

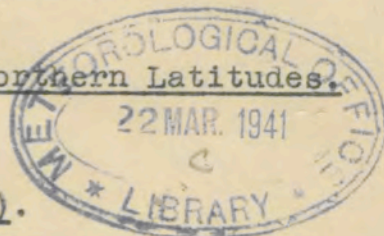
March, 1941.

Meteorological Magazine.

Changing Temperature Conditions in Northern Latitudes.

By

L.G. Cameron, M.Sc. (Lond.).



It has been recognised for some time by many workers that during the last twenty years the climate in northern latitudes has shown a marked change towards warmer conditions. Hitherto, however, the greatest attention has been focussed upon the temperature variation during the winter months, both F.Loewe and R.Scherhag, who have done much work on this subject, tending to emphasise this fact to the exclusion of the change which may be taking place during the rest of the year. The writer therefore considered that, in order to fill this gap, it would be necessary to survey the changing temperature conditions on a monthly basis, thus throwing some light upon the way in which the change is operating throughout the year.

In order to obtain sufficiently long periods for comparison, only those stations dating back to 1895 were used, thus limiting the number to fourteen. Two periods were taken, from 1895-1914 and from 1915-1930 and the mean monthly temperature for each month calculated. The difference of the monthly means thus gave the degree of temperature variation in the second period as against the first for each month. Monthly maps were then constructed and the isopleths of temperature variation drawn. The two specimens of these monthly charts shown, are typical of the change in temperature which has taken place during the summer and winter months. A similar procedure was adopted in dealing with the sea temperature but unfortunately in this case, owing to reliable observations not being available prior to 1911, two shorter periods from 1911-1924 and 1925-1938 had to be taken. A variation in the mean air temperature of less than 1°F above or below zero cannot be regarded as remarkably significant. With this in mind it is interesting to note that only 5% of the observations showed a negative variation greater than 1°F., whereas 39% recorded an increase greater than 1°F. In the case of sea temperatures however, even a small variation either way is of the greatest importance so that the fact that 92% of the results obtained showed a positive change of temperature is highly significant.

A comprehensive discussion of the results obtained cannot be entered into at this stage but certain salient facts and a few of the problems arising out of them, can be indicated.

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The most outstanding fact, also noticed previously by many workers, is the very great increase in winter air temperature during recent years along the west coast of Greenland. This however does not persist throughout the whole year but tends to vanish during the summer months. On the other hand the temperature variation along the Norwegian Coast shows a very definite summer maximum decreasing to zero during the winter months. These two conflicting temperature regimes are well illustrated by the curves of air temperature variation for Jacobshavn and Ivigtut in the former instance and for Bodo and Gjesvar in the latter. Moreover they are further emphasised by the curves for the sea temperatures of the same areas. The obvious question arising out of these facts is whether there is an annual oscillation in longitude of the factors influencing the changing temperatures.

Two further interesting features revealed by both the sea and air temperature variation maps is the persistent southward bulge of the isopleths between Scotland and Norway and the counterbalancing embayment in the region of Iceland. No definite explanation of the former phenomenon can yet be offered but it may well prove to be the result of a strengthening in the flow of the Irminger Current which, flowing northwards from the Gulf Stream has long brought added warmth to the shores of Iceland. The presence of this current is regarded as sufficient explanation of the northward embayment of the isopleths which in themselves indicate the absence of any temperature variation along the south and west coasts of Iceland. On reaching the northwest coast the Irminger Current divides into two arms, one of which turns eastwards and finally merges again into the warm waters of the North Atlantic Drift, while the second arm takes a westward trend and joins the East Greenland Polar Current. Any increase in the flow of the Irminger Current would therefore result in an added volume of warm water being transferred to both these arms and the consequent accession of heat to both the North Atlantic Drift and the East Greenland Polar Current thus accounting for the positive variation of both sea and air isotherms in the Southern Norwegian Sea and also off the East Greenland Coast. If the zero isopleth be regarded as the former limit of maximum influence of the warm currents it is suggested that, during the second period under discussion, a greater volume of warm water must have passed between the Faroes and Iceland possibly augmented by the further addition of warm water from the eastward flowing branch of the Irminger Current. In order to obtain, if possible, some confirmation of this fact the writer carried out an investigation into the behaviour of the main Gulf Stream from



Florida to Cape Cod. It was found that, during the years 1926-1938, the Gulf Stream has shown a decrease in mean speed of three miles per day over the whole year, as against that of the previous fourteen years. At first sight it would appear that this fact disproves the theory of the increased flow of either the Irminger Current or the North Atlantic Drift. C.O'D. Iselin however, in his "Preliminary Report on the Long Period Variations in the Transport of the Gulf Stream System", (Contribution 261 from the Woods Hole Oceanographic Institution, U.S.A.), regards the Gulf Stream as a vast eddy and maintains that during periods of weak flow, warm surface water is discharged from time to time to the left of the current. He goes on further to say that the strength of the Irminger Current and the Norwegian Atlantic Current (North Atlantic Drift) and the temperature of their superficial layers are held to be dependent upon the strength of the main eddy in lower latitudes.

