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Report on Norwegian participation in NORWESTLANT I
April, 1963

From 7-22 April, the R/V "G. O. Sars" participated in the first of the ICNAF Environmental Surveys (NORWESTLANT I). The area which should have been covered was from Nunarsuit in the south to the northern part of Store Hellefisk Bank in the north and to the drift ice border in the west. The drift ice border was nearer the West Greenland coast than first thought and some of the planned stations had to be deleted. The most northerly stations worked was just north of Holsteinsborg. Fig. 1 shows the planned stations, stations worked and the route of the cruise.

a. Hydrography

Fig. 1 shows the station grid from the cruise. Four hydrographic sections (IX, X, XI and XII) were worked. Bathythermograph observations are taken at the other stations. The programme is carried through between 10 and 22 April.

1. Current Conditions: Fig. 2 illustrates the dynamic topography of the sea surface which sums up the main features of the current conditions in the investigated area. The close isolines along the coast indicate the West Greenland Current. It is also seen that the current bends westwards when it meets the submarine ridge across the Davis Strait. The topography is, however, based on too few observations to give any details in the current.

Geostrophic current components have been computed in Sections IX, X and XI with 1000 decibars as reference depth. All the stations in Section XII are shallower than 1000 m. Dynamic computations in this section have therefore been omitted. The geostrophic current components are presented in the Figs. 3 to 6 which also illustrate the distribution of temperature, salinity and specific volume anomaly in the sections. It should be emphasized that the current components are computed on the assumption of no motion at the 1000 - decibar surface.

In all sections the computations give relatively strong current flowing north along the coast. The highest velocities, up to 30 cm/sec., are found off the slope of the shelf. At greater distances from the coast there are only slow current components.

The conditions in Section XI across the Fylla Bank differ from those in the two sections farther south. Here, current directions are more changeable, and a relatively strong current is extending farther out from the shelf, presumably because the West Greenland Current at this point is about to bend westwards. The changeable current directions may therefore indicate meanders or eddies in the area. According to the dynamic topography of the sea surface, the western part of the section is nearly parallel to the main direction of the current. Therefore it gives little or no information about the current velocity.

The distribution of the specific volume anomaly in section XII indicates that the current probably flows north along the coast also in this area. It seems, however, to be slower than in the sections farther south.

2. Water masses: It is difficult to define a border between the two water bodies of the West Greenland Current, but for convenience it shall be done here. Temperatures below 2°C and salinity values below 34.5‰ shall be used as criterion on

Arctic water. Water from the Irminger component of the West Greenland Current will be characterized by temperatures above 4°C and salinities exceeding 34.9‰.

The two southern sections have Arctic water only over the shelf close to the coast, while it has much greater extent in Sections XI and XII farther north. The extent of the Arctic water in Sections IX and X is thus only approximately 20 and 40 nautical miles respectively. In Sections XI and XII, however, there is Arctic water in the surface layers along the whole sections. Section XII shows the lowest temperatures at the westernmost station. Here the temperature is below -1.6°C down to 50 m with corresponding salinities between 33.5 ‰ and 33.6‰. This water seems to be coming from the west, and is probably an effect of the Baffin Island Current. The cold water that is dominating in the surface layers may otherwise be a consequence of the winter cooling.

The Irminger water appears beneath and outside the Arctic water. In the core of this component the salinity exceeds 34.95 ‰ and the temperature is higher than 4.5°C. The Irminger water seems to extend to a greater depth in Section XI than in Section IX and X farther south.

Section XI also illustrates the temperature conditions across the Fylla Bank. The greater part of the bank has bottom temperatures between 0°C and 1°C. Only in the western slope of the bank there is the water temperature above 1°C.

The conditions across Lille Hellefiske Bank are demonstrated by Section XII. The top of the bank has temperatures below 0°C, but in the western slope of the bank the temperature is increasing with the depth. Irminger water is here found at depths greater than approximately 300 m.

3. Horizontal distributions: The distribution of the temperature at the surface is illustrated in Fig. 7. This figure is based on the observations from the ship's sea surface temperature recorder (approximately 4 m depth). The isotherms for 0°C and 1°C seem to follow the path of the West Greenland Current fairly well. West of Godthaab the isotherms bend westwards, and the 0 - isotherm meets the ice border a little south of lat. 64°C. In the area south of this latitude, the colder water is found close to the coast, while opposite conditions are found to the north of 64°N. Here the temperature is below 0°C in the whole area, but the warmer water is found near the coast, while there is water of temperatures down to -1.7°C west of Lille Hellefiske Bank. The isotherms for -1 and -1.5°C indicate that west of Lille Hellefiske Bank there is a tongue of very cold water which seems to come from the west.

The warm Irminger component of the West Greenland Current extends towards northwest in a tongue like shape, but temperatures above 4°C are found only south of Cape Farewell.

The temperature distribution at 50, 100 and 200 m is illustrated in the Figs. 8-10. These figures are based on observations from the hydrographic stations and bathythermograph observations. At these depths the main picture is nearly the same as that at the surface, but the temperature is evidently increasing with the depth.

There is fairly good agreement between the horizontal distribution of salinity (Fig. 11 and 12) and the corresponding distribution of temperature, and the figures of these variables give nearly the same picture. The less saline water is found along the coast, but it is also shown that parts of this water flow westwards in the area west of Godthaab. North of this area the salinity is increasing again. The explanation of this may be that the supply of water of low salinity is decreasing here. Run off from land may further be insignificant at this time of the year. The effect of ice freezing in the area will further involve a rise of the salinity.

4. Distribution of oxygen and nutrient salts: The oxygen is presented in millilitres per litre (ml/l) and in percent of saturation, while the unit of the nutrient salts is micro gram atoms per litre. Truesdales data have been used to obtain the percent saturation of oxygen. The horizontal distribution of these variables is illustrated in the Figs. 13 to 20 and the vertical distribution in Figs. 21 to 24.

At 10 m the Irminger water seems to be the poorest in oxygen. In this water the oxygen content is less than 7.5 ml/l. Extremely high concentrations of oxygen are found in an area west of Godthaab where 10.14 ml/l are observed at station 19. The saturated values show that the whole investigated area is supersaturated. The Irminger water has about 103%, while the highest concentrations west of Godthaab exceed 125%. This is in good agreement with the distribution of nutrient salts and phytoplankton. In this area there are only traces of phosphate and silicate. Phytoplankton is present in such amounts that filters become clogged.

The highest content of nutrient salts is found in the Irminger component of the West Greenland Current.

	Sampling Bottle	Filter	Standing time before analysis	Method	Photometer cell length	Average Blank	Standard
S			Several months	Conductivity: N I O Salinometer			Copenhagen water
t				Reversing thermometer			
O_2	Calibrated glass flasks		Less than 2 days	Winkler		0	Bi-iodate N/50= 0.2N
PO_4	Aged glass flasks	Whatman Glass paper G.F/A	Analysed during cruise	Murphy&Riley	Unicam sp 500 10 cm	0.015	Supplied by U.K.
SiO_3	Polyethylene flasks	Oxoid membrane 0.5-1.0 μ	Analysed during cruise	Strickland's Manual	Unicam Sp 500 1 cm 10 cm	0.006 0.040	Supplied by U.K.

b. Biology

From 9-22 April, 81 of the NORWESTLANT I stations were worked with Hensen net while 74 of the same stations were worked with 2 m stramin net. Seven of the stramin net hauls had to be omitted due to bad weather. The rest of the planned NORWESTLANT I stations had to be omitted because of the heavy ice conditions.

Both the Hensen net and the 2 m stramin net were operated as described in the Guide Book to Surveys NORWESTLANT I-3. Kelvin Depth Tubes were not used. The depth was controlled by measuring the wire angle. Working up the sampled material, cod eggs and larvae have been counted in the whole sample. Concerning the zooplankton species given priority, the number in most cases were calculated from 1/10 or 1/100 of the total sample. The samples were divided into subsamples by using the Lea plankton divider. However, when the samples were small, the total sample was examined. Concerning other zooplankton species the total samples have been examined roughly to find the present species.

The volumes of the samples, fish eggs and larvae excluded, were measured by pouring the sample into a measuring cylinder and water was added until the total volume amounted to 10 ml, 50 ml, 100 ml, etc., according to the size of the sample. The liquid was then drained off through a sieve of plankton silk, in a Buchner funnel, using suction. Then the liquid was measured, the difference giving the volume of the plankton.

To find a conversion factor between the catches of the Hensen net and the 2 m stramin net number and total volume per 30 minute haul, per 10m^3 filtered water and per m^2 surface have been calculated for both net types. It showed impossible to establish a conversion factor.

1. Cod eggs and larvae: Tables 1 and 2*list the cod eggs and larvae from the Hensen net and the 2 m stramin net hauls. The stramin net seems to be much more effective in sampling than the Hensen net. Where no eggs were taken by the Hensen net, the stramin net took in many cases good samples of eggs.

The development stages of the eggs are also listed in Tables 1 and 2. Different scales have been used in the two tables as stage III in Table 1 also includes the same development stage as IV in Table 2. However, this does not matter very much as there are very few eggs in stage III in the Hensen net samples. A total of 13,565 cod eggs were taken in the stramin net hauls and 264 in the Hensen net hauls. 5,631, 4,458, 3,162 and 315 eggs belonged to stages I, II, III and IV respectively in the stramin hauls and 104, 150 and 10 to stages I, II, and III respectively in the Hensen hauls. Together the stages I and II both in the stramin and the Hensen hauls are dominating and this should mean that the eggs are recently spawned and that they are sampled early in the spawning season. This was also indicated by the maturity stages of the adult cod as about 40% of the mature cod in the trawl catches had not yet spawned.

The distribution of the sampled cod eggs are shown on Fig. 25 and 26. Few eggs are found north of 65°N. This indicates that the cod does not spawn in the cold water of almost pure Arctic origin. The heaviest concentrations of eggs were mainly found from the Fylla Bank and southward in surface temperatures between 1 and 3°C. Some eggs were found in water with surface temperature as low as -1.67°C. These eggs had probably drifted into this cold water as spawning cod were not found in temperatures lower than 2°C. The bottom temperatures in the area where the greatest amout of eggs were found, were between 2 and 4°C, and spawning cod were also only found in this area.

2. Zooplankton: Table 3 and 4*show the amounts of *Calanus* sp., *Spiratella* sp., *Thysanoessa longicaudata* and *Meganyctiphanes norvegica* in the Hensen net and the

the stramin net hauls. There is little or no agreement in the amounts of the different species in the hauls of the two net types. This is probably because the organisms occur in patches and because big organisms, such as euphausiids, are able to avoid the small opening in the Hensen net.

Organisms recorded in the stramin net hauls other than zooplankton organisms listed in Tables 3 and 4 are listed in Table 5.* Table 5 also shows the dominant organisms in the samples. Only in a few cases are other zooplankton species than those listed in Tables 3 and 4 dominant in the samples.

Fig. 27 and 28 show the distribution of volumes of zooplankton. Comparing the volumes with the water temperatures at 10 m temperatures are not so much influenced by the weather as in the surface, we find some agreement. Mainly, the smallest volumes were found in temperatures lower than 1 °C, but patches of high concentrations were also found in cold water.

The distribution of Calanus sp. are shown on Fig. 29 and 30. The highest concentrations were found mainly in temperatures more than 1 °C. In the cold coastal water none or very few were found.

Fig. 31 and 32 show the distribution of Spiratella sp. The distribution of these organisms seemed to be limited of the 0 °C isotherm. Only few patches were found in colder water.

Thysanoessa longicaudata were mainly found in small numbers (Fig. 33). Only a few patches were found in the cold water. The greatest numbers were caught in water temperatures higher than 2 °C.

Meganyctiphanes norvegica occurred also mainly in small numbers (Fig. 34). Only in a few small areas were sampled more than 1000 individuals per 30 minute haul with the 2m stramin net.

*Tables 1-5 of this paper have not been duplicated. Original copies are available in the ICNAF Secretariat

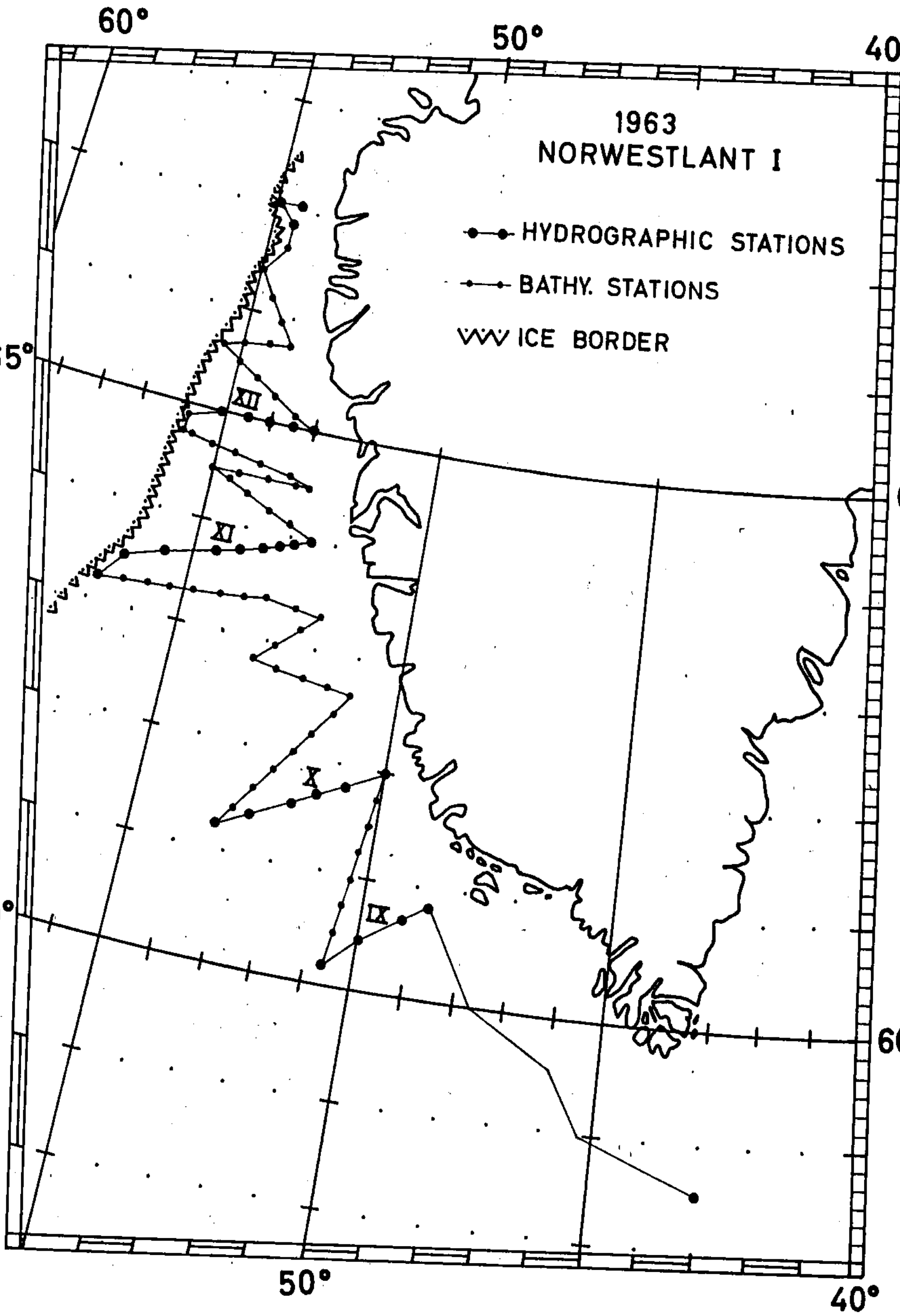

Fig. 1. "G.O.Sars", West Greenland, April 1963. Stations worked.

