 mb occurred near the Faroes on the 7th—8th and the 12th and near East Iceland on the 9th; the last-mentioned depression was associated with rapid pressure variations. The wind blew most frequently from northerly directions, and the force of the wind was mostly moderate, though high northeasterly winds prevailed northeast of Iceland on the 9th and 13th.

During the last half of the month the pressure was as a rule fairly uniform along the stretch the Faroes—Northeast Greenland, being most frequently between 1000 and 1020 mb. In front of a deep depression centred southwest of Iceland rather strong southeasterly winds prevailed on the 20th—21st.

In July the weather had a rather disturbed character near the Faroes and East Iceland, where the mean pressure was 1010 and 1004 mb respectively and the mean variability $6\frac{1}{2}$ and $7\frac{1}{2}$ mb respectively. At Myggbukta the mean pressure was 1010 mb and the mean variability only 3 mb.

No remarkable anticyclones occurred during the month—the greatest height of the barometer was 1023 mb at the Faroes on the 14th—but there were a great many lows, some of which were rather deep and intense. The direction of the wind was mainly northeast between Iceland and Northeast Greenland and variable, though chiefly southwesterly, near the Faroes.

On the 12th—13th the pressure was low, c. 990—95 mb, along the east coast of Greenland between Angmagssalik and Scoresbysund, and south-southwesterly winds, at times strong, prevailed over the sea near and to the north of the Faroes. On the 15th a depression of 985 mb moved across Iceland approximately from Reykjavik to Seyðisfjörður, accompanied by high winds over a large area. A less violent depression (c. 995 mb) on the 19th—21st followed an exceptional track, viz. from central Norway to the sea north of Iceland. Especially disturbed weather prevailed in the period from the 23rd to the 28th, when three depressions in succession moved in a northeasterly or easterly direction over or close past the south of Iceland. The last of these depressions was the deepest; on the 27th the pressure between the Faroes and Iceland fell below 985 mb. For the week from the 22nd to the 28th July the mean variability of the pressure at Seyðisfjörður amounted to c. 8 mb, which

is rather exceptional at this time of the year. After the passage of a ridge of high pressure in the night before the 30th, a fresh depression moved across Iceland from the southwest already in the next afternoon.

August had about the same mean pressure as July, viz. 1010 mb at Myggbukta, 1006 at East Iceland, and 1009 at the Faroes; the mean variability of the pressure was $3\frac{1}{2}$, $4\frac{1}{2}$, and 4 mb respectively. The direction of the wind was rather variable, though mostly northeasterly between Iceland and Northeast Greenland and mostly southwesterly near the Faroes. The period from the 13th to the 17th was very quiet, whereas the days around the 8th, the 20th, and the 25th—27th had rough weather. The deepest depressions occurred on the 8th (988 mb near Northeast Iceland), the 20th, when a depression of c. 985 mb passed Seyðisfjörður, moving north, the 25th (990 mb near Northeast Iceland), and the 27th, when a well-developed depression of c. 987 mb moved from the North Sea to the Faroes and then, filling up, curved towards the southwest during the evening and the night. On the 27th—28th a strong anticyclone developed over the Arctic regions, and the greatest height of the barometer during the month, c. 1025 mb, was registered on the 30th at Myggbukta, Scoresbysund, and Jan Mayen.

In September the mean pressure was high, 1018 mb, at Myggbukta, almost normal, 1008 mb, near East Iceland, and low, 1004 mb, at Thorshavn. In accordance herewith the prevalent wind direction along the whole stretch from Northeast Greenland to the Faroes was east or northeast, the cyclones followed fairly southerly tracks, and the variability of the pressure was greatest at Thorshavn (7 mb), and much less ($3-3\frac{1}{2}$ mb) near East Iceland and Northeast Greenland.