Apart from the great changes which such fundamental temperature variations as are shown further north have wrought upon the snow cover of the coastal regions of West Greenland and the ice conditions in the Spitzbergen region, it is interesting to note the changes which have resulted in the fishing industry.

Dr. Herbert O. Bull has proved in his "Studies on the Conditioned Responses in Fishes; Part VII, Temperature Perception in Teleosts: (Journal of the Marine Biological Association of the United Kingdom Vol. XXI Plymouth 1936), that fishes are able to appreciate and react to even small changes of temperature, responding to an increase in the temperature of the water surrounding them of between  $0.03^{\circ}$  and  $0.10^{\circ}$  C. Such changes as are recorded in northern latitudes must therefore have resulted in a considerable redistribution of the ocean fauna. This is amply borne out by the work of Ad. S. Jensen who has spent many years investigating the state of the fishing industry along the coasts of Greenland. He has shown that, during the last two decades, there has been a definite northward migration of such commercial fishes as cod, herring and haddock not only along the coasts of Greenland but also in the Denmark Strait, Greenland Sea and in the Barents Sea as far north as Spitzbergen, resulting in the opening up of flourishing fishery grounds where previously little or no fishing took place.

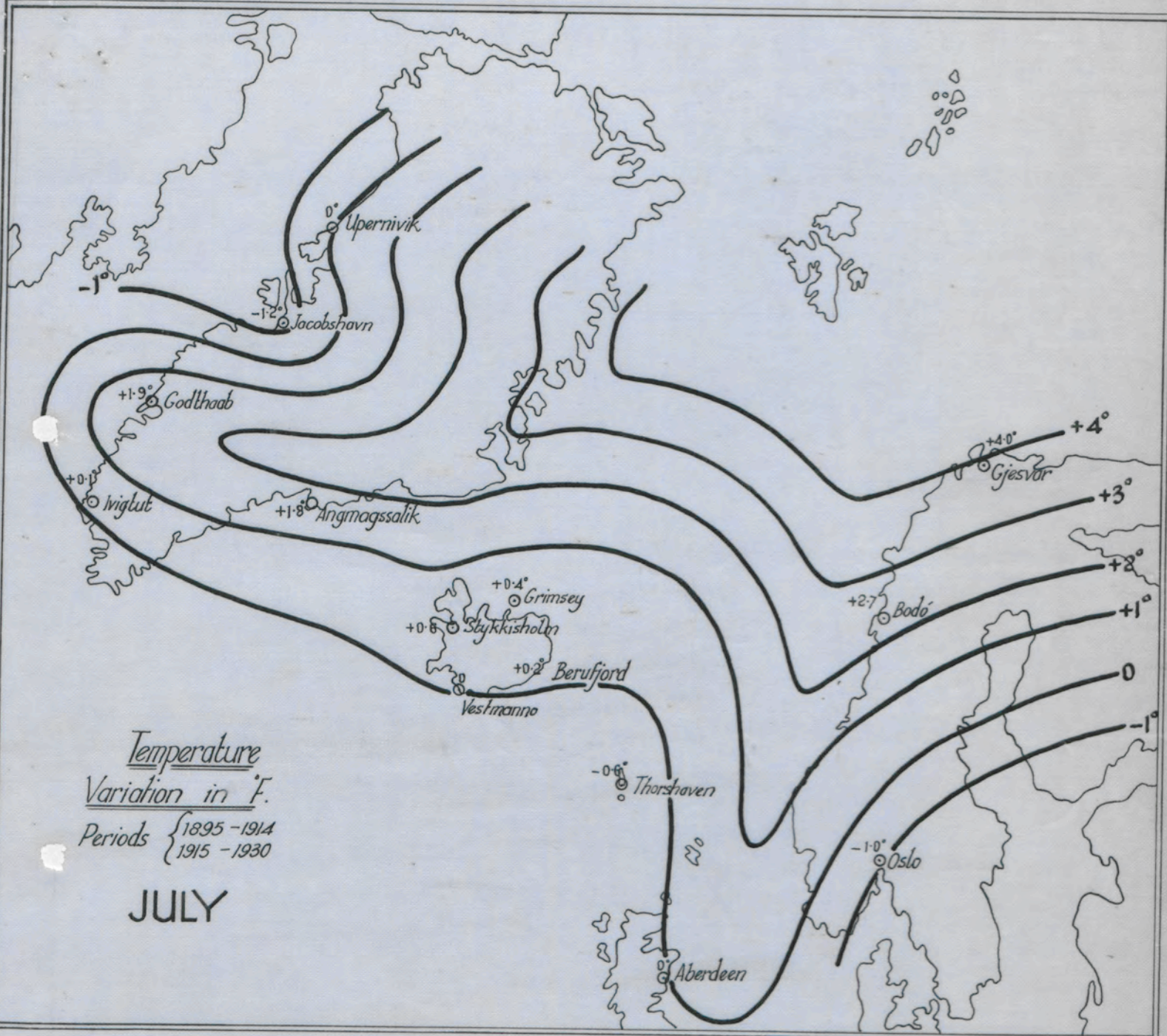
Further recent changes in the hydrographical conditions of S.W. Greenland seem to point to a recurrence of colder conditions. Arctic Fjord cod which had migrated northward