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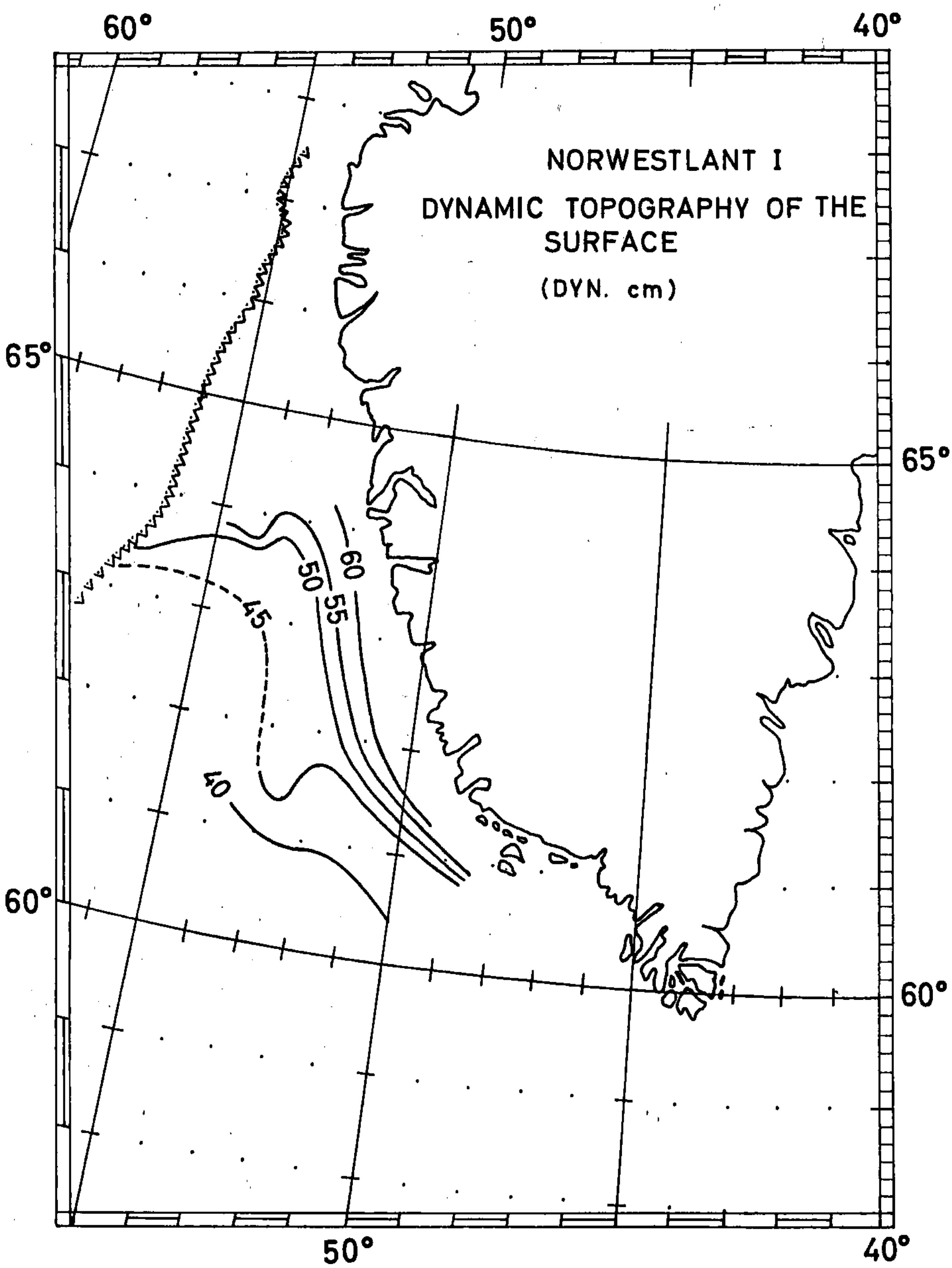


Fig. 2. "G.O.Sars", West Greenland, April 1963. Dynamic topography og the sea surface in dynamic cm. Reference level 1000 decibars.

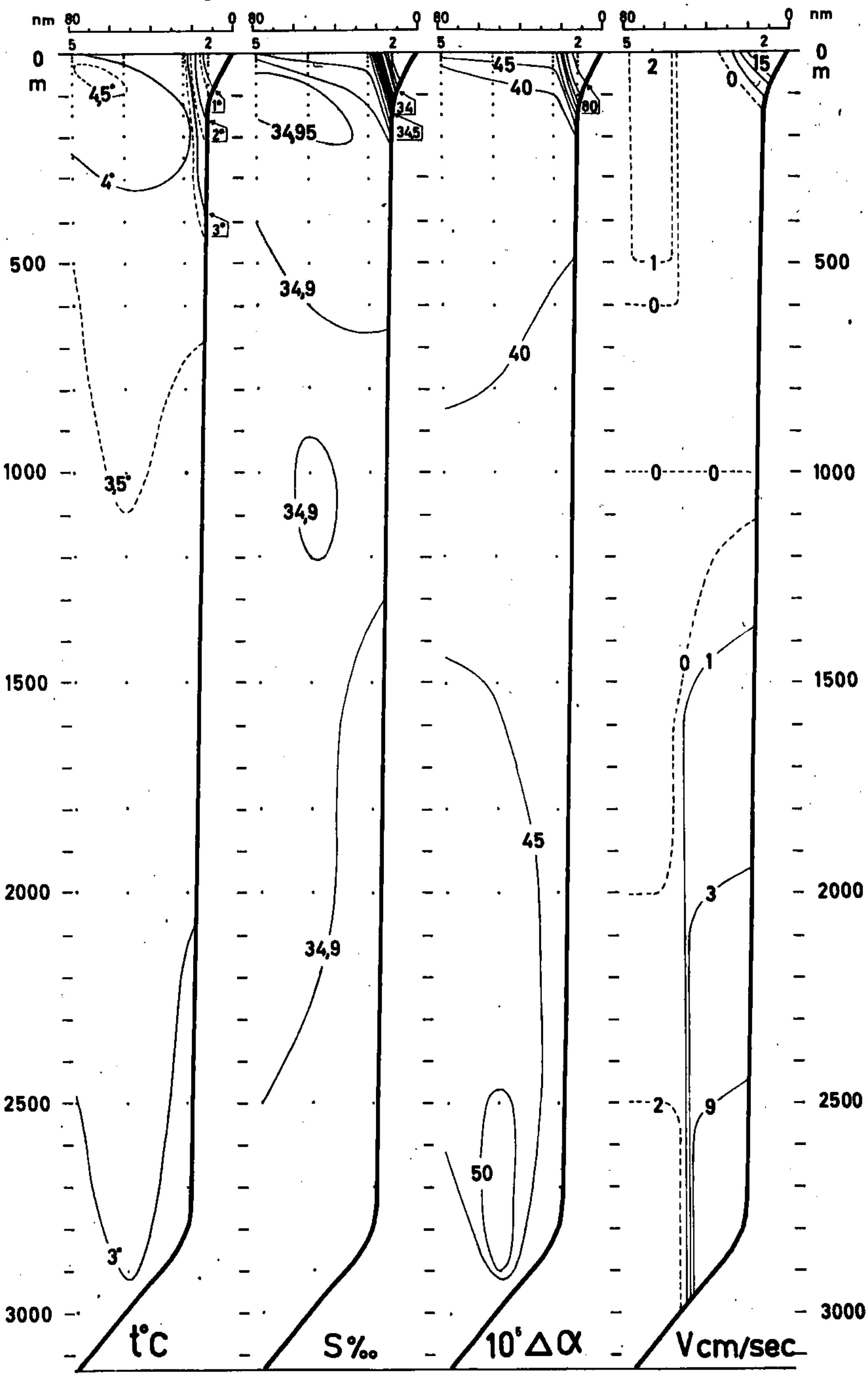


Fig. 3. "G.O.Sars", West Greenland, April 1963. Section IX. Temperature, salinity, specific volume anomaly and current components. Broken curves indicate current towards south, and unbroken curves indicate current towards north.

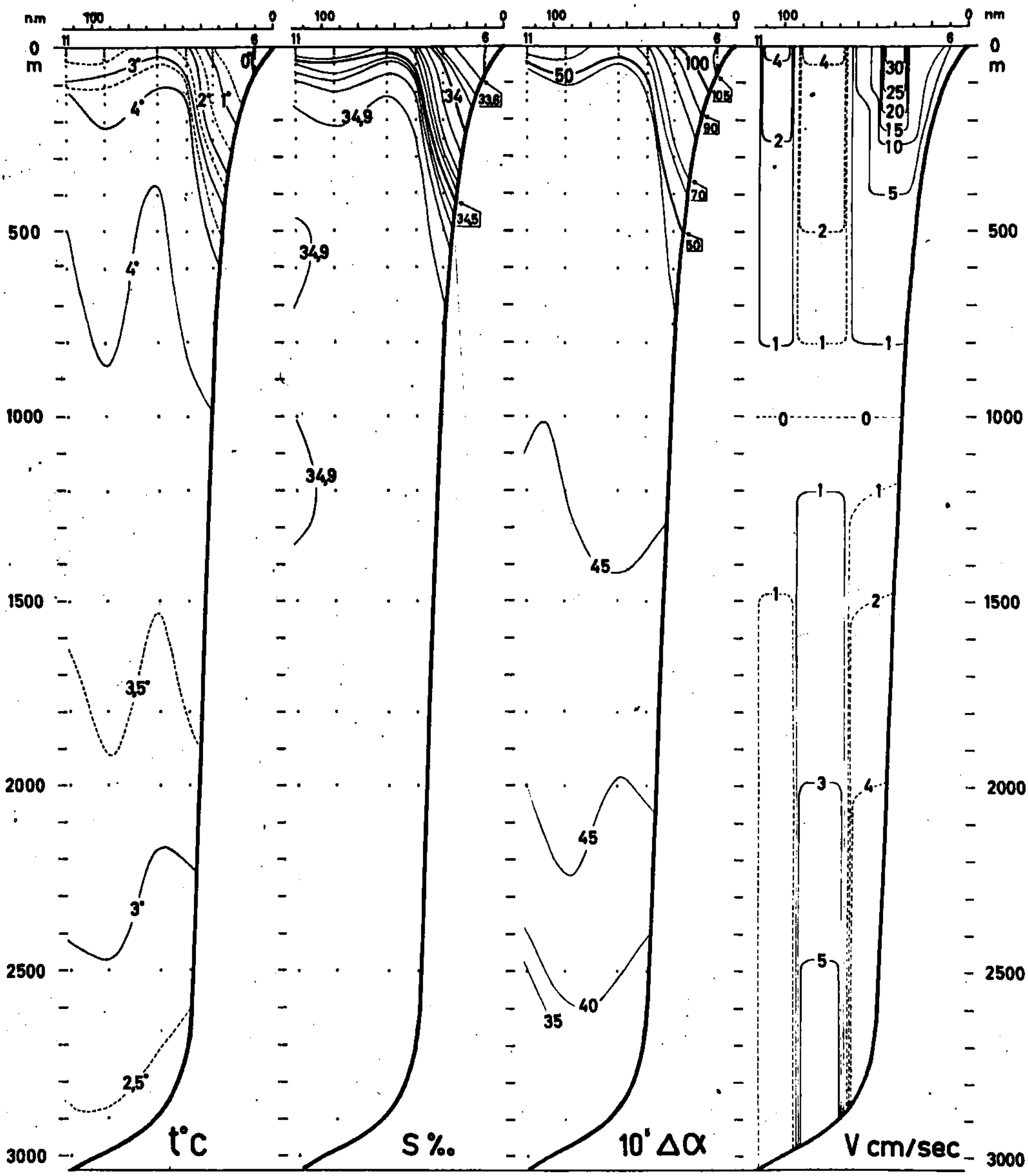


Fig. 4. "G.O.Sars", West Greenland, April 1963.Section X. Temperature, salinity, specific volume anomaly and current components. Broken curves indicate current towards south, and unbroken curves indicate current towards north.

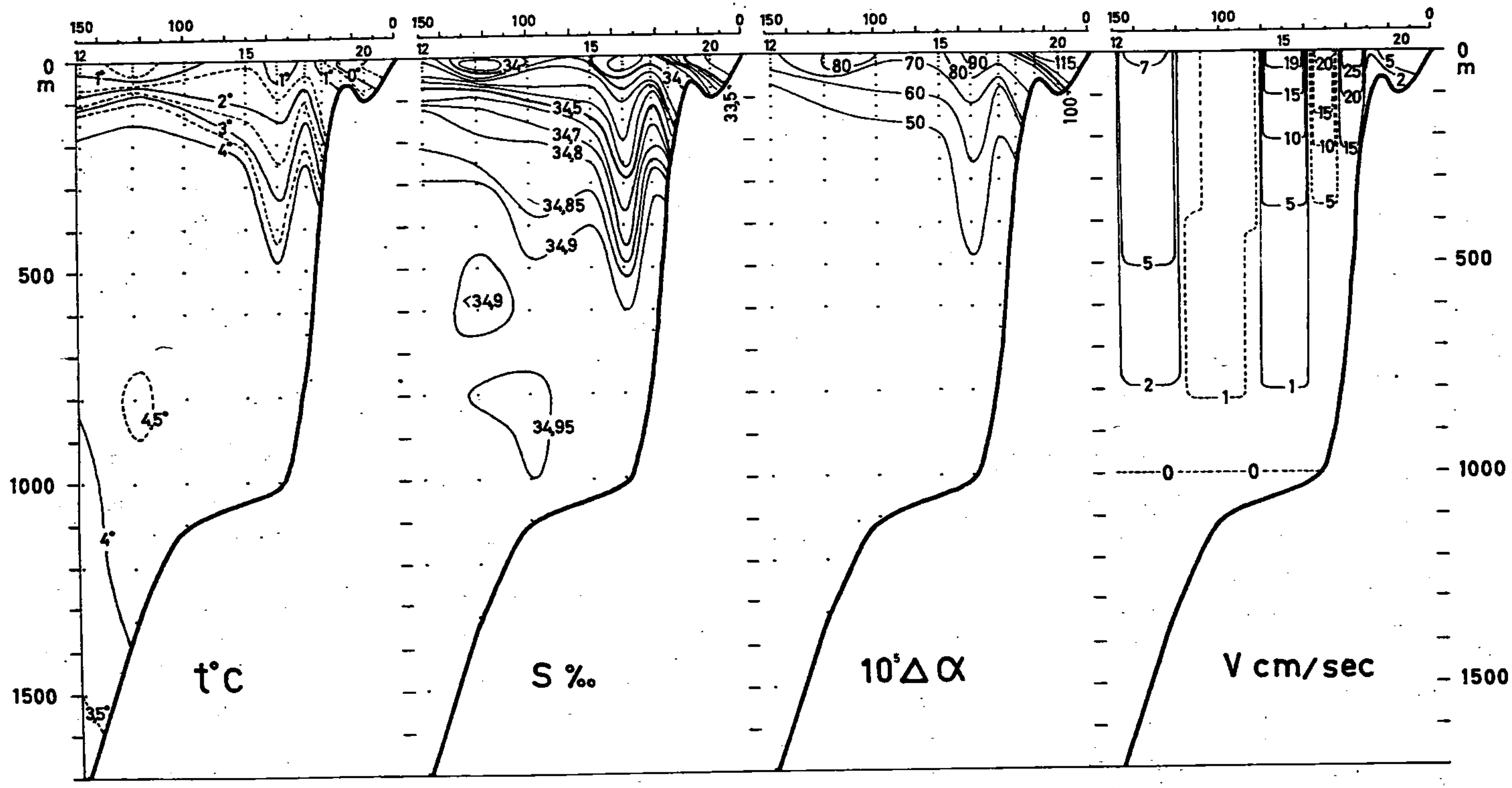


Fig. 5. "G.O.Sars", West Greenland, April 1963. Section XI. Temperature, salinity, specific volume anomaly and current components. Broken curves indicate current towards south, and unbroken curves indicate current towards north.