In the first days of the month the pressure was high, c. 1020 mb, near Northeast Greenland, while a depression of 995—1000 mb was centred near Scotland; between the Faroes and Iceland there blew at times a high northeasterly wind. Then followed some days—6th—9th—with a uniform, high and steady pressure (1022—30 mb) and light winds. From the 9th to the 13th the barometer fell from 1027 to 986 mb near the Faroes, but at Myggbukta only from 1027 to 1018 mb. In the following days, to and including the 19th, the pressure was mostly 1010—20 mb at Myggbukta and 977—90 mb at Thorshavn; the pressure difference between these two stations rose to an exceptionally high value for the season, c. 40 mb, on the 16th—17th, when a nearly stationary depression of c. 975 mb was centred near the Faroes, and the strong northeasterly wind to the east and north of Iceland probably culminated in these days. On the 18th—19th, when the pressure was moderately high over Greenland, while an almost stationary low of 980 mb was centred near the Lofoten Islands, an exceptionally strong north-northwesterly gale was experienced at Jan Mayen. On the 19th

a deep depression (970 mb) passed North Scotland, moving east; in its rear the barometer rose very rapidly—thus at Thorshavn from 981 to 1016 mb in the course of thirty-six hours—and in the days from the 21st to the 25th the pressure was fairly uniform, 1010—23 mb, along the stretch from the Faroes to Northeast Greenland. Subsequently sharp contrasts developed again, thus in the night before the 27th the barometer rose to 1027 mb at Myggbukta, but fell at the same time to 1000 mb at the Faroes, and the easterly wind increased once more though it did not attain very high forces. A general fall of the barometer over the sea between northern Norway and North Greenland in the night before the 29th merely occasioned a temporary change of the situation; at the end of the month the easterly wind again increased near Northeast Iceland.

Plate 8.

June—September 1936.

June had a mean pressure of 1016 mb near Northeast Greenland, 1011 mb near East Iceland, and 1014 mb near the Faroes; the mean variability of the pressure was rather great, viz. 4, $5\frac{1}{2}$, and 5 mb respectively. The wind was mostly between southeast and southwest near the Faroes, but was otherwise variable.

The pressure was high, c. 1015—25 mb, and the wind conditions quiet during the first days of the month, but on the 5th a deep depression—c. 985 mb—moved along the north coast of Iceland; another cyclone passed Iceland in the night before the 9th, deepening to c. 985 mb, and reached Jan Mayen in the morning of the 10th; these cyclones were both accompanied by rather high winds. On the 11th a well-developed cyclone of 985 mb was centred near Southwest Iceland. Then followed some days with fairly quiet weather conditions. In the morning of the 18th the pressure was high, above 1025 mb, near the west coast of southern Norway, while a deep depression was centred near Southwest Greenland; this depression moved over Angmagssalik to Myggbukta, where a fall of the barometer from 1002 to 984 mb in the course of 19 hours was registered from the evening of the 18th to the afternoon of the 19th—an exceptionally great fall for the locality and the season; the pressure remained high near western Norway, and southwesterly winds, at times strong, were blowing between the Faroes and Northeast Greenland from the 18th to the 20th. During the following days the weather situation was characterised by a well developed ridge of high pressure extending from the North Atlantic over the Faroes to Scandinavia; on the 24th—27th the pressure was highest southwest of Iceland, and in the last days

of the month it was c. 1010—20 mb over the whole area between the Faroes and Northeast Greenland.

July. The mean pressure was comparatively high, c. 1014 mb, at Myggbukta and Scoresbysund, but low, c. 1006 mb, near the Faroes. The mean variability was rather small—at Myggbukta $2\frac{1}{2}$ and at the Faroes $4\frac{1}{2}$ mb. Northeasterly winds were prevalent.

Until the 9th the pressure near Northeast Greenland was between 1005 and 1015 mb; from the 11th to the 19th it was constantly 1020—25 mb, and from the 21st to the 28th again 1005—15 mb. Near the Faroes the pressure ranged between 1000 and 1010 mb during the greater part of the month; here it was lowest, c. 995 mb, on the 9th—10th (during the passing of a depression moving slowly northwest), on the 15th—16th, when the pressure difference between Myggbukta and Thorshavn amounted to 27 mb, and on the 24th—25th, when a depression moved from North Ireland to the Faroes, but at the same time filled up from 980 to 995 mb. Besides, rather deep depressions (c. 980 mb) occurred near Southwest Iceland on the 3rd—4th and east of Jan Mayen on the 28th. A rather high northeasterly wind blew near the Faroes on the 24th, and a strong northwesterly gale at Jan Mayen on the 28th (see p. 146 f.), but otherwise the wind conditions were generally fairly quiet.

In August the mean pressure was 1009 mb at Myggbukta, 1005 mb at Seyðisfjörður, and 1010 mb at Thorshavn; the mean variability of the pressure was 3, 6, and 5 mb respectively. The wind was rather variable, though chiefly southwesterly near the Faroes and chiefly northeasterly north of Iceland.