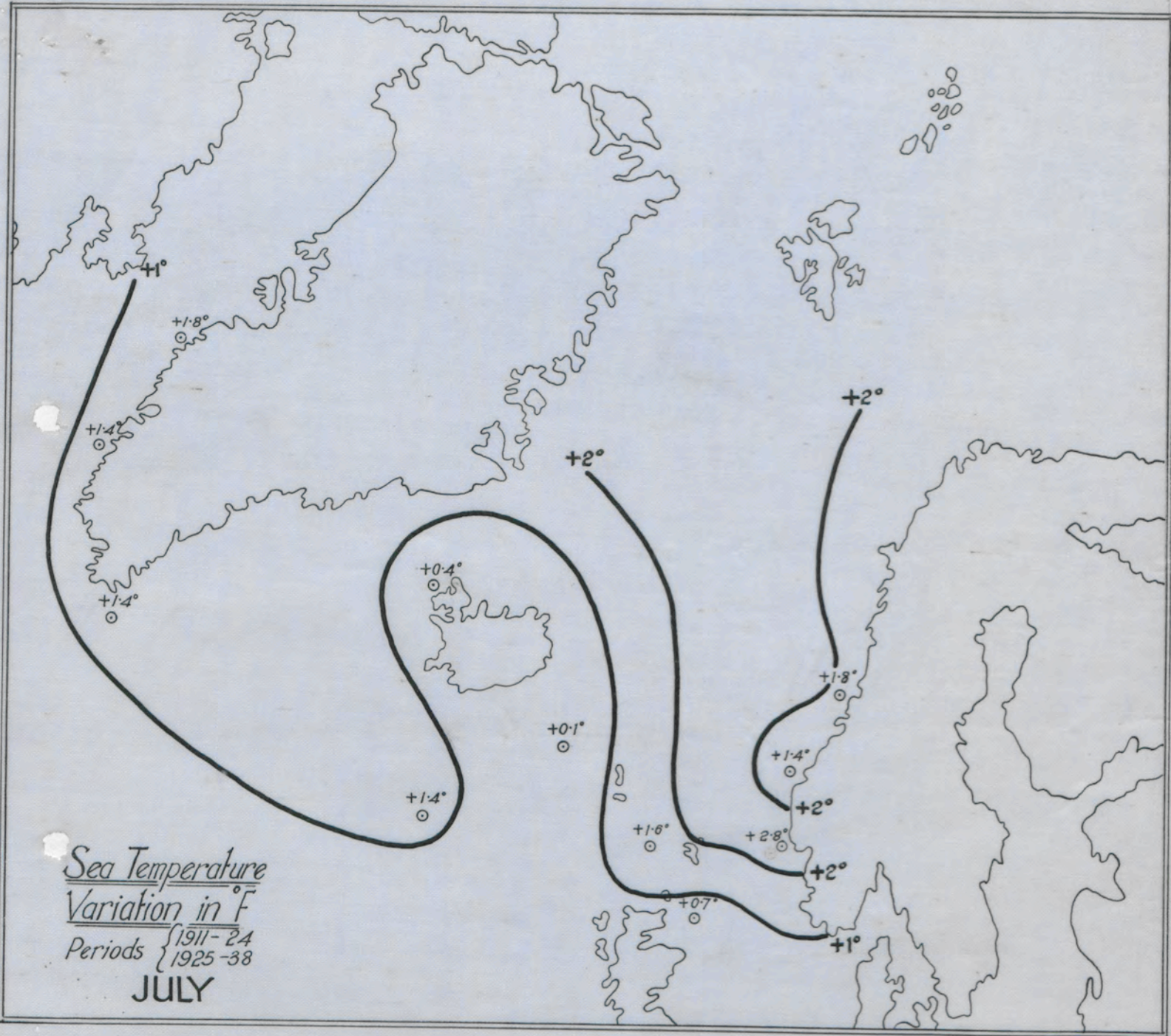
during the warm period, have again become common in the Julianehaab district, while on several occasions in 1937-38, along the W.Greenland Coast, dead haddock and cod, killed by the colder water, either came to the surface, or were brought up in the deep-water trawls. Furthermore the spawning of deep water prawns in 1938 was delayed from mid-July to mid-August, proving the persistence of very cold water even at great depths, well into the summer months.