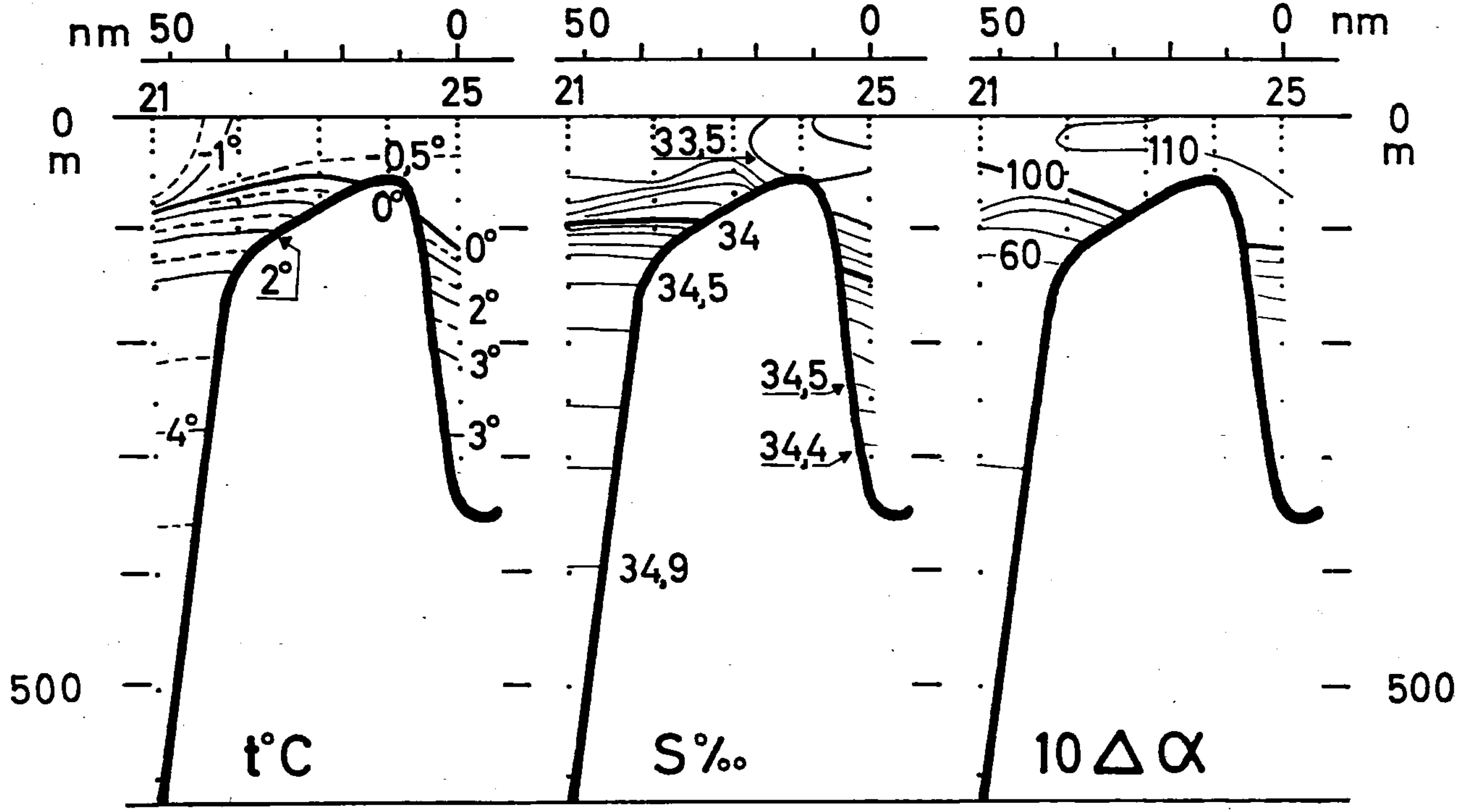


Fig. 6. "G.O.Sars", West Greenland, April 1963. Section XII. Temperature, salinity and specific volume anomaly.

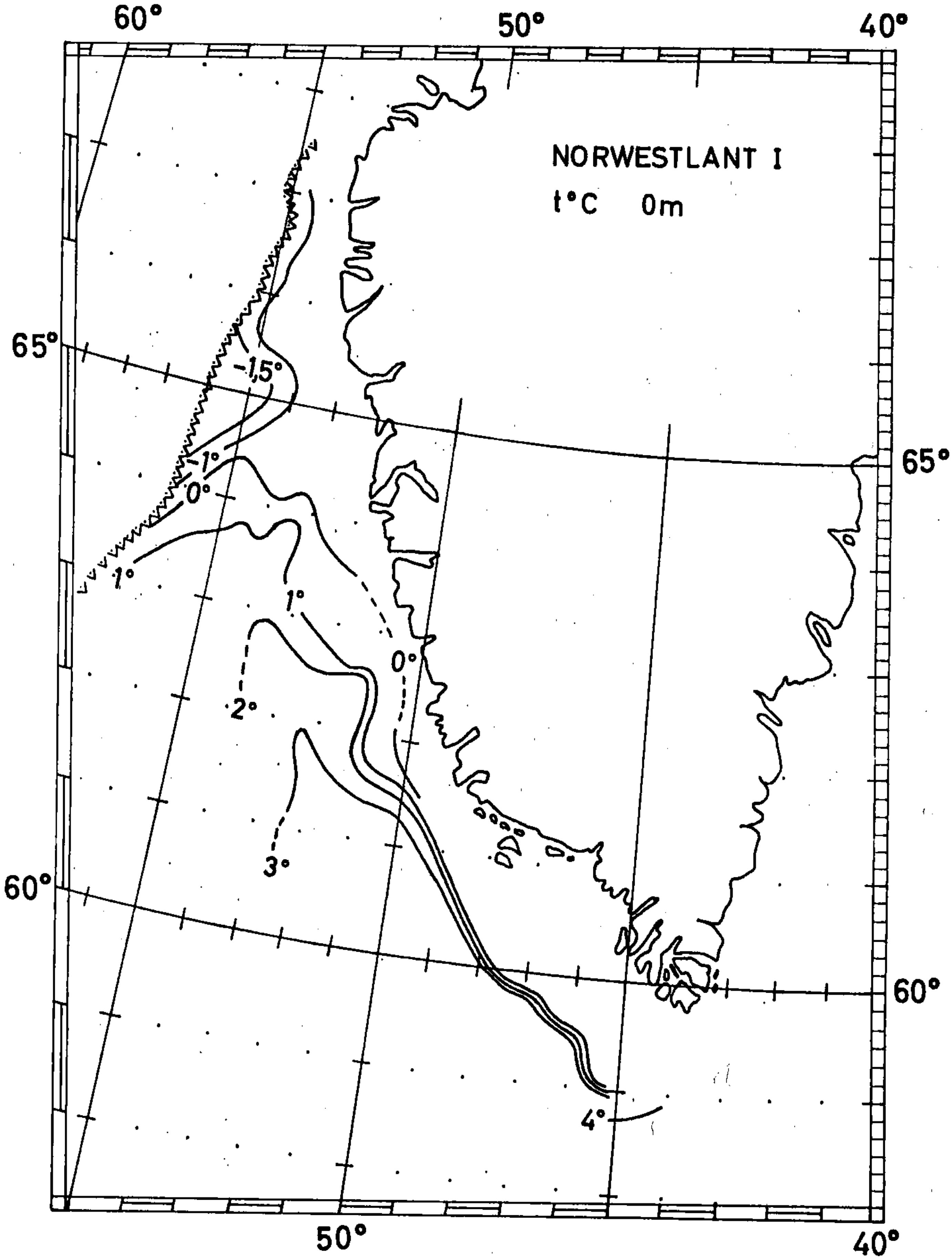


Fig. 7. "G.O.Sars", West Greenland, April 1963. Surface temperature (°C).

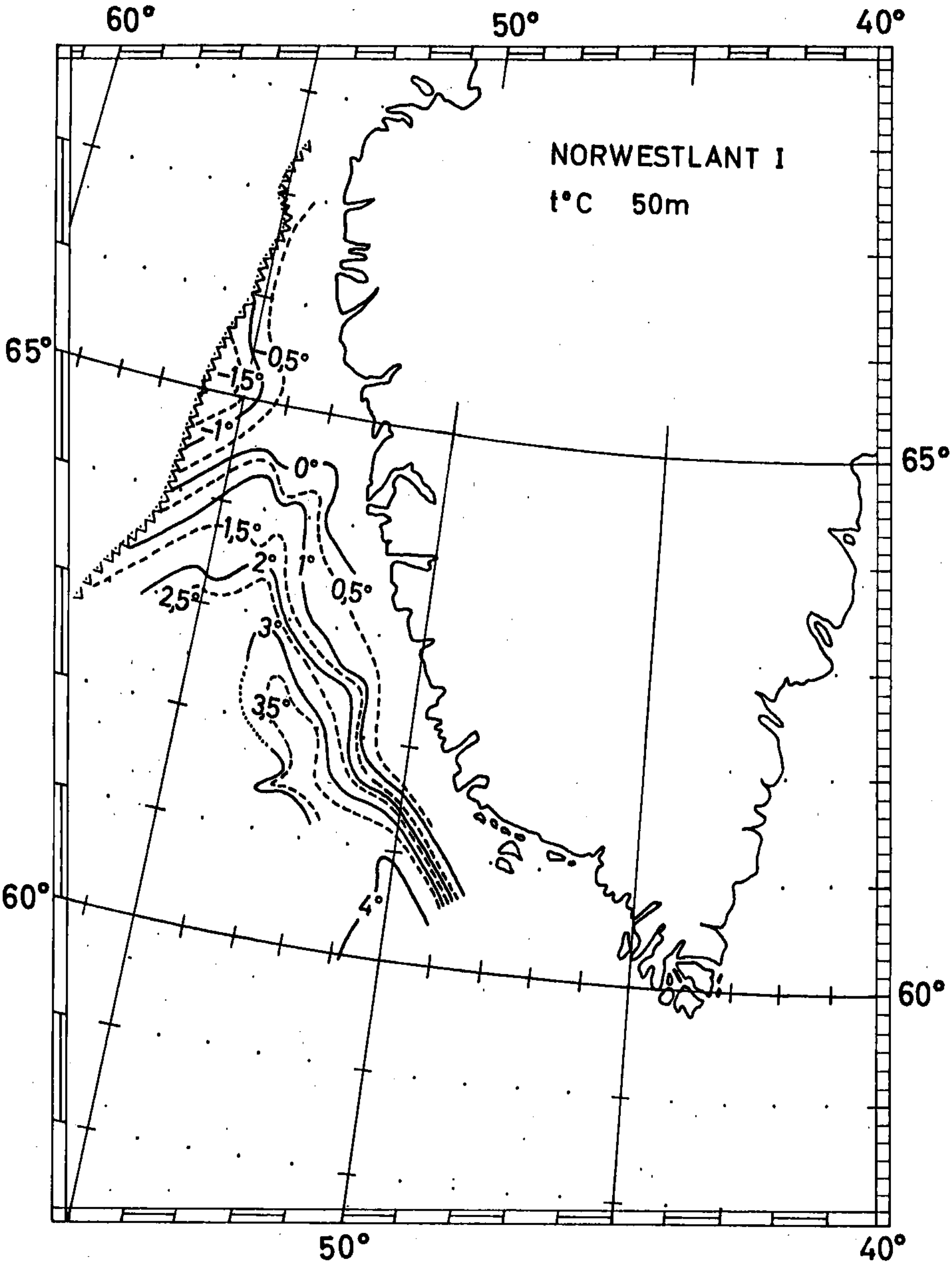


Fig. 8. "G.O.Sars", West Greenland, April 1963. Temperature (°C) at 50 metres depth.

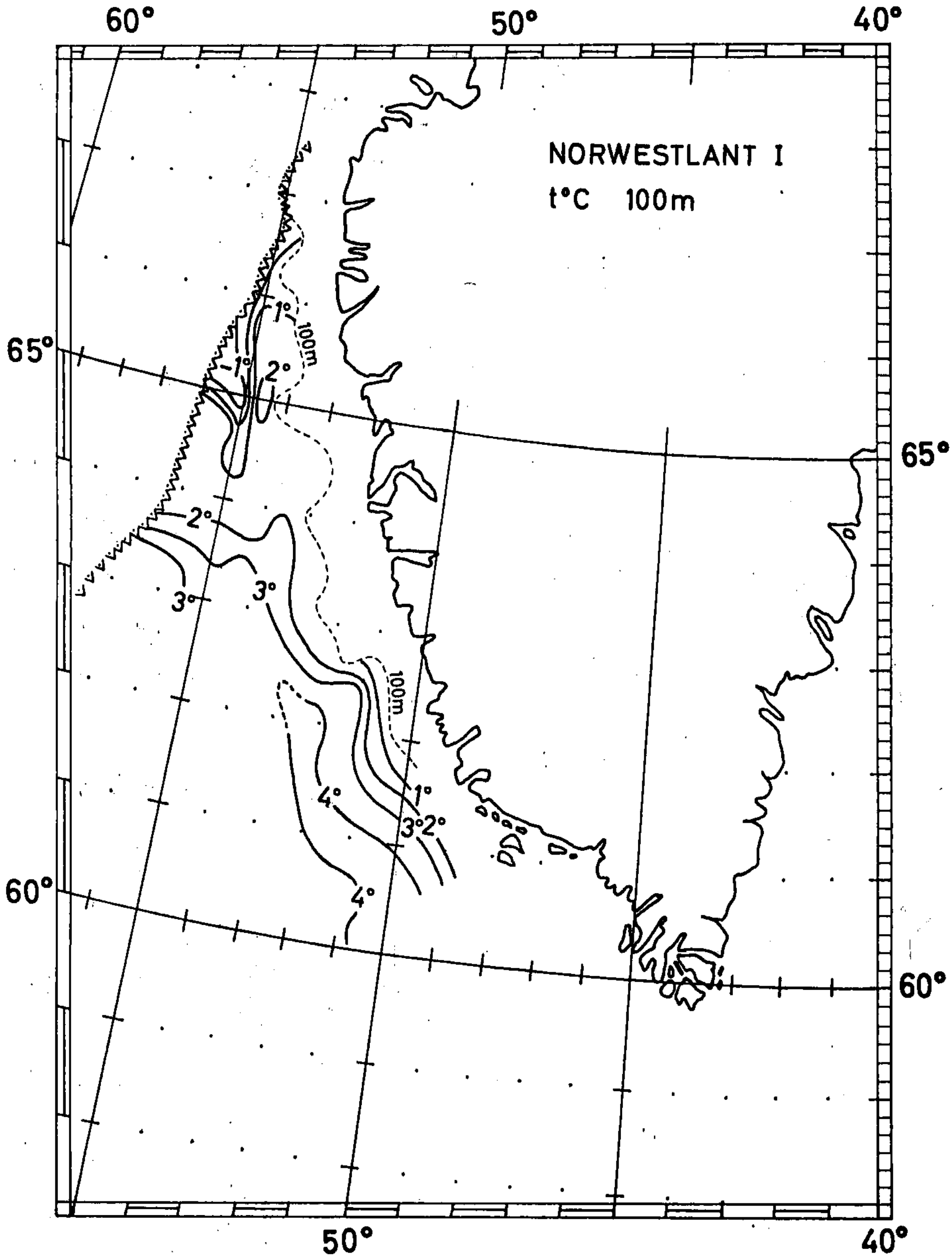


Fig. 9. "G.O.Sars", West Greenland, April 1963. Temperature (°C) at 100 metres depth.