During the first half of the month the pressure was generally between 1000 and 1015 mb, and the wind conditions were on the whole quiet; however, a rather high easterly wind blew north of Iceland on the 13th, when a depression of 990 mb was centred near Isafjörður. Then followed a period with more disturbed weather; on the 17th—20th a well-developed depression of 985—90 mb moved slowly from the sea south of Iceland to the sea off East Iceland, and after a high pressure ridge had passed, a very considerable fall of the barometer took place in the night before the 23rd (at Seyðisfjörður 20 mb in the course of 13 hours) in the front of a depression whose centre (c. 985 mb) moved across northern Iceland. Subsequently the depression moved off in an east-northerly direction, and at the same time a well-developed anticyclone over the Channel regions spread northward; the maximum height of the barometer during the month, 1026 mb, was registered at Thorshavn on the 25th. A low of somewhat less than 1000 mb on the 29th—30th moved fairly rapidly from the Denmark Strait to central Scandinavia. At the end of the month the pressure was low east of Jan

Mayen and high over Greenland, a rather high northwesterly wind blowing off the coast of Northeast Greenland.

September had a fairly high mean pressure, 1016 mb, near the Faroes; at East Iceland and Myggbukta the mean pressure was c. 1013 mb. The mean variability of the pressure was c. 5 mb in all these places. The wind was rather variable, but chiefly between the southeast and southwest.

During the first week of the month the pressure was generally high, about 1020 mb, over Northeast Greenland; on the 2nd a ridge of high pressure extended from Northeast Greenland to the Faroes, but during the following days the barometer fell rather considerably near the Faroes and Scotland; near the Hebrides there was, on the 5th, a depression of c. 990 mb, and on the 7th a rather intense cyclone of 980 mb. The pressure difference between Myggbukta and Thorshavn amounted to 27 mb on the 7th, but was entirely levelled out in the course of the next twenty-four hours. On the 10th a depression of 990 mb occurred near Southwest Iceland, and on the 12th another depression of 996 mb, moving north close past Seyðisfjörður. In the rear of this depression the barometer rose considerably; on the 15th an anticyclone of 1030—35 mb extended from Ireland over the Faroes to southern Norway. In the morning of the 16th the anticyclone (nearly 1040 mb) was centred over southern Norway, while a storm centre (below 990 mb) northwest of Iceland was moving north-northeast; the centre passed Myggbukta in the evening, a pressure as low as 985 mb being registered here after an extraordinarily rapid fall (16 mb in the course of 11 hours). (The pressure distribution over the northern seas in the evening of the 16th September 1936 shows a remarkable similarity to the pressure distribution in the morning of the 19th June 1936, but otherwise it represents a type which is of rather rare occurrence in the summer half-year.—Further it can be mentioned that on the 16th of September a cyclone, exceptionally deep for the season (c. 975 mb), was centred west of Baffins Land.) On the 17th a fresh cyclone of 990 mb moved rapidly northeast along the coast of Greenland from Angmagssalik to Scoresbysund. During the following days the pressure differences were gradually levelled out, and during the last week of the month the pressure was generally high and fairly uniform, c. 1015—25 mb, over the whole area between the Faroes and Myggbukta; however, an eastward-moving cyclone of 1004 mb passed Myggbukta in the evening of the 27th, deepening considerably.

Plate 9.

June—September 1937.

In June 1937 the mean pressure was moderately high, 1011 mb, near the Faroes and rather low, 1006—08 mb, along the stretch from East Iceland to Northeast Greenland. The mean variability of the pressure was 5—6 mb, increasing towards the north. The wind was rather variable, but blew more frequently from westerly than from easterly directions.

During the first week of the month several cyclones of c. 1000 mb occurred, especially near Iceland, but as a rule they were not accompanied by high winds. Two somewhat more vigorous cyclones (below 995 mb) passed East Iceland on the 9th and the Faroes on the 10th respectively. Then followed a fairly long period, from the 11th to the 23rd, with a high pressure, c. 1015—25 mb, near the Faroes; a depression of 1000 mb passed north of Iceland on the 13th—14th, and another passed Northeast Greenland, moving east, on the 18th.

On the 23rd, when a low near the west coast of Greenland (off Godthaab) was filling up, another low developed near the east coast (between Anglagssalik and Scoresbysund); the last-mentioned depression moved east, deepening very considerably, and subsequently north, passing east of Jan Mayen, where a very low pressure (below 975 mb) was registered on the 25th—26th (see p. 143 f.). A rather high wind from westerly directions blew on the southern and western sides of this depression. A cyclone (below 990 mb) passed south of the Faroes on the 28th.