It is impossible to say whether this biological evidence points to a returning cold period or to a mere brief fluctuation prior to a new onslaught of the warm period.

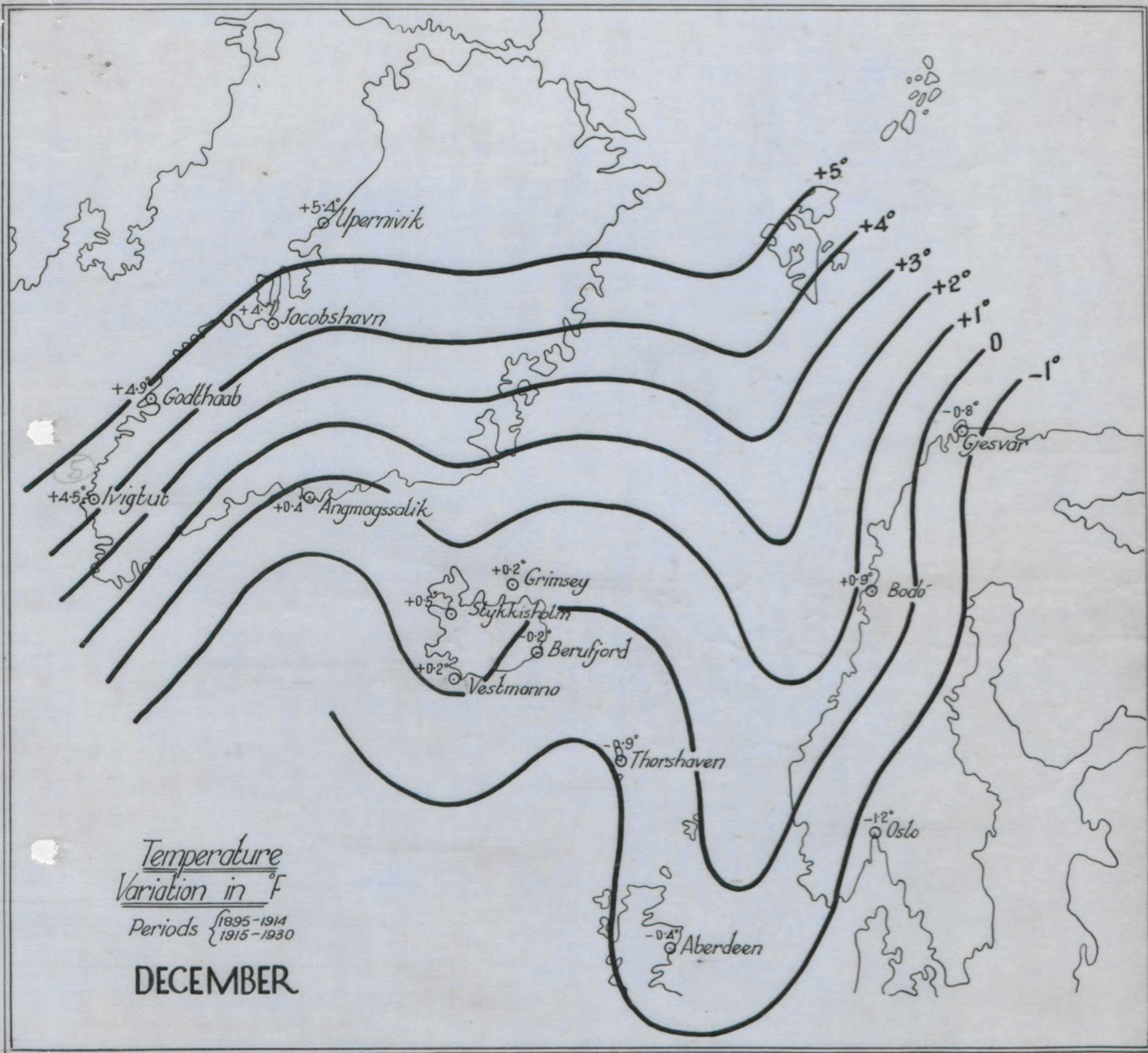












Temperature  
Variation in °F

Periods { 1895-1914  
1915-1930

DECEMBER



THE HALO DISPLAY OF MARCH 6th, 1941.

An unusually complete halo display was seen about midday on March 6th in the west Midlands. So far reports are available from Tern Hill (Shropshire), Ross-on-Wye (Hereford), Gloucester and Stonehouse (Glos.). The display was noteworthy for the prodigal number of mock suns and for the presence of some rare arcs. For the purposes of illustration the various drawings supplied have been combined in fig. 1.

At Tern Hill, Shropshire, the main display was visible from 1140 to 1240 G.M.T., after which it gradually faded out but partial haloes were observed until 1420. Five mock suns were seen at A, B, C, D and E. A sketch sent by Mr. H. Forster shows the two mock suns at A and B on the  $22^{\circ}$  halo, but they were probably slightly outside it. A and B were very luminous and coloured, C slightly less so, D and E very luminous and white. Mr. Forster's sketch also included the complete parhelic circle or mock sun ring L, the nearly complete  $22^{\circ}$  halo F, the  $46^{\circ}$  halo G, the upper arc of contact J and the arc M passing through the mock sun ring at the  $120^{\circ}$  mock suns. S is the sun, Z the zenith, H the horizon and P the ~~anthelion or antisolar point~~.