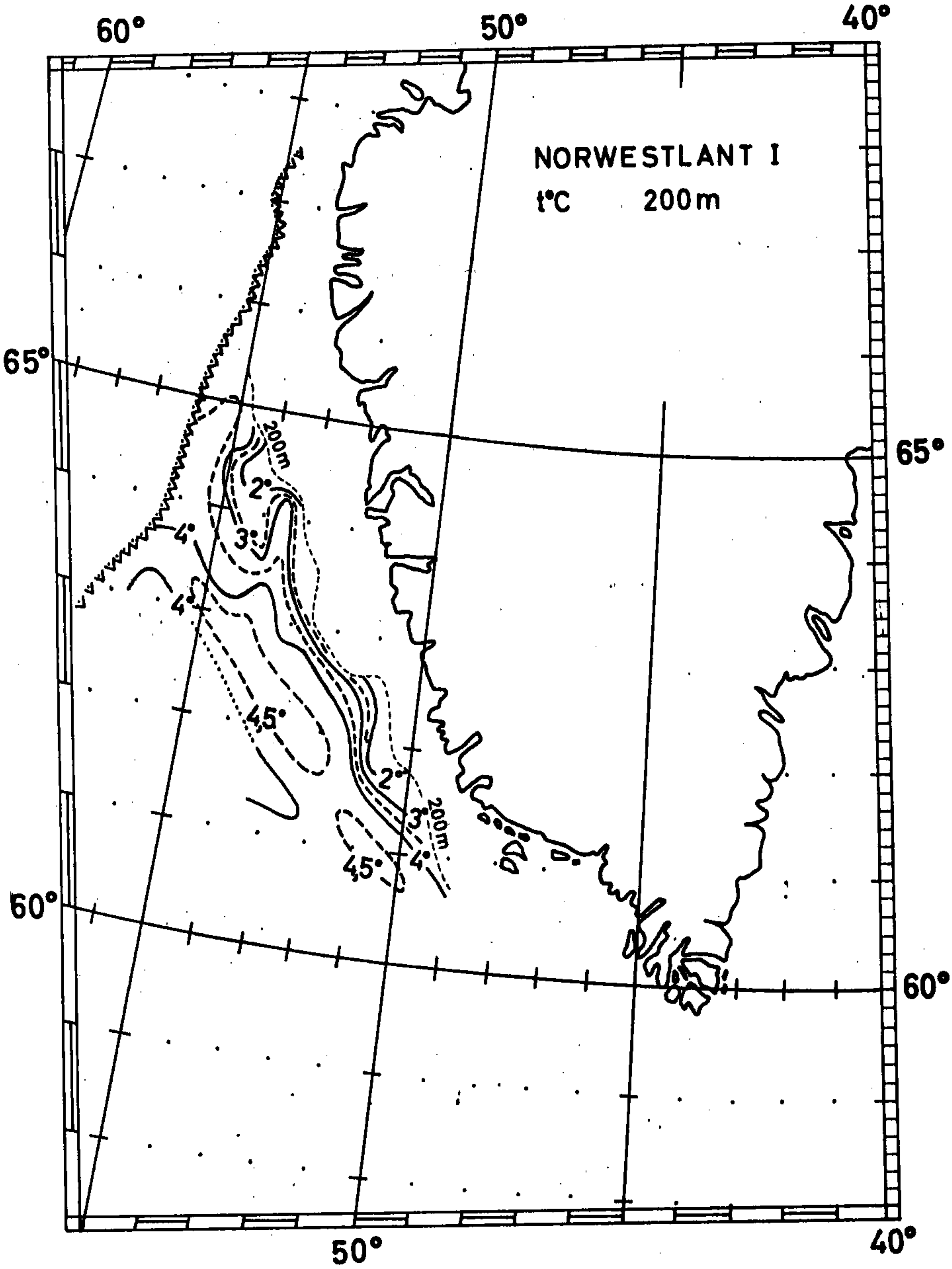
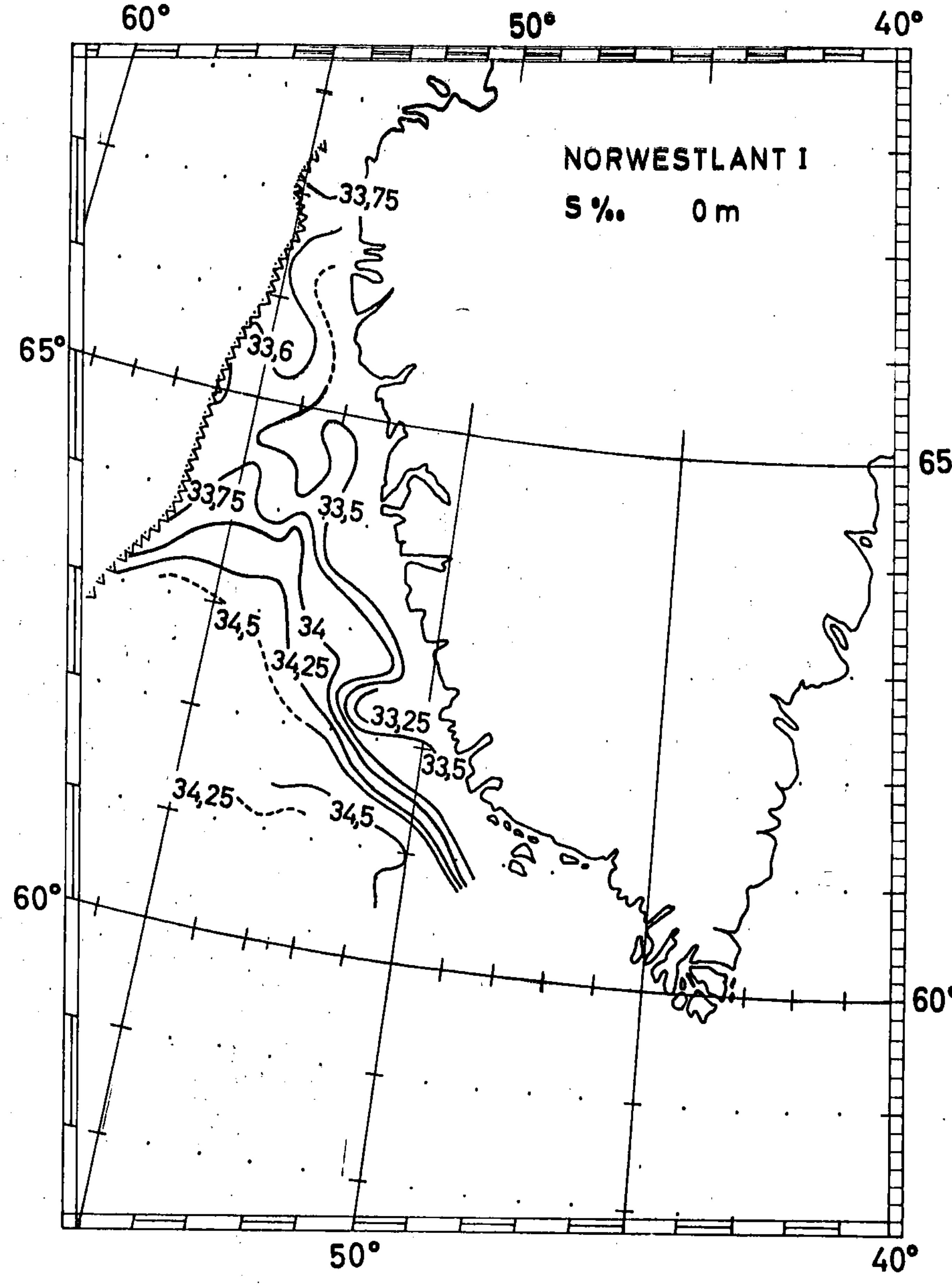


Fig. 10. "G.O.Sars", West Greenland, April 1963. Temperature (°C) at 200 metres depth.



11. "G.O.Sars", West Greenland, April 1963. Distribution of salinity at the surface.

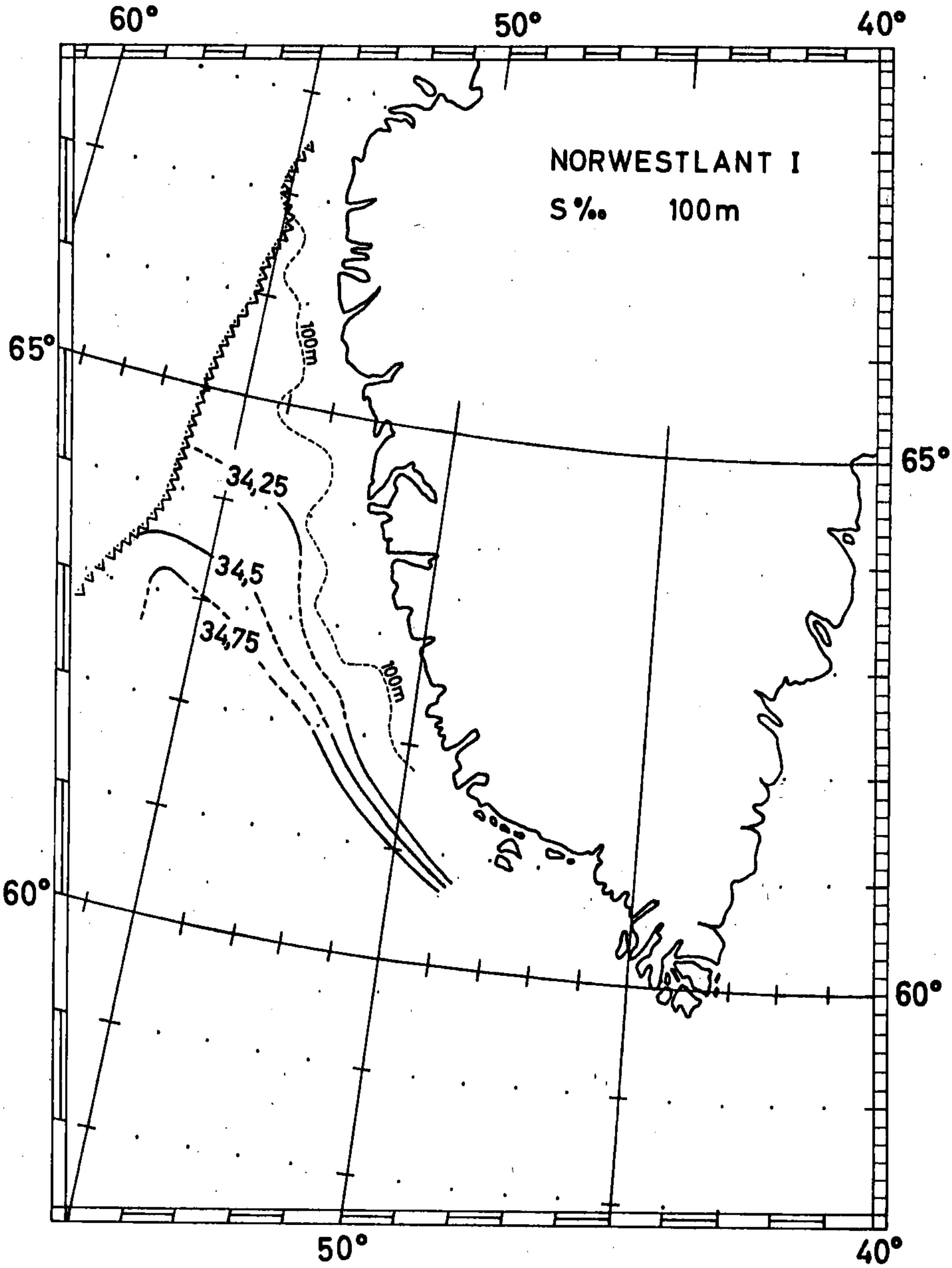


Fig. 12. "G.O.Sars", West Greenland, April 1963. Distribution of salinity at 100 metres depth.

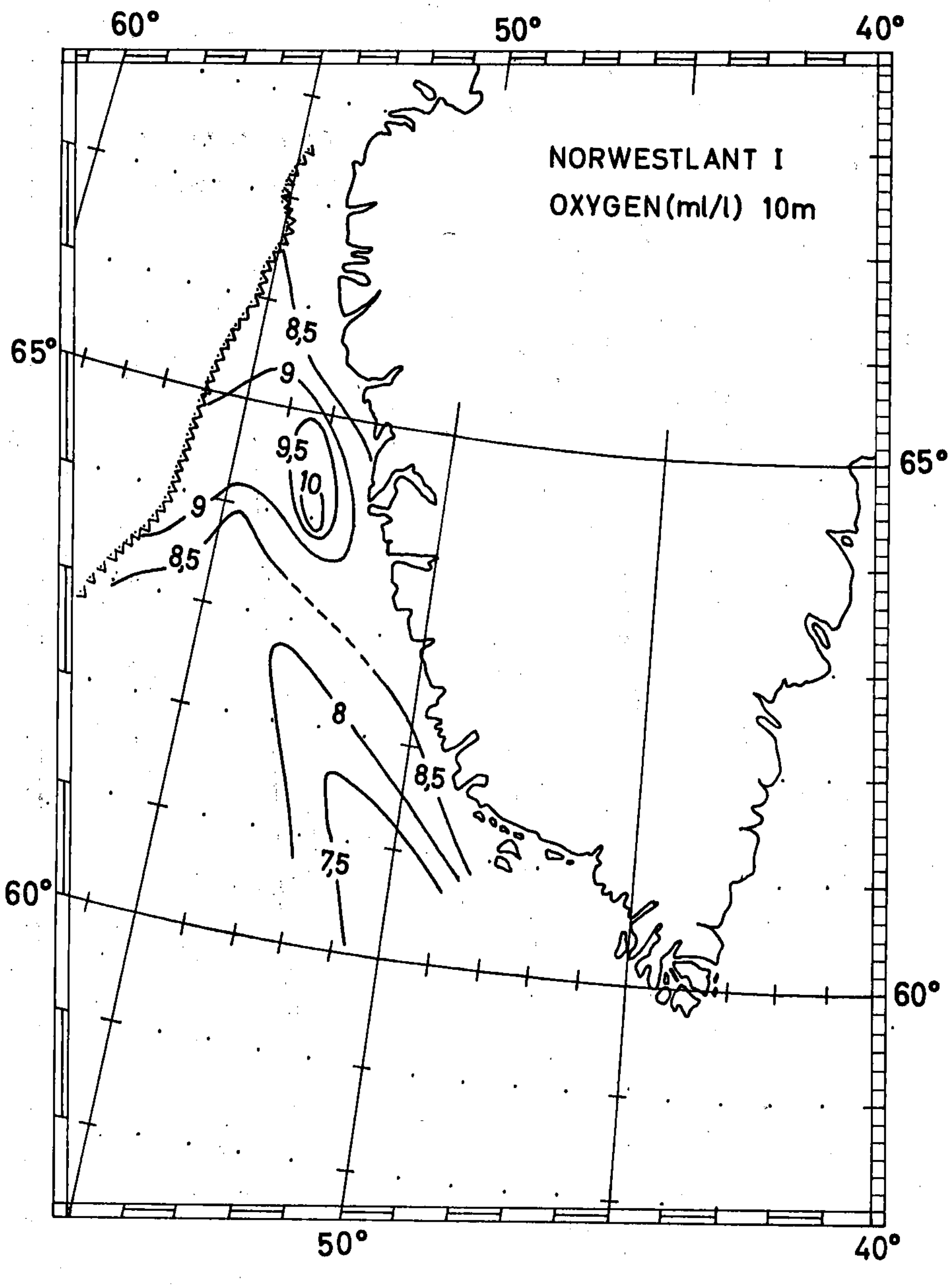


Fig. 13 "G.O.Sars", West Greenland, April 1963. Distribution of oxygen (ml/l) at 10 metres depth.

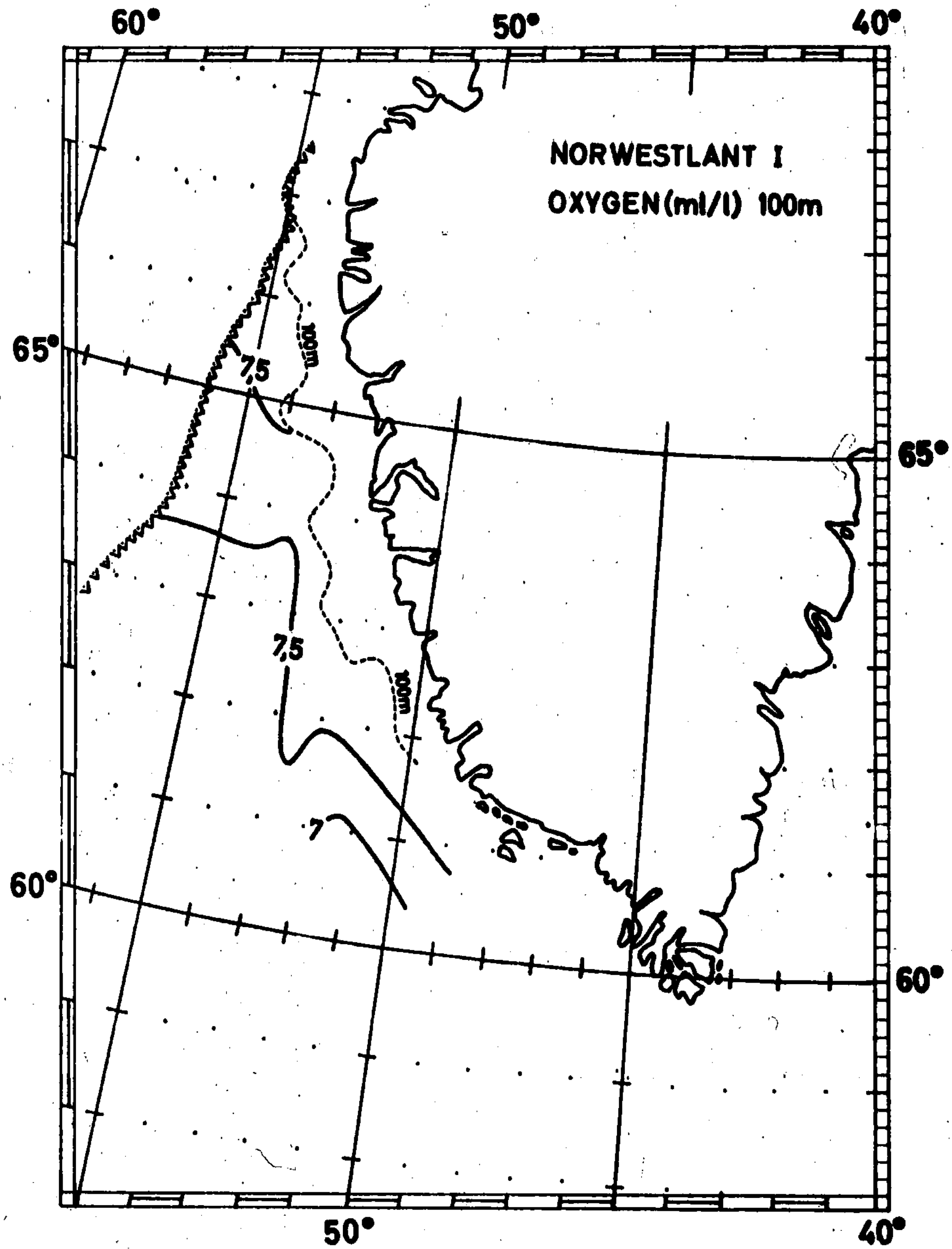


Fig. 14. "G.O.Sars", West Greenland, April 1963. Distribution of oxygen (ml/l) at 100 metres depth.