In July the pressure was moderately high, 1012 mb, near the Faroes and Myggbukta and somewhat lower, 1008 mb, near East Iceland. The mean variability of the pressure was fairly uniform, 4—5 mb. Between the Faroes and Iceland the wind mostly blew from southerly directions, but north of Iceland it was most frequently between north and southeast.

At the beginning of the month a depression was centred south of Iceland; it deepened slowly and moved northeast to East Iceland, where a pressure of 985 mb was registered in the night before the 3rd; subsequently the low moved off towards the north. In the period from the 5th to the 12th the pressure was high, c. 1015—22 mb, near Northeast Greenland and moderately high near the Faroes. About the 14th a stationary cyclone was centred south of Iceland; on the 15th—16th another, rather weak low which developed southeast of this cyclone, moved northward to Jan Mayen. On the 19th a fresh depression of 1000 mb passed East Iceland, moving towards Jan Mayen, and on the 21st a low of 995 mb passed south of the Faroes towards southwestern Norway. Then the pressure was moderately high and fairly uniform until the 30th, when an intense northward-moving cyclone (below 990 mb)

passed West Iceland; this cyclone reached Myggbukta by noon of the 31st and the North Pole in the evening of August 1st.

In August the mean pressure was fairly high, 1013 mb, near the Faroes and a little lower, c. 1008 mb, along the stretch East Iceland—Myggbukta. The mean variability was greatest, $6\frac{1}{2}$ mb, near the Faroes and least, 4 mb, at Myggbukta. Between the Faroes and Iceland the wind was most frequently southerly or southwesterly, north of Iceland most frequently between south and east.

At the beginning of the month the pressure was high, 1025 mb, near Scotland; on the 3rd—4th it was low, c. 1000 mb, at Myggbukta. A cyclone (below 990 mb) passed the Faroes on the 8th accompanied by rather rough weather; the pressure was likewise low near West Iceland on the 11th—13th and northeast of Iceland on the 16th—17th. On the 20th—21st the pressure was high, 1020 mb, near the Faroes and low, about 1000 mb, over Greenland. The deepest and most violent cyclone of the month (below 980 mb) passed East Iceland on the 24th and Jan Mayen in the morning of the 25th, whence it proceeded to the North Pole (see p. 148 ff.); on its south side there followed a considerable rise of the barometer, and on the 26th the pressure was c. 1025 mb near the Faroes; in the evening of the same day a rather well-developed cyclone of c. 990 mb passed Iceland, moving northeast. The end of the month had fairly high pressures and rather quiet weather conditions.

Apart from some few days around the 20th, September had very disturbed pressure and wind conditions.

The mean pressure was highest, 1009 mb, at Myggbukta, and lowest, 1000 mb, near East Iceland; the mean variability was great, c. 6 mb, near Northeast Greenland and very great (nearly 9 mb) near East Iceland and the Faroes. Between the Faroes and Iceland the wind varied rather frequently between southeasterly and northwesterly directions; north of Iceland northerly and northeasterly winds were highly predominant.

At the beginning of the month a storm centre of c. 970 mb lay southwest of Iceland, moving slowly in an easterly direction and filling up.

On the 5th the pressure was fairly uniform, about 1000 mb, over the whole area between the Faroes and Northeast Greenland, but in the course of the day a cyclone developed southeast of Kap Farvel; already in the morning of the 6th, when it reached South Iceland, it had developed into a deep storm centre of 965 mb. This cyclone continued towards the east-northeast, and it did not begin to fill up until the 8th, when it lay northwest of the Lofoten Islands. During its passage easterly winds, backing north, were experienced over the sea north of Iceland, and, in the night before the 7th, a strong southerly gale, veering west, near the Faroes.

In accordance with the considerable fall of pressure in front of the storm centre—near East Iceland c. 30 mb in the course of twenty-four hours—there followed, in its rear, a great rise of the barometer, which continued right from the 10th, when in the evening a ridge of high pressure (c. 1030 mb) extended from the sea west of the British Isles across East Iceland to Northeast Greenland; the rise near East Iceland amounted to c. 25 mb during the first twenty-four hours and further 40 mb during the next three days.

