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### The climate of the interior of Greenland

Professor H. Mohn <sup>a</sup>

<sup>a</sup> Christiania

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## THE CLIMATE OF THE INTERIOR OF GREENLAND.

By PROFESSOR H. MOHN, of Christiania.

I HAVE already discussed the results of the meteorological observations, taken during Dr. Nansen's journey across Greenland in 1888, in a memoir published as *Ergänzungsheft*, No. 105, to *Petermanns Mittheilungen*,<sup>1</sup> and recently I have acquired a knowledge of the results obtained on Lieut. Peary's journey over the inland ice of Northern Greenland from the newspapers and the lectures delivered in Christiania by his companion, Mr. Astrup, a Norwegian. From these data it is possible to construct, in general outline, a sketch of the climatic conditions of the interior, which I shall now proceed to delineate.

Greenland is an elevated land covered with eternal snow and ice; only a narrow strip along the coast is free from snow in summer. The highlands of the interior have the form of a shield, sloping steeply to the coasts, but, further inland, inclining gently up towards the centre. On the 64th parallel, the culminating line lies somewhat nearer to the east coast than the west. Both in the lower and higher latitudes, considerable altitudes are attained. Nansen's highest point was at 8800 feet above sea-level, and Mr. Peary found, near the 80th parallel, elevations of about 8000 feet.

In respect to atmospheric pressure, the interior constitutes an almost permanent anticyclonic region. Areas of minimum pressure that pass steadily over the adjacent seas may sometimes extend their limits over the inland ice, but a belt of high pressure is generally left between the cyclones of Baffin's Bay on the one side, and those in the Greenland Sea on the other. It is rare that a centre of minimum pressure passes across Greenland from west to east, as in the case observed by Dr. Nansen, on September 7th, 1888, when a strong wind from the south-east was followed, after a short lull, by an equally strong wind from the north-west.

The variations of pressure are less in the interior of Greenland than on the west coast or in Iceland.

In complete accordance with the existence of high pressure in the interior is the observed fact, that the winds over the inland ice blow, as a rule, towards the coasts. During Dr. Nansen's journey, 45 per cent. of the winds on the eastern side blew from the north-west, while on the western side 29 per cent. came from the east, and 21 per cent. from the south-east, the least frequent winds being the north-east on the one side and the west on the other. On Mr. Peary's route, the prevailing wind was from the south.

The observations of Dr. Nansen, and of the Danish meteorological stations on the east coast, show that on the 64th parallel the mean annual temperature at an elevation of 6560 feet is about  $-13^{\circ}$  F., or, reduced to sea-level,  $5^{\circ}$  F. Assuming the mean annual range to be the same as in Lapland, which is certainly not too high an estimate, we arrive at a mean temperature for the warmest month, July, of  $14^{\circ}$  F., or  $32^{\circ}$  at

<sup>1</sup> *Wissenschaftliche Ergebnisse von Dr. F. Nansen's Durchquerung von Grönland*, 1888. Von Professor H. Mohn und Dr. F. Nansen. Gotha: Justus Perthes, 1892. I. Theil: *Ergebnisse der astronomischen, magnetischen, trigonometrischen und meteorologischen Beobachtungen*, von H. Mohn.

sea-level. For the coldest month (January?), the mean, found in the same manner, will be  $-40^{\circ}$  F., or  $-22^{\circ}$  reduced to sea-level.

From these figures it is evident that it is incorrect to draw the isotherms, as has hitherto been done, due east to west across Greenland. They should be drawn in curves following the outline of the coast, a method fully justified by the more recent observations in other continental countries. If we examine a good set of isothermal charts—those, for instance, of Dr. Julius Hann<sup>1</sup> or Dr. Buchan—we see that an isothermal line for the year of  $5^{\circ}$  F. must follow the curvature of the coast.

Within this lies the isotherm for  $0^{\circ}$  F., passing through the interior and the northern parts of Greenland. The isotherm for  $14^{\circ}$  F. runs from the  $72^{\circ}$  parallel on the west coast southwards along the sea-board, touching or crossing the long fiords, turns eastward round the south of Greenland, and, following the east coast past Scoresby Sound and over Franz Josef fiord, reaches the shore at about the  $78^{\text{th}}$  parallel, where it passes out to sea.

The isotherm of  $32^{\circ}$  F. through the central parts of Greenland is easily drawn on Hann's or Buchan's<sup>1</sup> chart (for July). I have carried it up to the  $80^{\text{th}}$  parallel, determining its course from the following reasoning. The sun in summer is here circumpolar, but only about noon is it high and powerful enough to check the radiation from the ground, and the highest temperature it can produce is  $32^{\circ}$  F., its energy being chiefly spent in melting snow. During the night, on the other hand, the sun is so low that radiation from the snow is freely propagated through the rarefied air, and the temperature sinks considerably below the freezing-point. The mean temperature of the 24 hours will, therefore, be several degrees below  $32^{\circ}$ , and only just reach that point when reduced to sea-level.

Now, Mr. Peary observed in July, near the  $80^{\text{th}}$  parallel and at elevations of about 8000 feet, temperatures ranging during the day from  $26\frac{1}{2}^{\circ}$  to  $32^{\circ}$  F., and in the night from  $23^{\circ}$  to  $5^{\circ}$ , from which records we obtain a daily mean of about  $21^{\circ}$ , or, reduced to sea-level,  $37^{\circ}$  to  $39^{\circ}$ . Consequently the isotherm of  $32^{\circ}$  at sea-level seems not to reach quite as far north as I supposed, but the difference is immaterial.