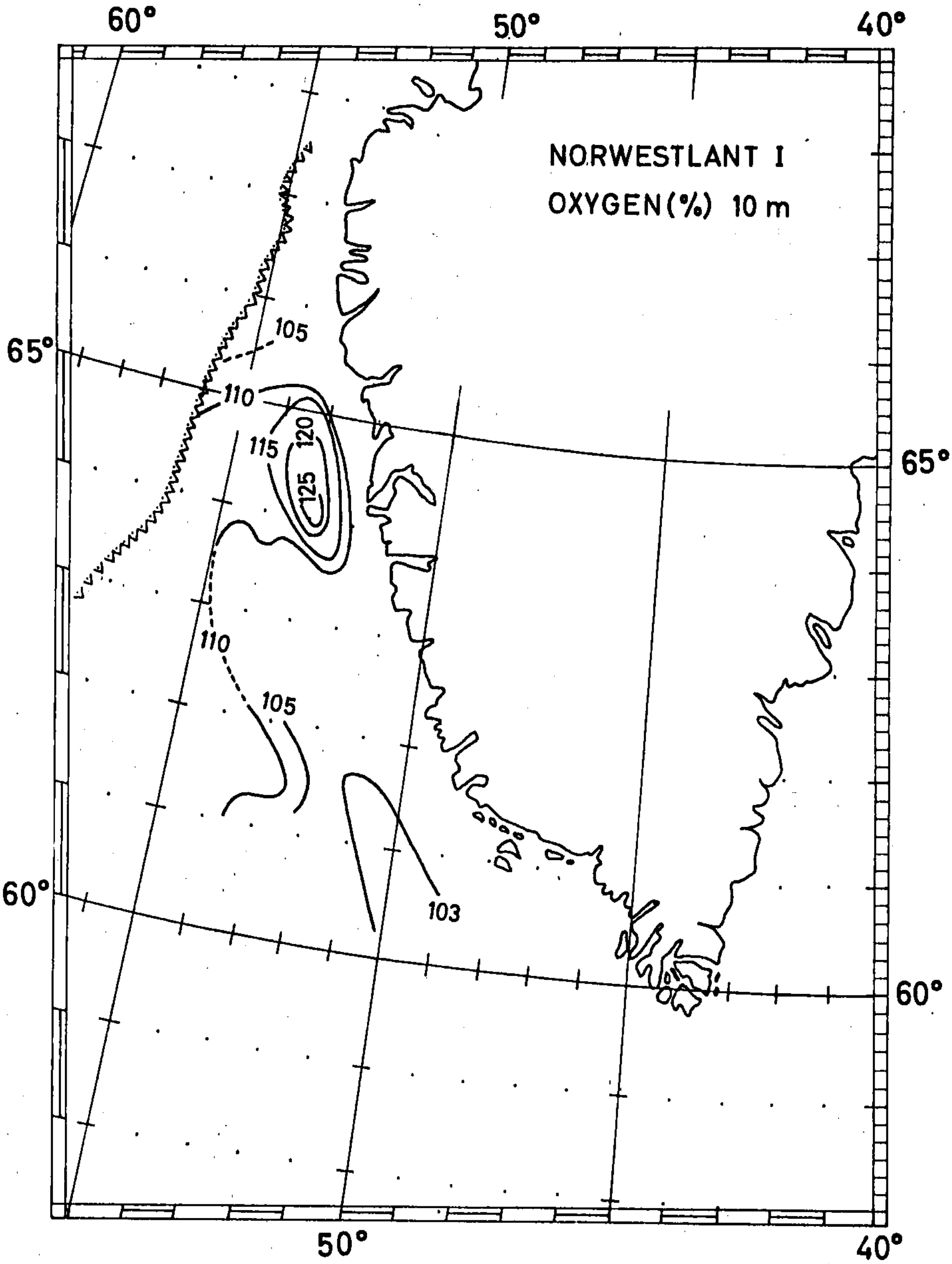


Fig. 15. "G.O.Sars", West Greenland, April 1963. Distribution of oxygen in percent of saturation at 10 metres depth.

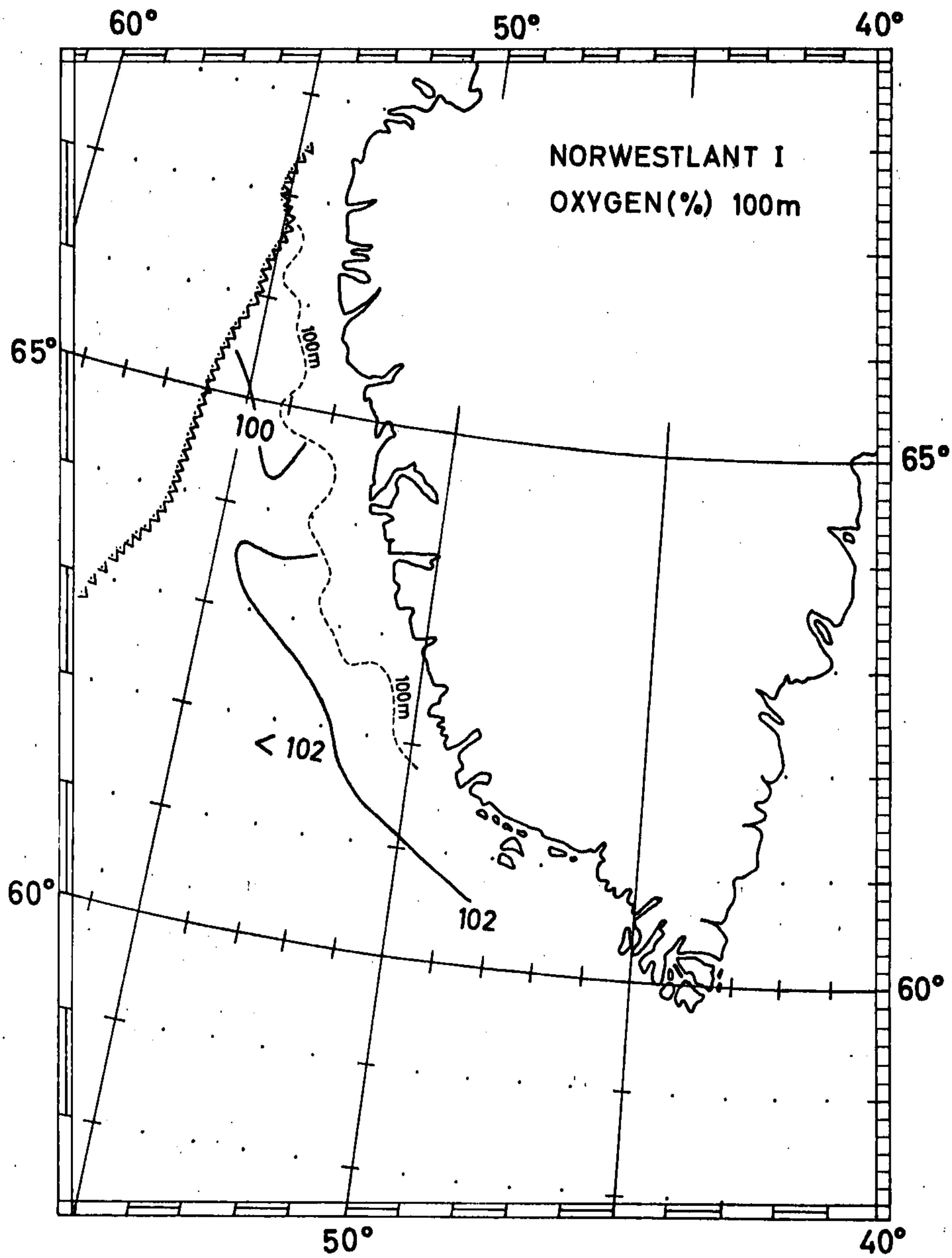


Fig. 16. "G.O.Sars", West Greenland, April 1963. Distribution of oxygen in percent of saturation at 100 metres depth.

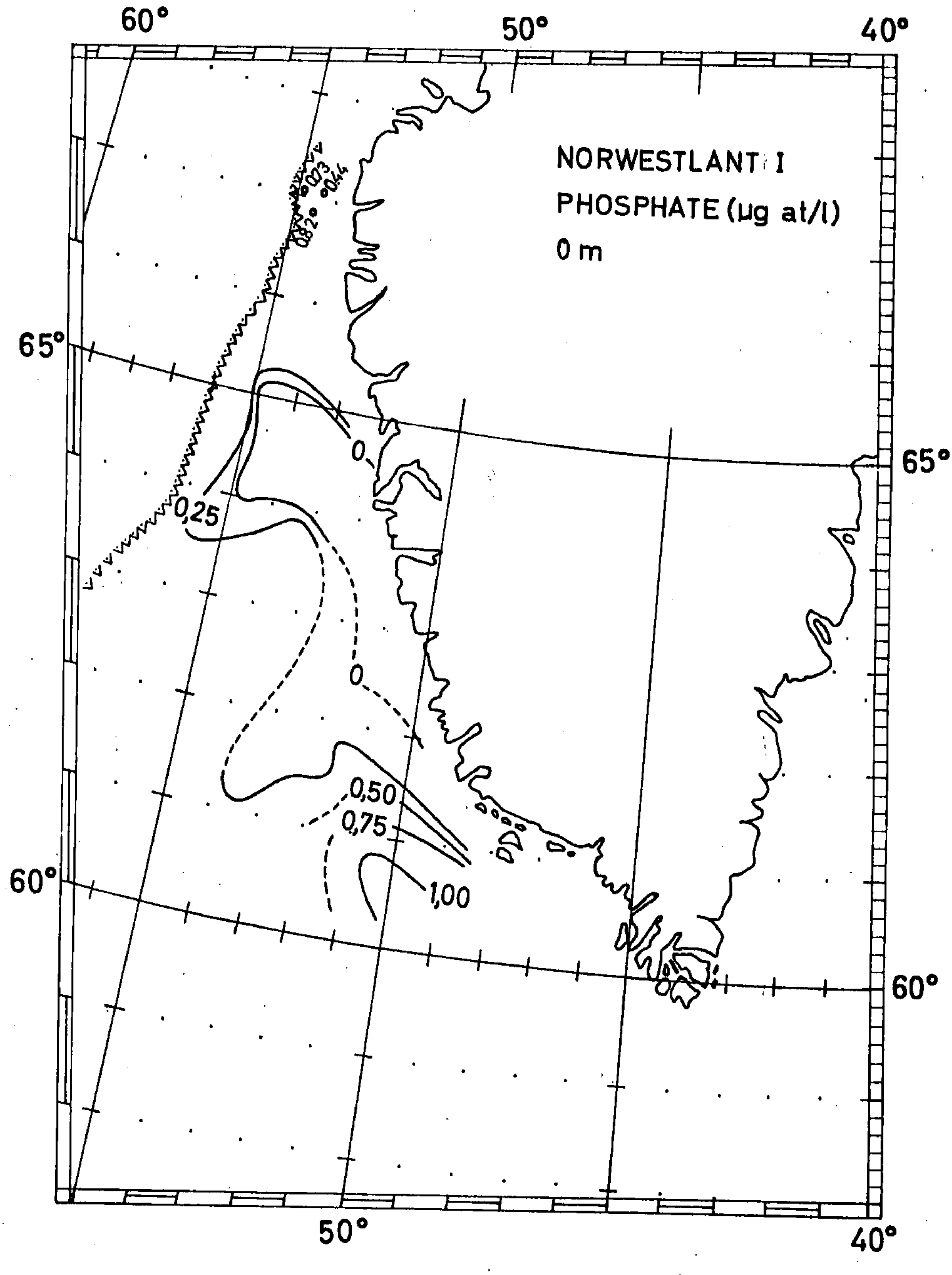


Fig. 17. "G.O.Sars", West Greenland, April 1963. Distribution of phosphate (µ g at/l) at the surface.

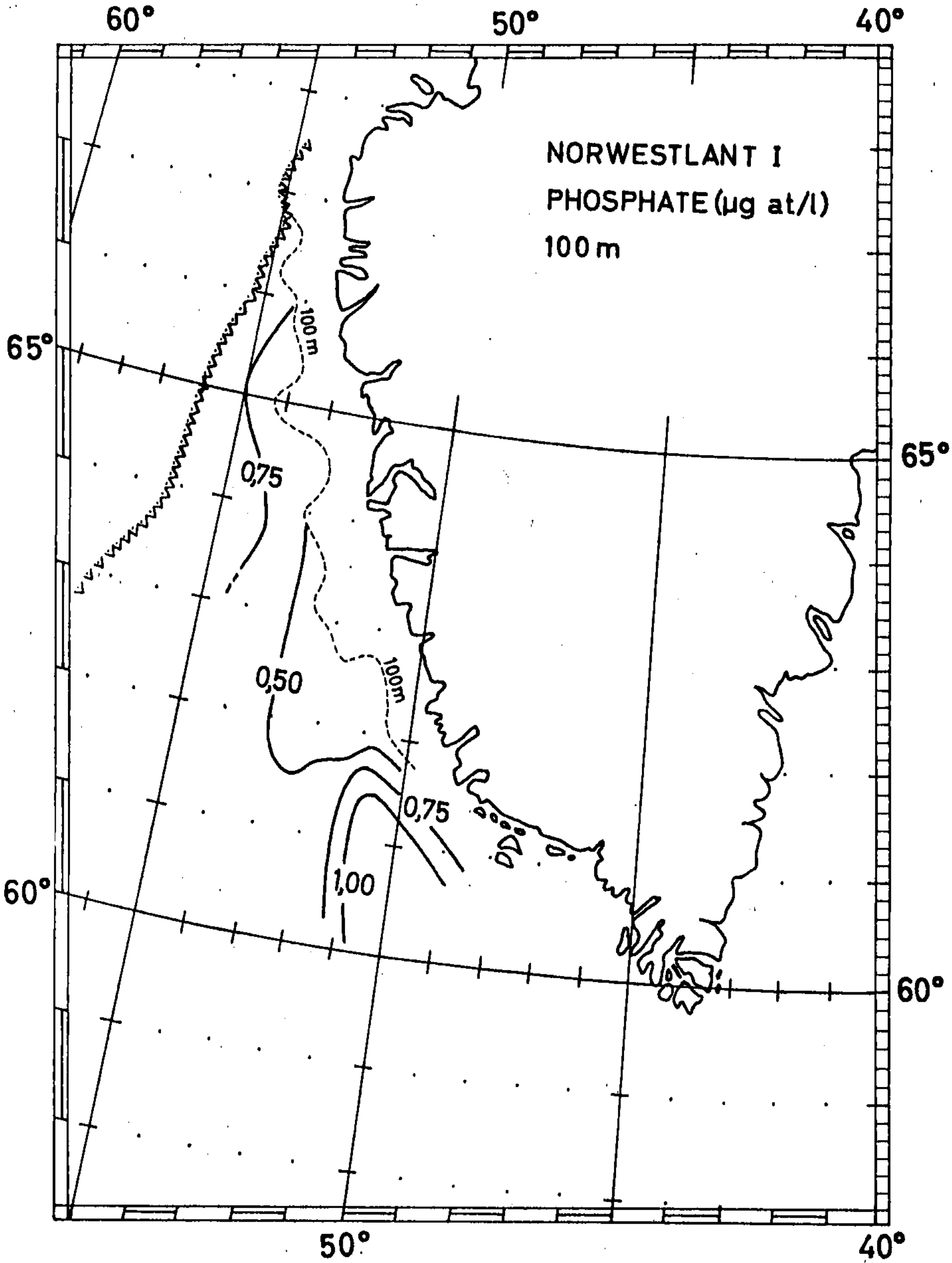


Fig. 18. "G.O.Sars", West Greenland, April 1963. Distribution of phosphate (µ g at/l) at 100 metres depth.