The anticyclonic ridge gradually moved east, a fresh northeastward-moving, rather weak depression reaching Iceland on the 12th. A more strongly developed cyclone of c. 975 mb on the 14th approached the Faroes from the west, but changed its direction next day, moving towards Ireland, and at the same time a ridge of high pressure developed along the east coast of Greenland.

The following days—the 16th—20th—constituted a fairly quiet period, the pressure difference being levelled out more and more. A cyclone (below 1000 mb) passed just north of the Faroes on the 22nd, moving east, and another, much more intense cyclone (c. 975 mb) on the 24th moved across the northern seas from the Faroes to the Lofoten Islands; in the rear of this cyclone there followed a fairly great rise of the barometer (to about 1015 mb), which, however, was succeeded by a fresh fall already in the night before the 27th.

During the following days another deep cyclone moved from the southernmost point of Greenland (985 mb on the 28th) across western Iceland (975 mb on the 30th) to Jan Mayen. Especially on the 29th a high northeasterly wind blew off Scoresbysund and a high southwesterly wind near the Faroes.

Plate 10.

June—September 1938.

In June 1938 the mean pressure was moderately high, 1013 mb, at Myggbukta and low, 1005—07 mb, near East Iceland and the Faroes. The mean variability of the pressure was low, 3 mb, near Northeast Greenland and great, $6\frac{1}{2}$ mb, near the Faroes. Off the northern part of the east coast of Greenland northerly and northeasterly winds were highly prevalent; near East Iceland and the Faroes the wind was more variable, but here, too, most frequently between the west and the northeast.

In the period from the 3rd to the 8th June the pressure was low south of Iceland and fairly high over Northeast Greenland; on the 7th the pressure difference between Myggbukta and Thorshavn amounted to 30 mb, and at Scoresbysund the wind increased to a fresh gale from the

northeast. Then followed a period, from the 10th to the 18th, when the pressure was highest, c. 1015—20 mb, near the Faroes; a low of c. 1000 mb moved eastward along the north coast of Iceland on the 12th and 13th, while a depression was centred at Scoresbysund on the 15th—16th and another near Southeast Greenland on the 16th—18th. The latter cyclone, in the centre of which the pressure was c. 990 mb, passed Iceland, moving east, on the 19th, and another eastward-moving depression of c. 990 mb passed the Faroes on the 21st, succeeded by a briskly rising barometer. At the end of the month, on the 25th—30th, the cyclones followed more southerly tracks, the pressure remaining fairly high, c. 1015 mb, at Myggbukta, and strong winds from northerly directions blowing at times northeast of Iceland—thus on the 27th—28th, when a depression, very deep for the season (970 mb), passed the Shetland Islands, and on the 29th—30th, when a low of 980 mb was centred off the coast of central Norway.

July had about the same mean pressure as June: 1011 mb at Myggbukta and 1005—07 mb near East Iceland and the Faroes. The mean variability of the pressure was very small, $2\frac{1}{2}$ mb, at Myggbukta and rather great, a little more than 5 mb, near the Faroes. During the first half of the month northerly and northeasterly winds prevailed; during the second half the wind direction was mostly between northeast and southeast off the coast of Northeast Greenland and between southeast and southwest near East Iceland.

The pressure remained as a rule between 1000 and 1020 mb, and the wind conditions were generally rather quiet. A fairly well-developed anticyclone (c. 1020 mb) extended from the Denmark Strait to the sea north of Norway on the 7th—9th. On the 11th a depression of c. 995 mb was centred near the Faroes, on the 13th—14th south of Iceland, on the 20th near North Iceland, on the 23rd near East Iceland, and on the 29th—30th near East Iceland; the greater number of these depressions moved slowly in an easterly or a northerly direction.

In August the mean pressure was 1012 mb near the Faroes and 1009—10 mb along the stretch East Iceland—Northeast Greenland. The mean variability of the pressure was fairly uniform, c. 4 mb. During the first half of the month southerly winds prevailed, especially near the Faroes and East Iceland; during the second half northerly winds were most frequent, especially off the coast of Northeast Greenland.

On August 1st a cyclone moved slowly northeast between Iceland and Jan Mayen; the pressure rose on the south side of the cyclone, amounting to c. 1028 mb near the Faroes on the 2nd—3rd. On the 7th—9th several depressions (below 1000 mb) moved across Greenland in a northeasterly direction, while the pressure remained high near the Faroes until the 11th. From the 10th to the 15th the pressure difference along

the stretch Thorshavn—Myggbukta were small. Then followed some days—from the 16th to the 21st—on which the pressure was moderately high near Northeast Greenland and low near the Faroes; the gradient culminated on the 19th—20th, when a low of c. 980 mb was centred east of the Faroes and northerly gales occurred along the stretch from Spitsbergen to Iceland and the Faroes.