In the coldest month we find in the interior on the parallel of  $64^{\circ}$  a mean temperature, reduced to sea-level, of  $-22^{\circ}$  F. The corresponding isotherm also runs parallel to the coast, beginning on the  $76^{\text{th}}$  parallel on the west, and reaching the  $64^{\text{th}}$  in the interior, whence it ascends to lat.  $80^{\circ}$  on the east coast. We are further warranted in drawing an isotherm for a temperature as low as  $-40^{\circ}$  F. in North Greenland, for the mean for January in the straits between Greenland and America is  $-31^{\circ}$ .

In the month of September Dr. Nansen experienced during the night temperatures of  $-49^{\circ}$  F., and in the winter Mr. Peary recorded minima below  $-58^{\circ}$ . On board the *Alert* Sir George Nares observed a temperature of  $-74^{\circ}$ . We may, therefore, conclude that in winter the minima are as low as  $-76^{\circ}$  or even  $-90^{\circ}$ . The interior of Greenland is, indeed, a pole of cold, situated in the opposite longitude to that of Siberia, with which it is well able to compete in extreme severity.

The daily range is very considerable in the interior during the

<sup>1</sup> *Atlas der Meteorologie* (in *Berghaus' Physikalischer Atlas*, Part III.), Tafel II., Nos. 27, 28, 29. "*Challenger*" Report—*Physics and Chemistry*, Vol. II., Part v.

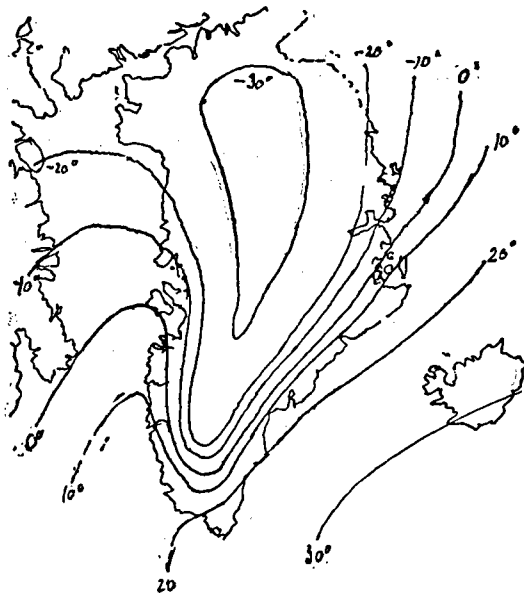
solstices, owing to the great radiation that takes place from, or to, the earth through the highly rarefied atmosphere. In clear, cold weather it sometimes amounts to  $40^{\circ}$ . Such a range is elsewhere found only in deserts, but the interior of Greenland is really an elevated, snow-covered desert.

The low temperatures and large ranges observed refer only to the lower strata of air immediately above the snow, where the effect of radiation is most powerful. In the higher regions of the atmosphere the downward movement of the air in the centre of the anticyclonic area must render the air warm relatively to the height, and the climate will be less severe than on the snow-clad ground.

The relative humidity in the interior of Greenland is generally rather considerable, the mean being above 90 per cent. *Föhn* winds are not observed here: they are confined to the valleys on the edge of the inland ice, the fiords, and the coasts.

In the interior of Greenland Dr. Nansen found that the coldest wind was the north-east, and the warmest the south-west. On the eastern side the south-east was accompanied by the greatest amount of cloud, and the north-west by the least. On the western side the west and south-west were the cloud-bearing winds, the clearest sky occurring during north-east winds. When the wind blew from the sea there was the greatest probability of precipitation. Thus we see that those coming from the interior were dry winds. Snow fell about every fourth day, and every fourth day the sky was clear; every other day the sky was overcast. Fog was rare.

From the foregoing remarks it will be seen that the climate of Greenland is continental, with large ranges of temperature. The mean temperature for the year is low, and for the winter very low—perhaps the



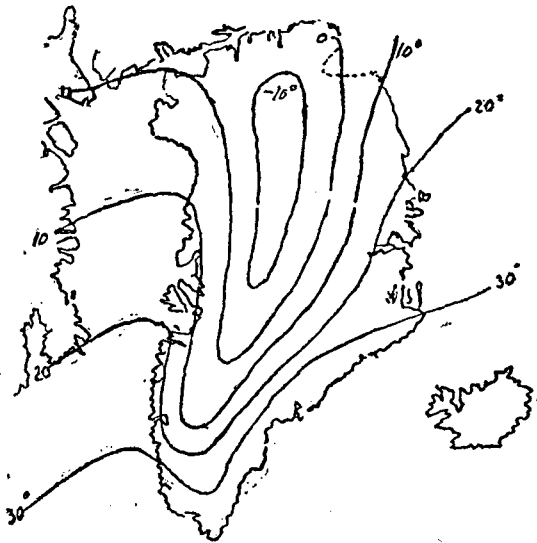
Isotherms for January.

lowest to be found on the globe. In contrast to the climate of other continents the summer temperature is also low, owing to the high latitude, the great elevation, and the vast extent of continuous snow-fields. Both in summer and winter the interior of Greenland contains a pole of low temperature, a centre of high atmospheric pressure from which anticyclonic winds radiate.

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Isotherms for July.



Isotherms for the year.