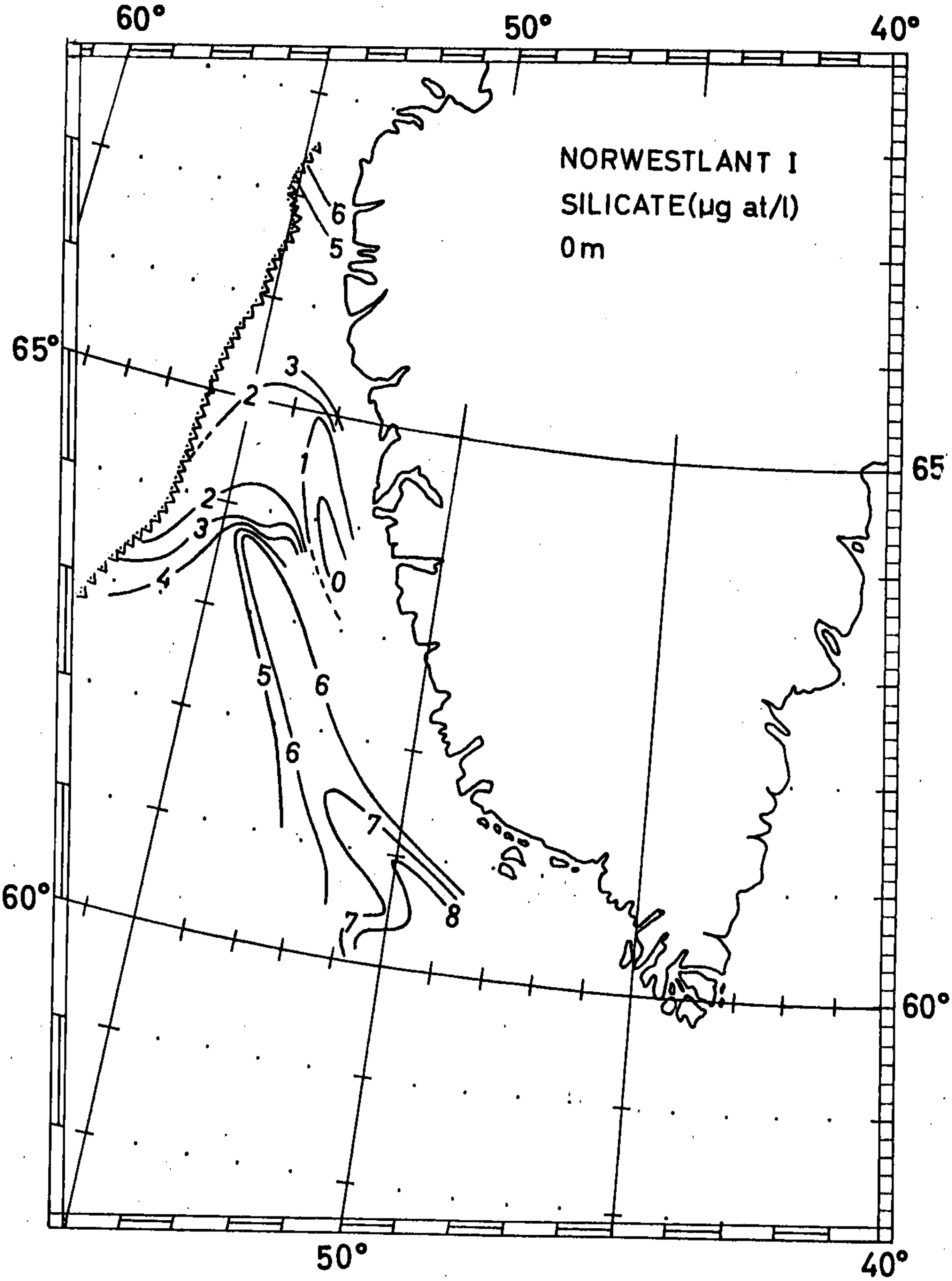


Fig. 19. "G.O.Sars", West Greenland, April 1963. Distribution of silicate (μ g at/l) at the surface.

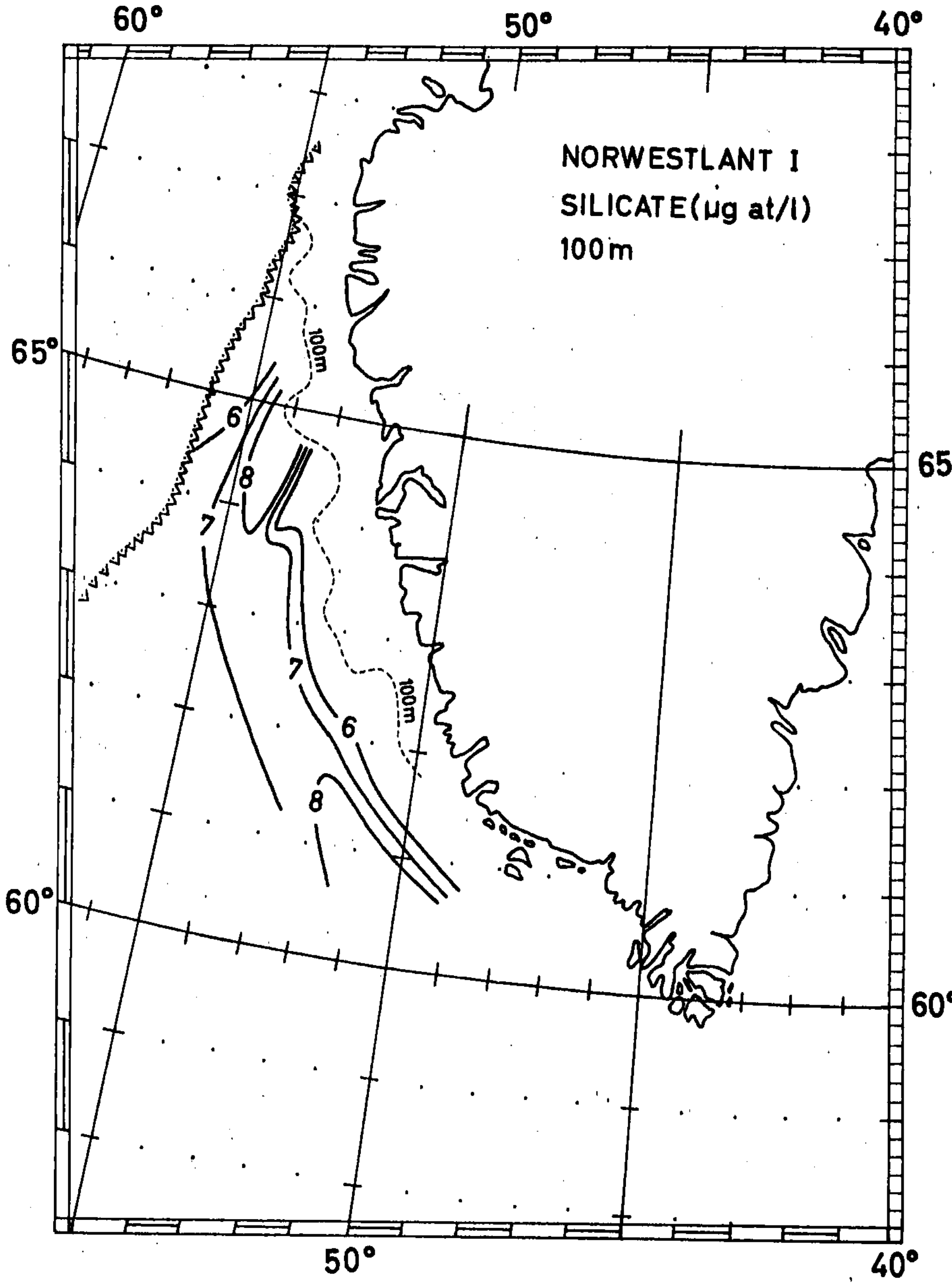


Fig. 20. "G.O.Sars", West Greenland, April 1963. Distribution of silicate (µ g at/l) at 100 metres depth.

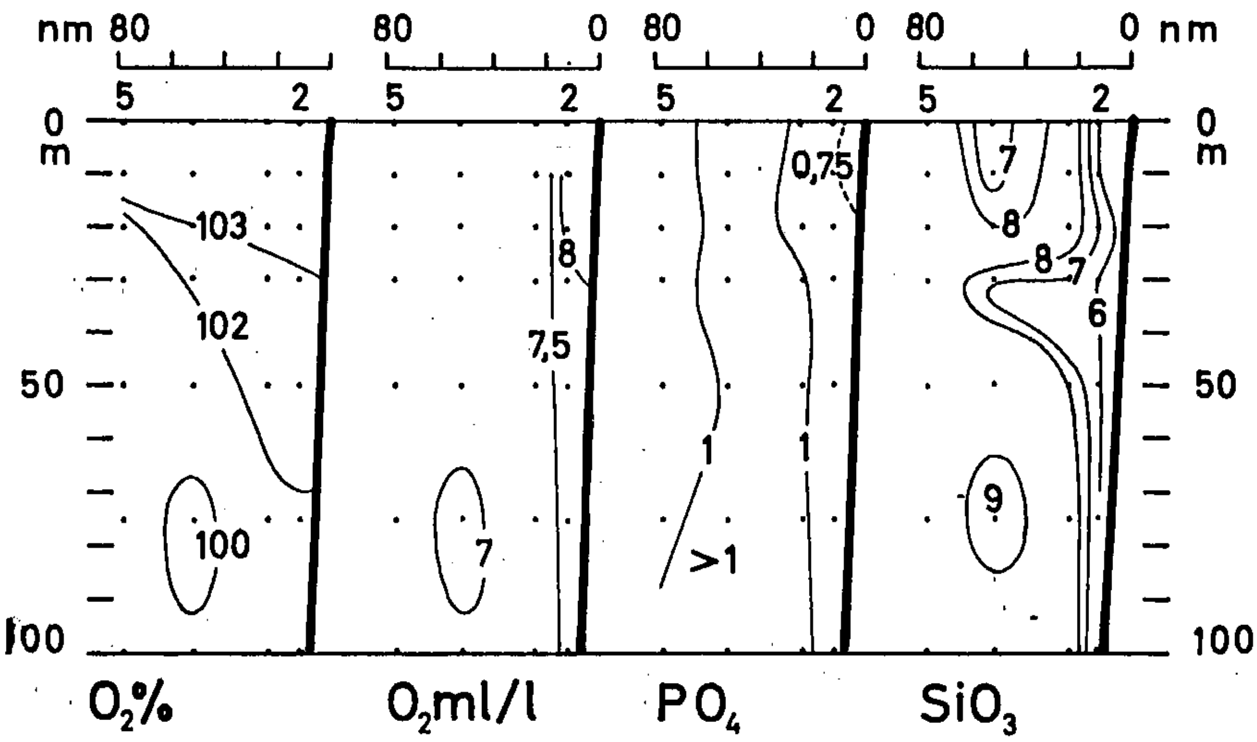


Fig. 21. "G.O.Sars", West Greenland, April 1963. Section IX. Vertical distribution of oxygen in ml/l, oxygen in percent of saturation, phosphate and silicate in µ g at/l.

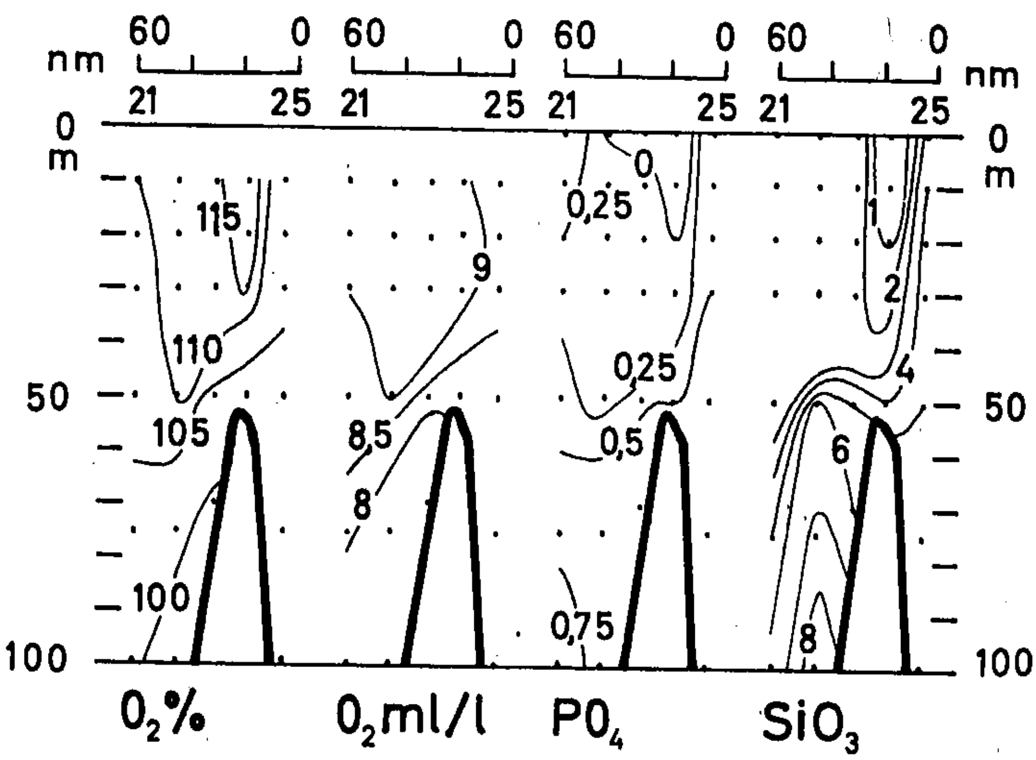


Fig. 24. "G.O.Sars", West Greenland, April 1963. Section XII. Vertical distribution of oxygen in ml/l, oxygen in percent of saturation, phosphate and silicate in µ g at/l.

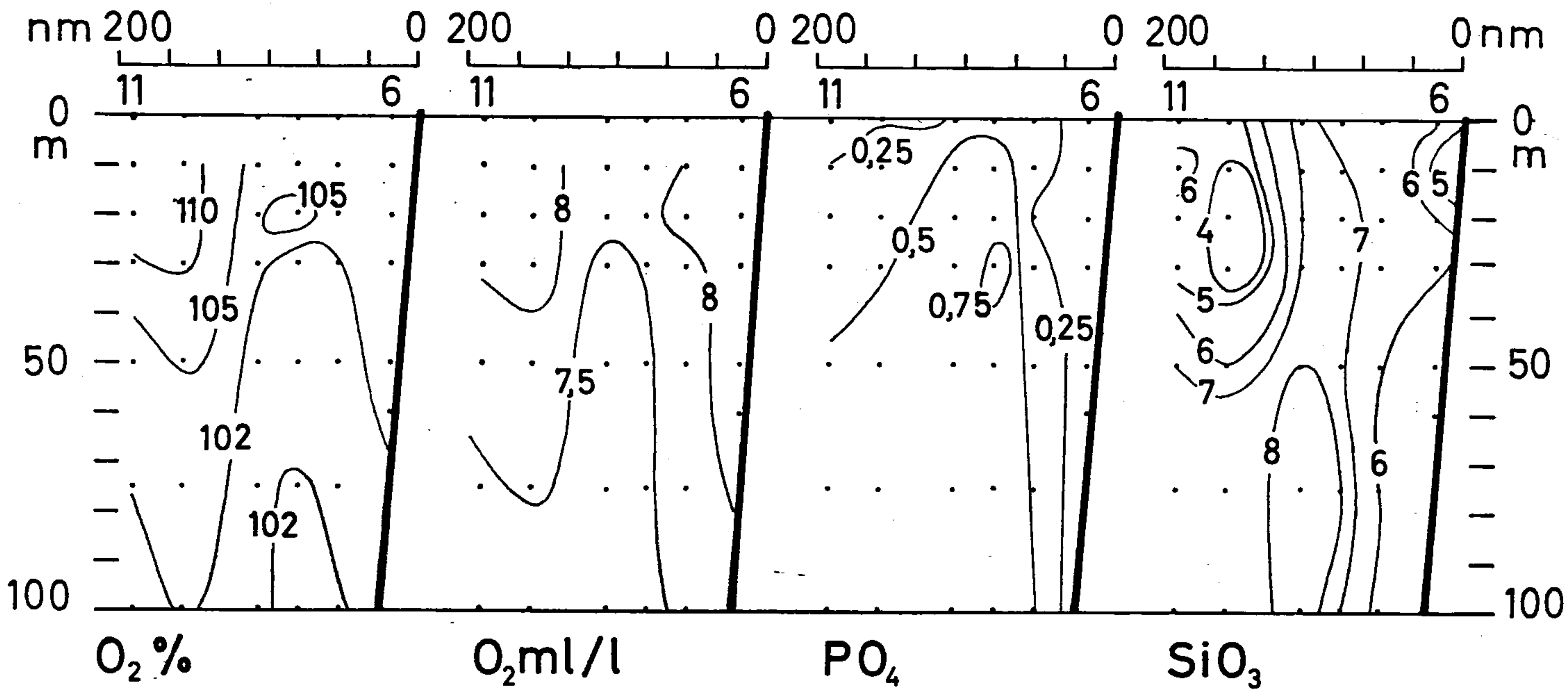


Fig. 22. "G.O.Sars", West Greenland, April 1963. Section X. Vertical distribution of oxygen in ml/l, oxygen in percent of saturation, phosphate and silicate in μ g at/l.