On the 21st—22nd the velocity of the wind decreased, as an anticyclone moved from Greenland to the northern seas; but already on the 23rd the weather was influenced by a rather deep and intense cyclone (c. 985 mb) approaching Iceland from the southwest; this cyclone passed Iceland on the 24th, at the same time filling up to 995 mb. Another, less intense cyclone passed north of Iceland on the 26th and south of Jan Mayen on the 27th. In its rear a rather vigorous anticyclone developed, which dominated the weather near Iceland and East Greenland during the last days of the month.

In September the mean pressure was approximately normal, 1010 mb, near the Faroes and low, 1004—06 mb, from East Iceland to Northeast Greenland. Over the area under consideration the mean variability of the pressure was everywhere c. 5 mb. Off the east coast of North Greenland the wind was rather variable, though most frequently northerly or easterly; near East Iceland and the Faroes, however, the wind was mostly southerly, while winds blowing from northeasterly directions hardly occurred.

During the first week of the month the pressure was mostly 1010—20 mb near the Faroes and 1005—15 mb near Northeast Greenland; on the 7th the barometer rose to 1025 mb near the Faroes. On the 8th a cyclone of c. 995 mb moved from the Denmark Strait to Jan Mayen, accompanied by rather high winds. On the 9th, when the pressure was nearly 1025 mb near the Faroes and c. 995 mb between Scoresbysund and Jan Mayen, Iceland and the surrounding waters had rather high southwesterly winds. Another depression moved across Iceland on the 11th—12th in an easterly direction. Then followed some days, 14th—17th, with a fairly uniform, moderately high pressure and quiet wind conditions. On the 18th the pressure was fairly high near the Faroes and low over the Denmark Strait; on the 20th—23rd, however, it was low, c. 985 mb, south of Iceland and fairly high at Myggbukta. The deepest depression of the month, below 985 mb, passed East Iceland in the night of the 25th in the direction of Jan Mayen; a rather strong southerly wind blew on its east side. At the end of the month the pressure was generally higher near the Faroes (1015—18 mb on the 27th) than at Myggbukta (993 mb in the night before the 29th).

Plate 11.

June—September 1939.

In June 1939 the mean pressure was fairly high and uniform, 1014—15 mb, along the stretch Thorshavn—Myggbukta; the mean variability of the pressure was great, 6 mb, near the Faroes, but otherwise moderate, $4\frac{1}{2}$ —5 mb. Off Northeast Greenland the direction of the wind was mostly between west and north though fairly often easterly also; near East Iceland and the Faroes the wind was mainly southwesterly during the first ten days, southeasterly about the middle of the month, and blowing from northerly directions during the last ten days.

At the beginning of the month the pressure was high over Northeast Greenland and very high, above 1030 mb, near Scotland. Both these high pressures decreased somewhat in intensity during the following days; weak lows passed east-northeastward just north of Iceland on the 4th—5th and just north of the Faroes on the 6th. A much more intense cyclone (below 990 mb) moved across Iceland on the 10th, travelling towards the Lofoten Islands. After a few quiet days, another equally deep depression in the night before the 13th made its way from the southwest to the western part of the Denmark Strait; on the southeastern side of this depression another depression developed, which lay south of Iceland on the 15th—16th. During the following days the barometer rose considerably (near the Faroes 45 mb in six days); from the 19th to the 24th the pressure was generally 1020—30 mb over the whole area Thorshavn—Myggbukta, and on the 21st it was even nearly 1040 mb at South Iceland, an exceptionally high value for the season.

The quiet weather persisted until the 28th, when a rather well developed cyclone approached the Faroes from the south; on the Faroes the lowest pressure during the month, 990 mb, was registered on the 29th; a rather narrow belt between the Faroes and Iceland had north-easterly gales during the last days of the month.

In July the mean pressure was high, 1016 mb, near Northeast Greenland and rather low, 1008 mb, near the Faroes. The mean variability of the pressure was rather small everywhere (3—4 mb). Near the coast of Northeast Greenland the weather was as a rule calm, or a light wind blew from northerly directions; near East Iceland and the Faroes winds from northeasterly directions were highly prevalent.