At Ross-on-Wye Mr. F. J. Parsons reported two exceptionally brilliant parhelia at A and B, the complete  $22^{\circ}$  halo, the complete parhelic circle and the upper arc of contact J. The display lasted from 1240 to 1315 G.M.T.

At Gloucester Mr. R. R. Waite reported between 1300 and 1400 G.M.T. the incomplete  $22^{\circ}$  halo, the mock suns A, B, D, E, the parhelic circle and the upper arc of contact. The angles of the mock suns A and B, measured with a theodolite, were given as  $29^{\circ}$  which is unusually great. Possibly these parhelia were drawn out along the parhelic circle away from the sun. Mr. Waite definitely states that there were no parhelia at the intersection of the  $22^{\circ}$  halo and the parhelic circle. The angles of D. and E were measured as  $122^{\circ}$  and  $119^{\circ}$  respectively, agreeing well enough with the theoretical angle of  $120^{\circ}$ .

At Stonehouse, Glos., about 1245 G.M.T. various observers saw all the phenomena in the sketch with the exception of the arc M. Most interesting and unusual, not so far reported by observers elsewhere, are the lower arc of contact K and the oblique arc N through the anthelion. No mock sun was reported by an observer at the ~~antisolar point~~ P.  
*anthelion*



The mock suns at  $120^\circ$  result from double internal reflection of light from the sun at two adjacent columnar faces of horizontal hexagonal prisms. The rare arc through these mock suns seen at Tern Hill (M) is attributed to internal reflection by crystals disturbed from their horizontal position; it consists of two separate arms, which Mr. Forster's sketch shows as forming a continuous arc; if correct this must be very rare.