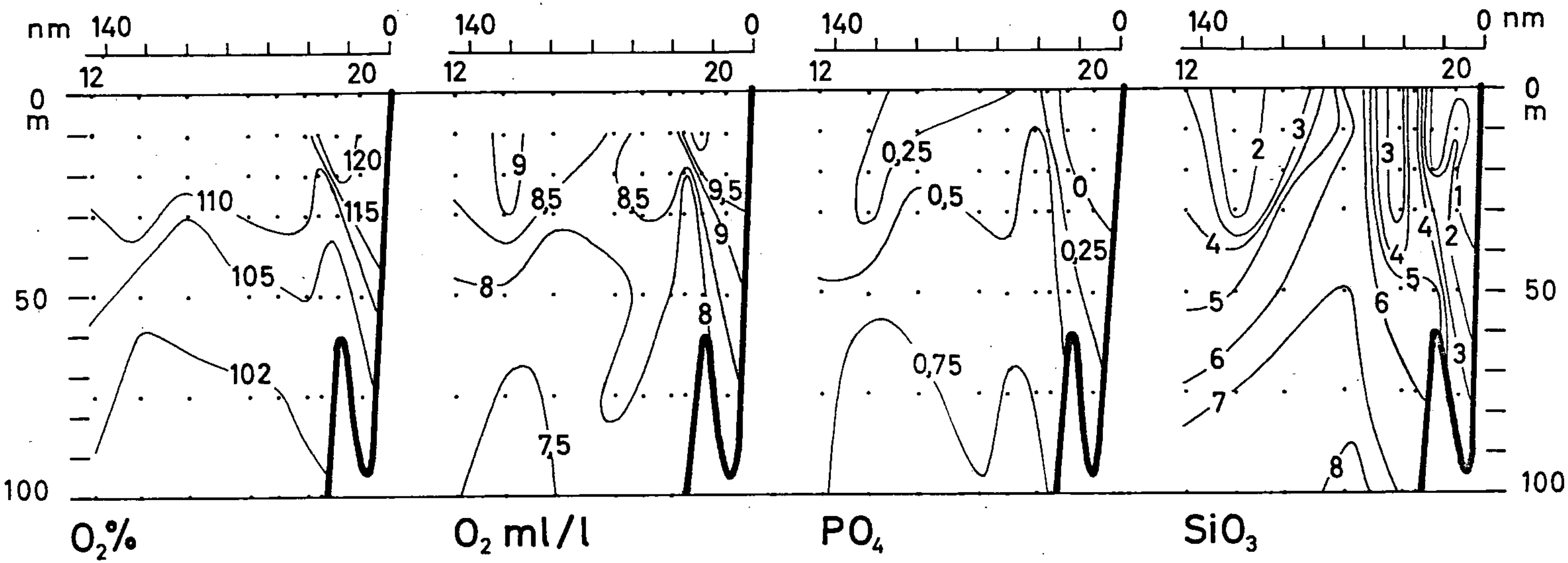


Fig. 23. "G.O.Sars", West Greenland, April 1963. Section XI. Vertical distribution of oxygen in ml/l, oxygen in percent of saturation, phosphate and silicate in µ g at/l.

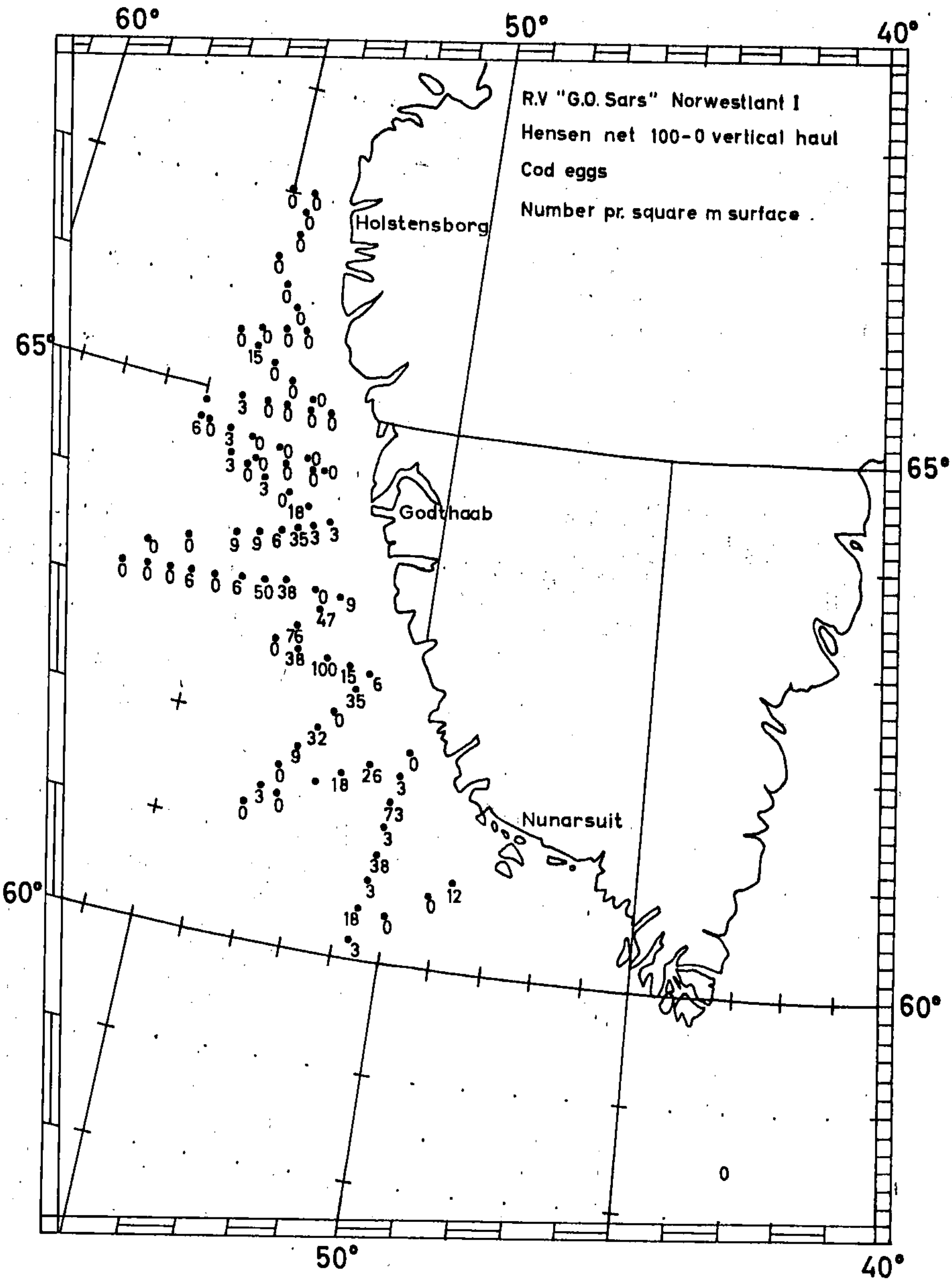


Fig. 25. "G. O. Sars", West Greenland, April 1963. Distribution of cod eggs. Hensen net.

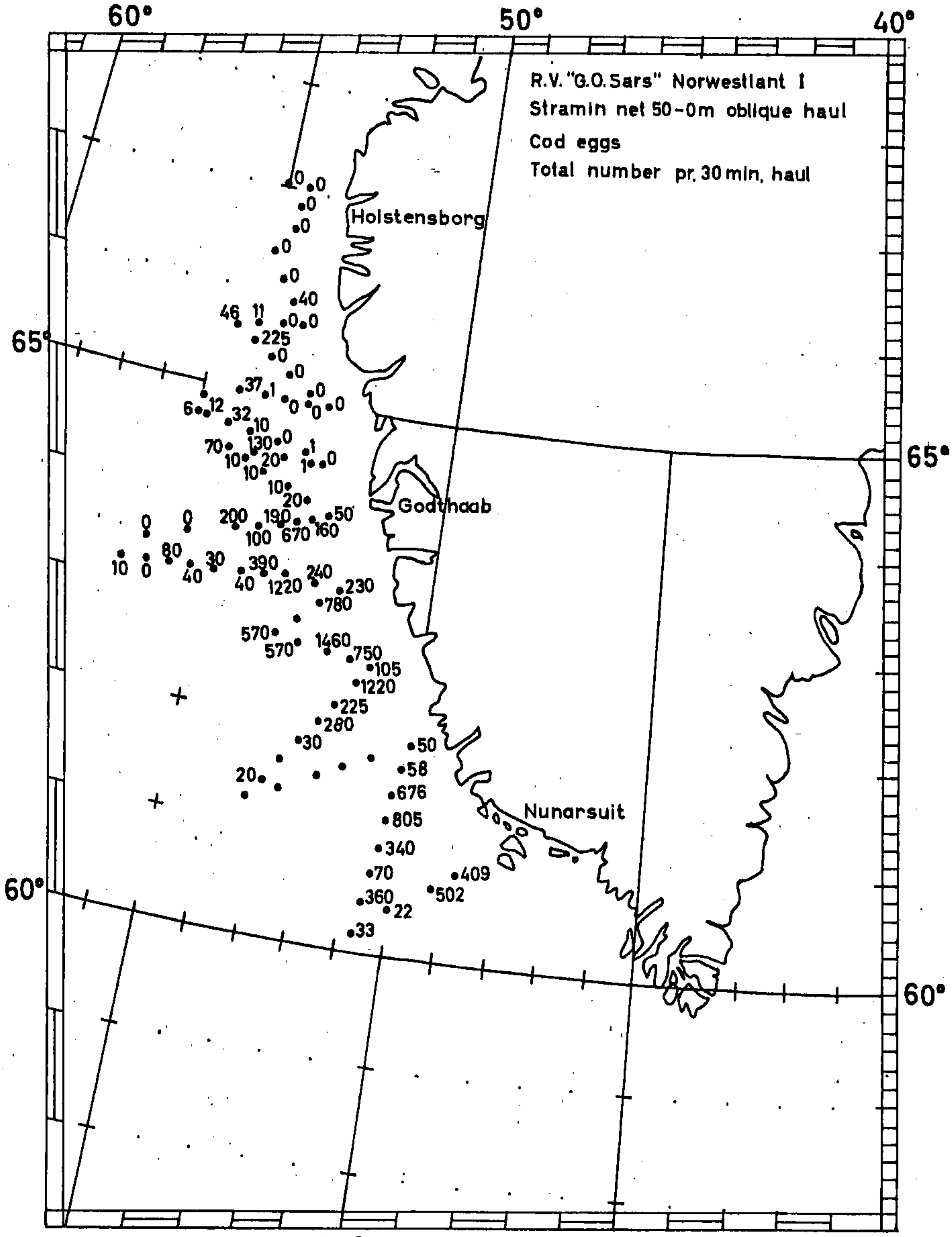


Fig. 26. "G.O.Sars", West Greenland, April 1963. Distribution of cod eggs. 2 m stramin net.

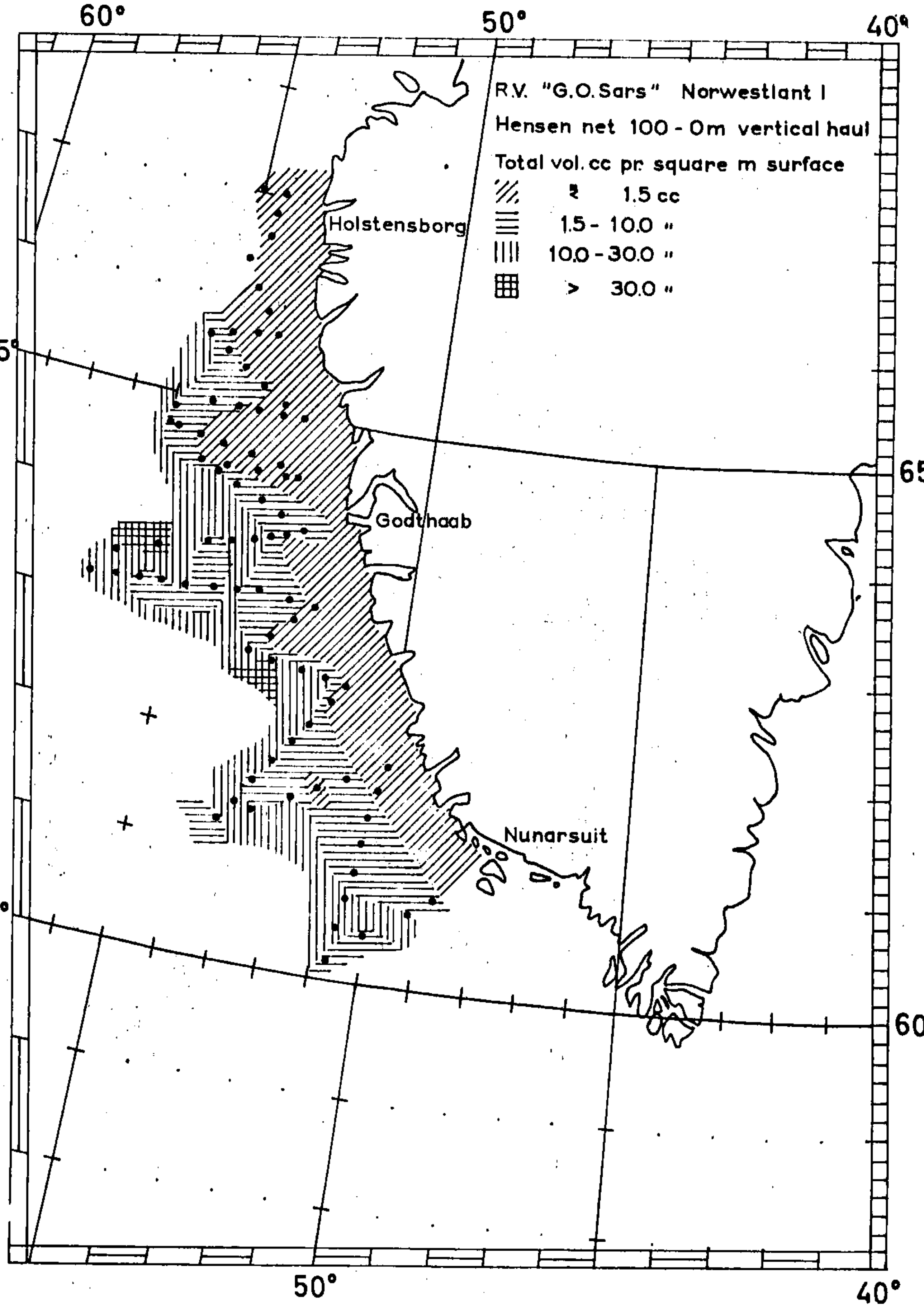


Fig. 27. "G. O. Sars", West Greenland, April 1963. Distribution of zooplankton. Volumes. Hensen net.

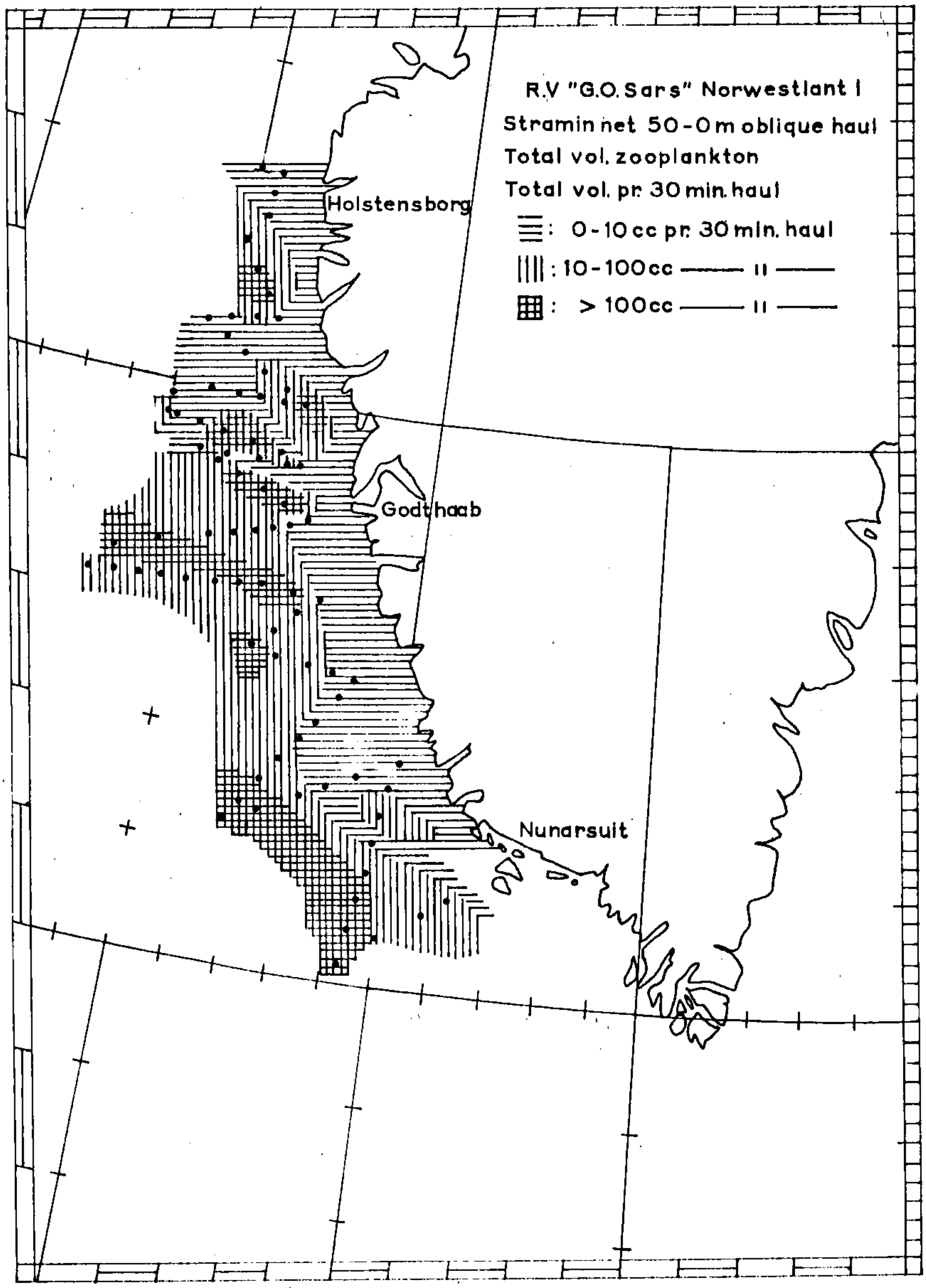


Fig. 28. "G. O. Sars", West Greenland, April, 1963. Distribution of zooplankton. Volumes. 2m stramin net.