At Myggbukta the pressure remained above 1010 mb during nearly the whole month (as also during the last half of June), and on several days (1st—3rd, 6th, 12th, 17th—18th, 23rd, and 25th) it was a little above 1020 mb. Between Iceland and Jan Mayen similar conditions prevailed, except that a low of 995 mb was centred a little north of Iceland on the 20th. Near the Faroes the pressure was c. 1005—15 mb

during the first half of the month and c. 1000—10 mb during its last half; a low of 995 mb moved on the 17th from the northernmost part of the North Sea to the Faroes, and on the 29th a stationary low of 995 mb was centred between the Faroes and the Hebrides.

In August the mean pressure was c. 1012 mb at Myggbukta and c. 1014 mb near the Faroes, while it was lower over the intermediate area, thus in 68—70° N. lat. it was c. 1008 mb. The mean variability of the pressure was c. 4 mb at Myggbukta, c. 4½ mb at Thorshavn, and somewhat greater, up to 5½ mb, over the intermediate area. Over the northern part of the area the wind blew mostly from easterly directions, over the southern part most frequently from the south or southwest.

From the 3rd to the 25th August the development of the weather was characterised by a rather persistent cyclonic activity; in the centres of the cyclones the pressure was in most cases c. 995 mb. Such cyclones occurred on the 3rd near Myggbukta (moving east), on the 8th near West Iceland, on the 10th—11th near the Faroes, on the 12th near Jan Mayen (accompanied by high northerly winds on the west side), further, on the 14th—15th near Scoresbysund, on the 17th—18th near Northwest Iceland, on the 22nd northeast of Iceland (moving towards Jan Mayen), and finally on the 24th—25th near Iceland, where a cyclone accompanied by gales moved slowly in a northerly direction. The highest pressure up to the 25th was c. 1022 mb (near the Faroes on the 4th and the 20th and at Myggbukta on the 24th).

At the end of the month the weather situation was dominated by a well-developed anticyclone, over the Norwegian Sea or over Scandinavia; on the 26th a pressure of 1027 mb was registered near East Iceland.

September was characterised by a very high mean pressure: 1020 mb at Thorshavn, 1018 mb over East Iceland, and 1022 mb at Myggbukta. The mean variability of the pressure was fairly uniform, c. 5—5½ mb, over the whole area. Off the coast of Northeast Greenland the wind most frequently blew from northerly directions; near East Iceland and the Faroes it was southeasterly or southerly during the first week, variable during the second week, and mostly between southwest and northwest during the last half of the month.

At the beginning of September the pressure was high, c. 1020—25 mb, from North Greenland to Scandinavia; from the 4th to the 7th it was rather low, c. 1005 mb, near West Iceland. A depression of c. 1000 mb passed the Faroes on the 8th, moving east-northeast, another depression—likewise of 1000 mb—passed south of the Faroes on the 10th, followed by a briskly rising barometer.

About the middle of the month the cyclonic activity was rather intense; one cyclone of 995 mb moved east-northeast across Iceland on the 12th—13th, another passed north of Iceland on the 15th, and a

third followed the east coast of Greenland from Kap Farvel to Scoresby Sund on the 18th—19th. However, already on the 17th an anticyclone (above 1030 mb) had developed south of the Faroes; on the 19th a rather high southwesterly wind blew along the northern slope of this high pressure, but in the evening a great rise of the barometer set in over Northeast Greenland with northerly winds, and from the 20th until the end of the month the pressure was generally 1020—35 mb over the whole area between Thorshavn and Myggbukta. The greatest height of the barometer, 1040 mb at Myggbukta on the 23rd, was exceptional for the season; on the Faroes a pressure of 1036 mb was registered on the 27th.

On the 26th, when the central area of the anticyclone extended from the Faroes and Iceland to central Greenland, remarkably high temperatures occurred near the shores of Greenland owing to foehn winds; thus at 1 h. Julianehaab had ESE 4, 14°, and Godhavn E 5, 10°, and at 7 h. Myggbukta had N 6, 8°.