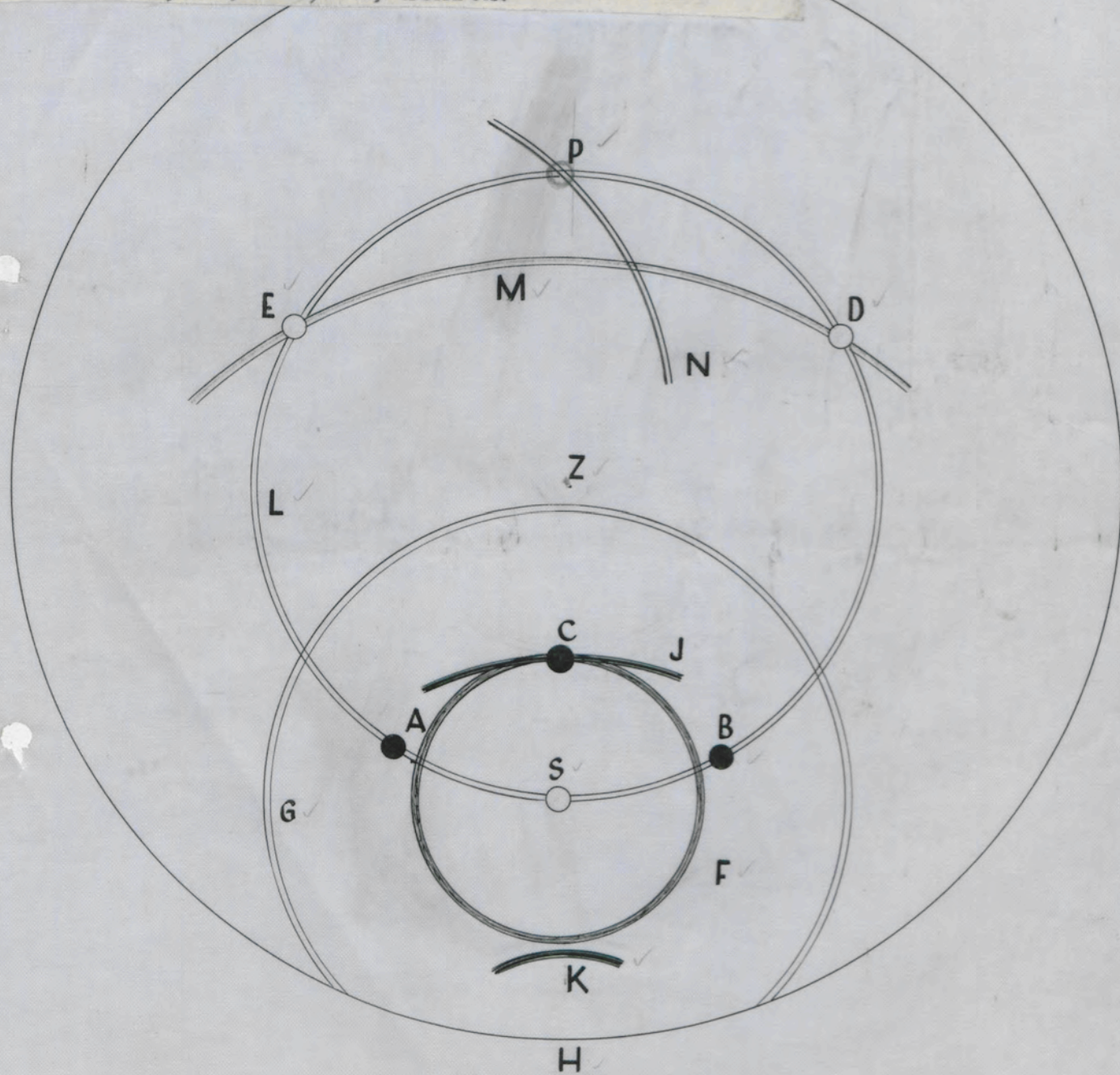
The oblique arc N through the anthelion, which is one of a pair (the opposite one was not visible) is attributed to external reflection by the same ice crystals floating with their major axis and two faces horizontal, their most stable position. Being caused by reflection, all these arcs as well as the parhelia of  $120^\circ$ , are white, whereas the halo of  $22^\circ$  and the mock suns adjacent to it, being caused by refraction through ice crystals, are coloured, often brilliantly. In this display the brilliance was very notable, especially in the upper arc of contact J, where the colour sequence seen at Gloucester, from above downwards, was:— violet, blue, green, yellow, orange, red, violet. The two violet bands were far wider than any of the other colours.

At Gloucester brilliant iridescence had been seen during the morning on fine high alto-clouds. This persisted up to the appearance of the halo complex. At Tern Hill a lunar halo was seen during the night from 1930 G.M.T. on the 6th to 0145 on the 7th.

At Stonehouse, Glouc., about 1945 G.M.T. various observers saw all the phenomena in the sketch with the exception of the arc M. Most interesting and unusual, not so far reported by observers elsewhere, are the lower arc of contact K and the oblique arc N through the anthelion. No mock sun was reported by an observer at the anthelion point.