LITERATURE

1. AHLMANN, H. W.: Den nutida klimatfluktuationen. (Ymer 1941.)
2. BAUR, FRANZ: Das Klima der bisher erforschten Teile der Arktis. (Arktis 1929, Heft 3—4.)
3. BIRKELAND, B. J.: Mittel und Extreme der Lufttemperatur. (Geof. Publ. XIV Nr. 1, Oslo 1936.)
4. BIRKELAND, B. J. und FØYN, N. J.: Klima von Nordwesteuropa und den Inseln von Island bis Franz-Josef-Land. (Handbuch der Klimatologie, herausgegeben von Köppen, W. und Geiger, R. Bd. III, L.)
5. BIRKELAND, B. J. et SCHOU, GEORG: Le climat de l'Eirik Raudes Land. (Skrifter om Svalbard og Ishavet, Nr. 51. Oslo 1932.)
6. Cartes synyistiques de l'Hémisphère Nord, publiées sous les auspices de l'Organisation Météorologique Internationale par le Deutsche Seewarte à Hamburg.
7. Danmark-Ekspeditionen til Grønlands Nordøstkyst 1906—08, Bd. II. (Meddelelser om Grønland, Bd. XLII, 1914.)
8. EGEDAL, J.: On variations of mean temperatures of the air. (Geografiska annaler, 1941.)
9. EVJEN, SIG.: Beitrag zur Kenntnis der barometrischen Unruhe. (Met. Zeitschrift 1930.)
10. HESSELBERG, TH. und BIRKELAND, B. J.: Säkulare Schwankungen des Klimas von Norwegen. Die Lufttemperatur. (Geof. Publ. XIV, Nr. 4. Oslo 1940.)
11. HOBBS, W. H.: The Glacial Anticyclones, the poles of the atmospheric circulation. (University of Michigan Studies, Scient. Ser. IV, 1926.)
12. Islensk Veðurfarsbók. Reykjavik.
13. JENSEN, AD. S.: Concerning a Change of Climate during Recent Decades in the Arctic and Subarctic Regions. (Det Kgl. Danske Vidensk. Selskab. Biolog. Medd. XIV, 8. Kbh. 1939.)
14. JOHANSSON, OSCAR V.: Die Temperaturverhältnisse Spitsbergens. (Ann. d. Hydr. 1936.)
15. KINCER, J. B.: Is our climate changing? (Monthly Weather Review 61, 1933.)
16. LYSGAARD, L.: Lufthav, Vejr og Klima. Kbh. 1943.
17. — Ændringer i Danmarks Klima i den nyeste Tid. (Geogr. Tidsskr. 1937.)
18. Meteorologisk Aarbog, udg. af Det Danske Meteorologiske Institut.
19. Morgenvejrberetning, udg. af Det Danske Meteorologiske Institut.
20. Norwegischen Meteorologischen Institut, Jahrbuch des.
21. PETERSEN, HELGE: Das Klima der Küsten von Grønland. (Handbuch der Klimatologie (Köppen—Geiger) Bd. III, K.)
22. — Extrem hohe Temperaturen und Föhn in Grønland. (Met. Zeitschrift 1934.)
23. — Om meteorologiske Middeltal som klimatiske Karakteristika. (Geogr. Tidsskr.)

24. SCHERHAG, R.: Die Zunahme der atmosphärischen Zirkulation in den letzten 25 Jahren. (Ann. der Hydr. 1939.)
 25. — Die Erwärmung des Polargebietes. (Ann. der Hydr. 1939.)
 26. — Die gegenwärtige Milderung der Winter und ihre Ursachen. (Ann. der Hydr. 1939.)
 27. SCHOU, GEORG: Mittel und Extreme des Luftdruckes in Norwegen. (Geof. Publ. XIV, 2, Oslo 1939.)
 28. Täglicher Wetterbericht, herausgegeben von der Deutschen Seewarte, Hamburg.
 29. Veðráttan (udg. af Veðurstofan, Reykjavik.)
 30. WAGNER, A.: Klimaänderungen und Klimaschwankungen. Braunschweig 1940.
 31. WEGENER, K. m. fl.: Wissenschaftliche Ergebnisse der Deutschen Grönland-Expedition Alfred Wegener 1929 u. 1930/31. Bd. IV, 1—2, u. VII: Meteorologie.
 32. (WILLAUME-JANTZEN, V.): Meteorologiske Middeltal og Ekstremer for Færøerne, Island og Grønland. Kbh. 1899.
 33. Österreichische Polarstation Jan Mayen, Die. Wien 1886.
 34. ÅNGSTRÖM, A.: Temperaturklimatets ändring i nuvarande tid och dess orsak. (Ymer 1939.)
 35. — Principiella synpunkter på undersökningar över klimatets förändring. (Geogr. Ann. 1941—42.)
-