A, B, C, D, E parhelia or mock suns;  
 F,  $22^\circ$  halo; G,  $46^\circ$  halo; H, horizon J Upper arc  
 of contact of  $22^\circ$  halo; K, lower arc of contact;  
 L, parhelic circle or mock sun ring; M, arc through  
 parhelia of  $120^\circ$ ; N, oblique arc through anthelion;  
 P, anthelion; S, sun; Z, zenith.



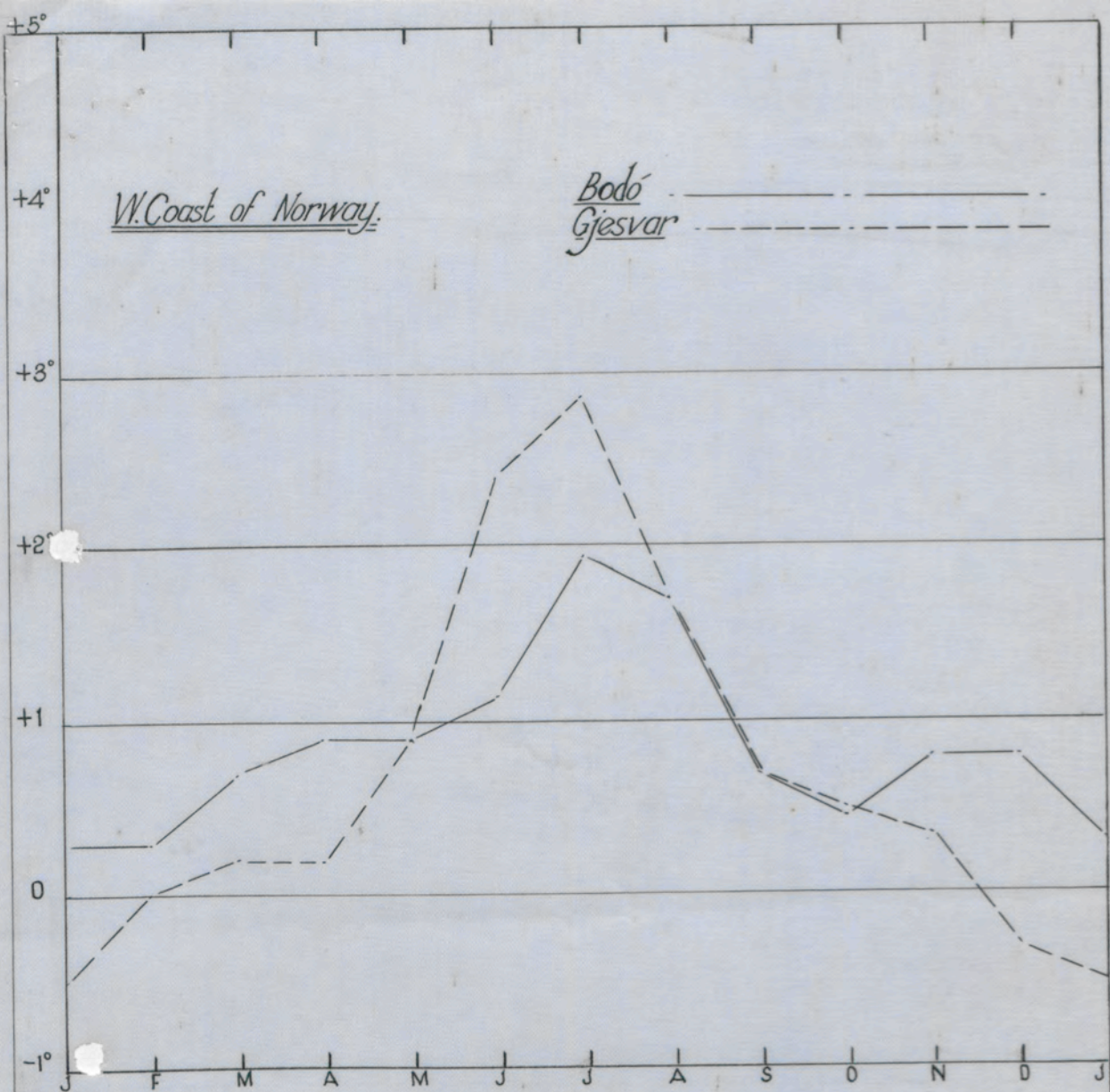


NOTES.

The Physical Society has made the first award of the Charles Chree Medal and Prize to Professor Sydney Chapman, F.R.S., Professor of Mathematics in the Imperial College, London, for his contributions to the science of terrestrial magnetism.

The Holborn Office which Messrs. Negretti and Zambra, the famous firm of instrument makers, have occupied for 90 years, has been destroyed by a direct hit from a bomb, and the headquarters of the firm has been removed to another address. The Holborn Office had been previously damaged by blast, and both the factories have been more or less damaged, but the firm carries on.

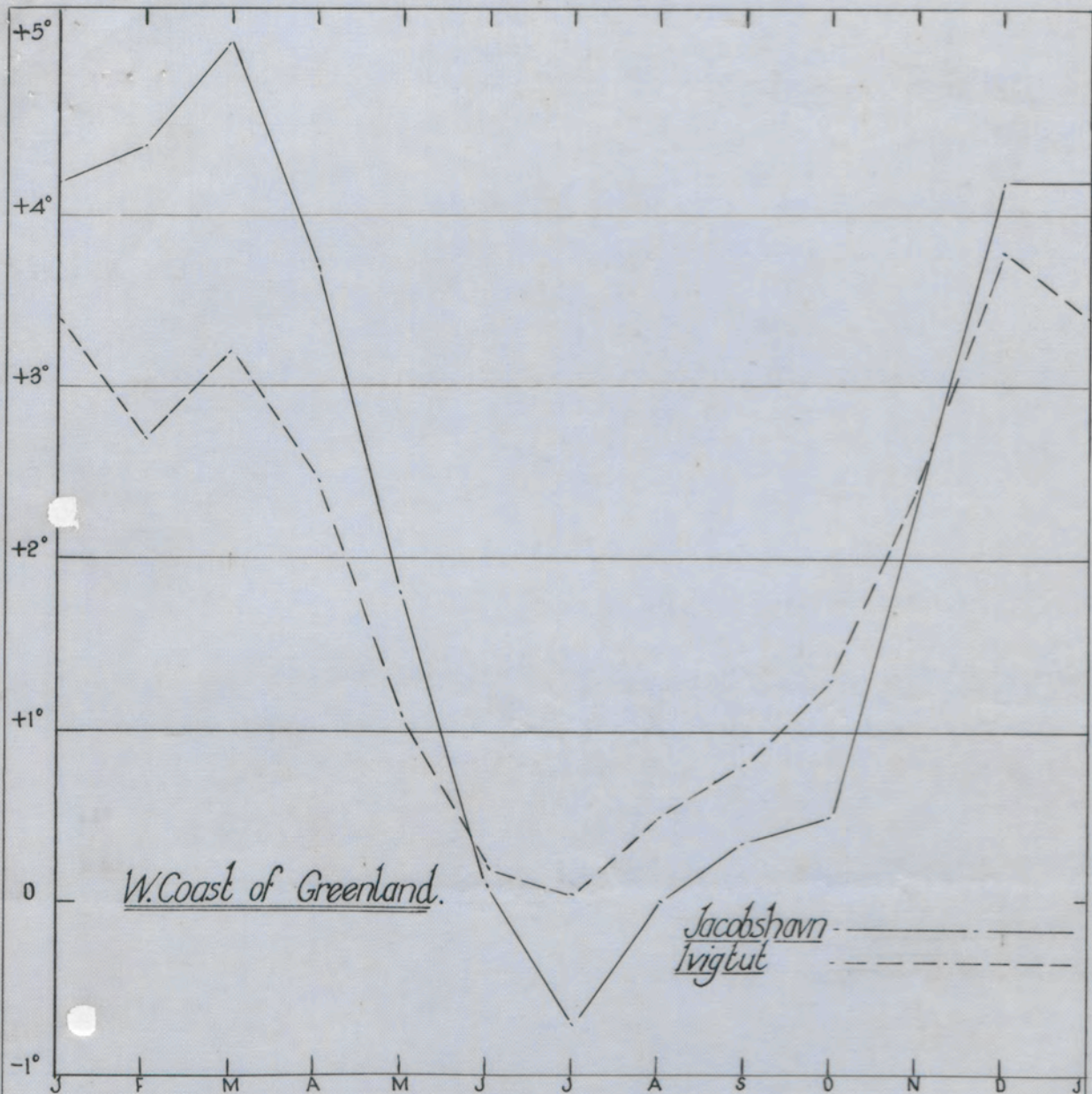




Temperature  
Monthly Variation

Periods { 1895 - 1914  
 1915 - 1930





W. Coast of Greenland.

Jacobshavn  
Ivigtut

Temperature  
Monthly Variation.  
Periods { 1895-1914  
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