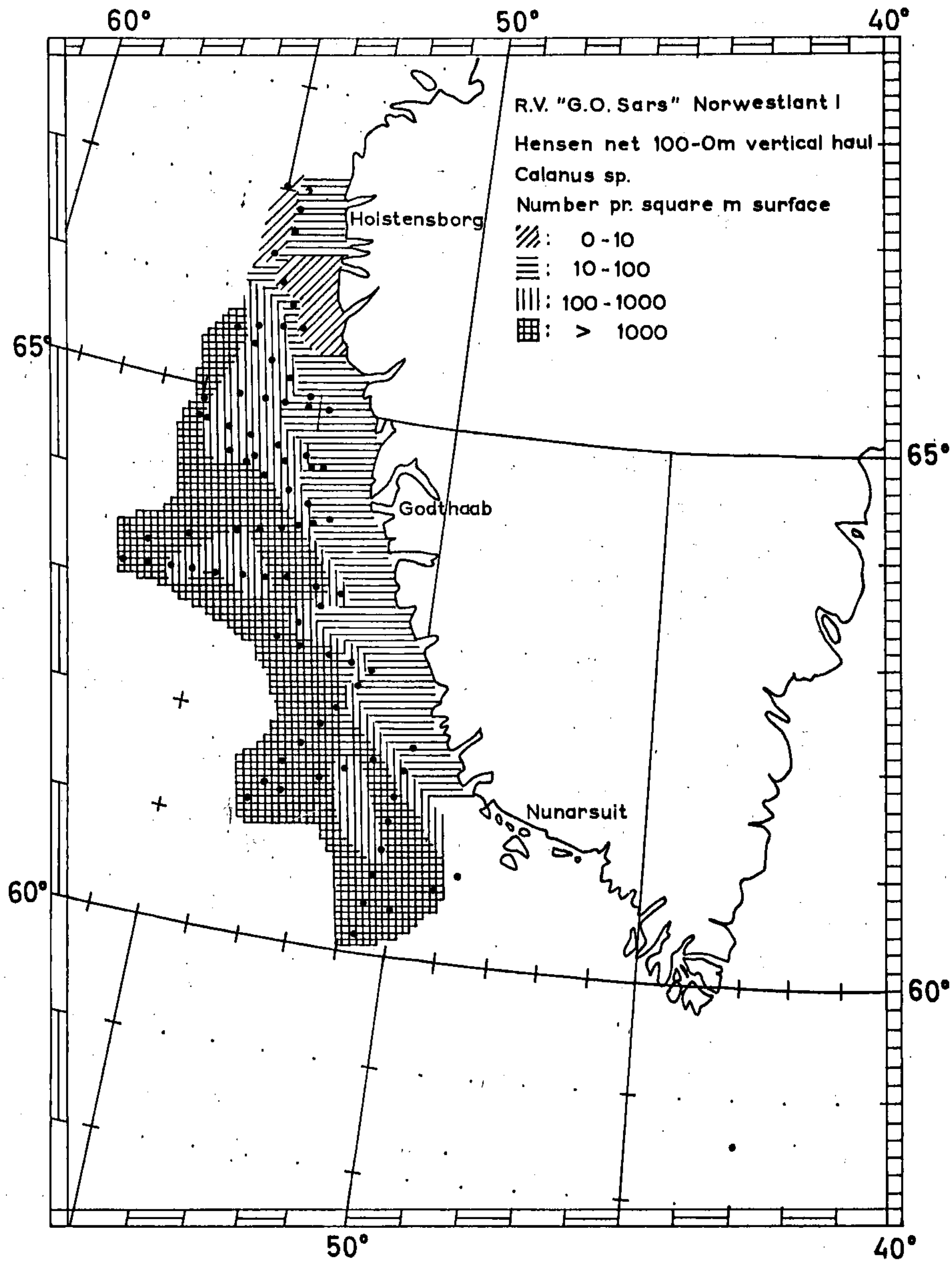


Fig. 29. "G. O. Sars", West Greenland, April 1963. Distribution of Calanus species. Numbers. Hensen net.

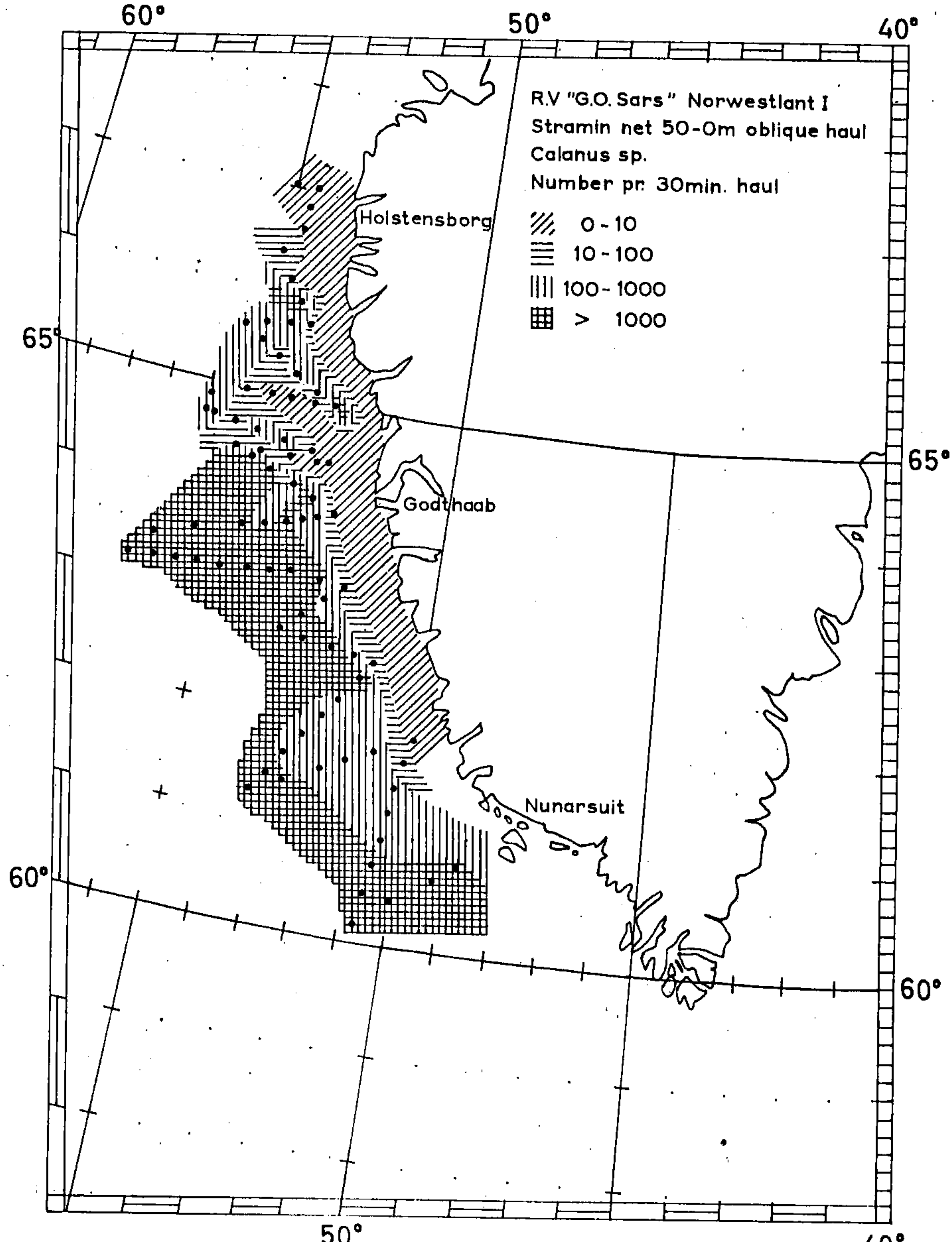


Fig. 30. "G. O. Sars", West Greenland, April 1963. Distribution of Calanus species. Numbers. 2m stramin net

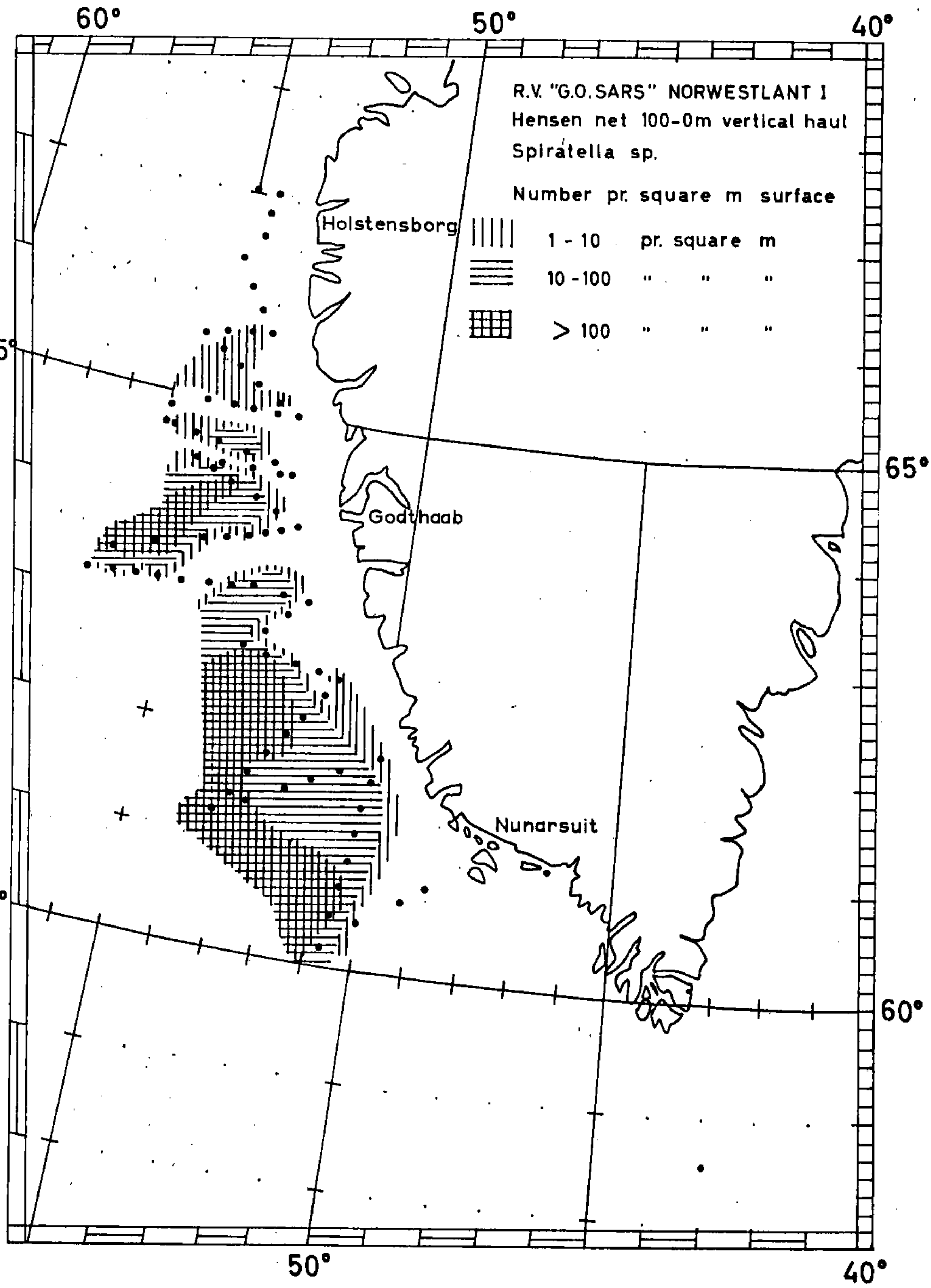


Fig. 31. "G. O. Sars", West Greenland, April 1963. Distribution of Spiratella species. Numbers. Hensen net.

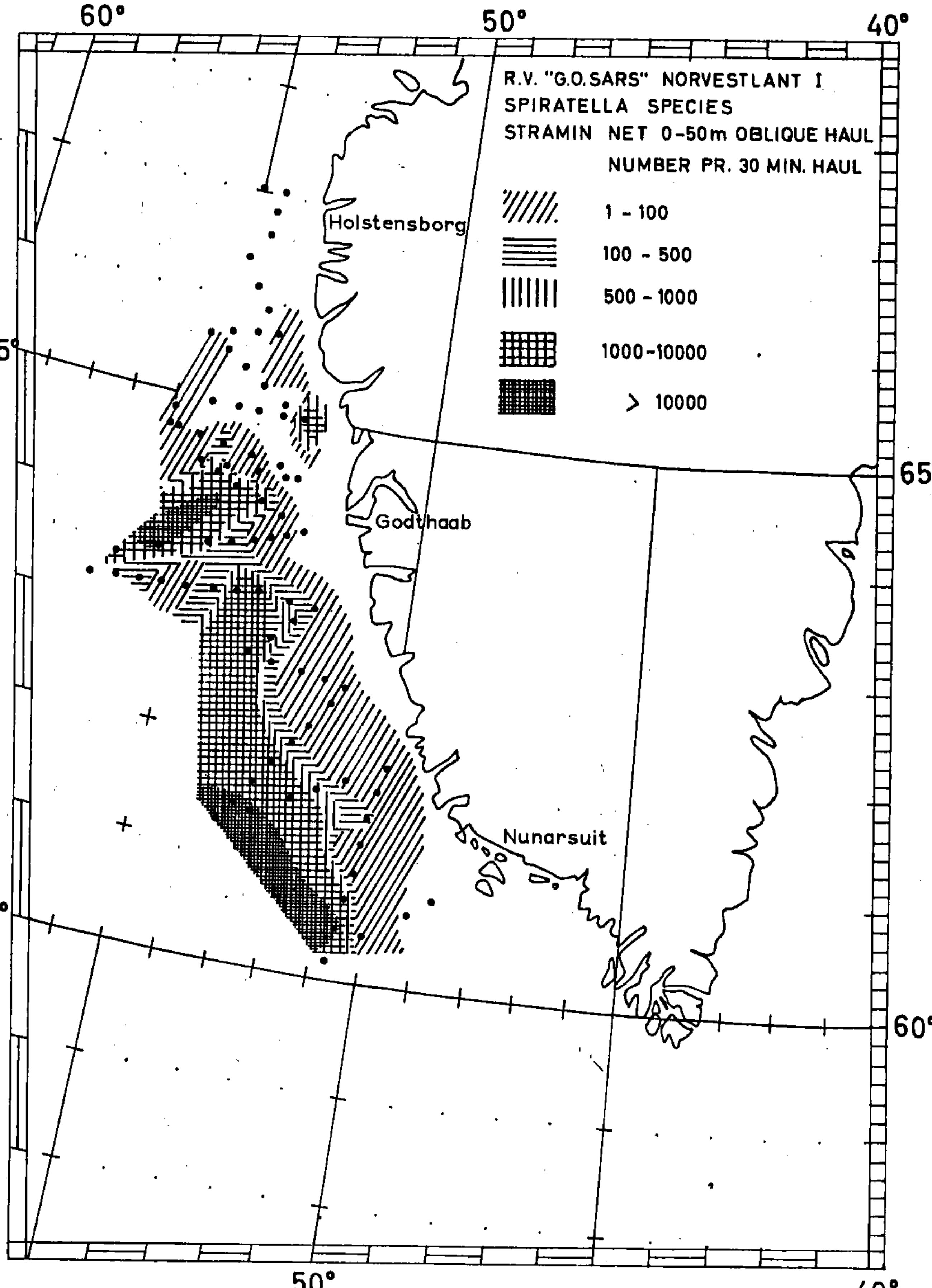


Fig. 32. "G.O. Sars", West Greenland, April 1963. Distribution of spiratella species. Numbers. 2m stramin net.

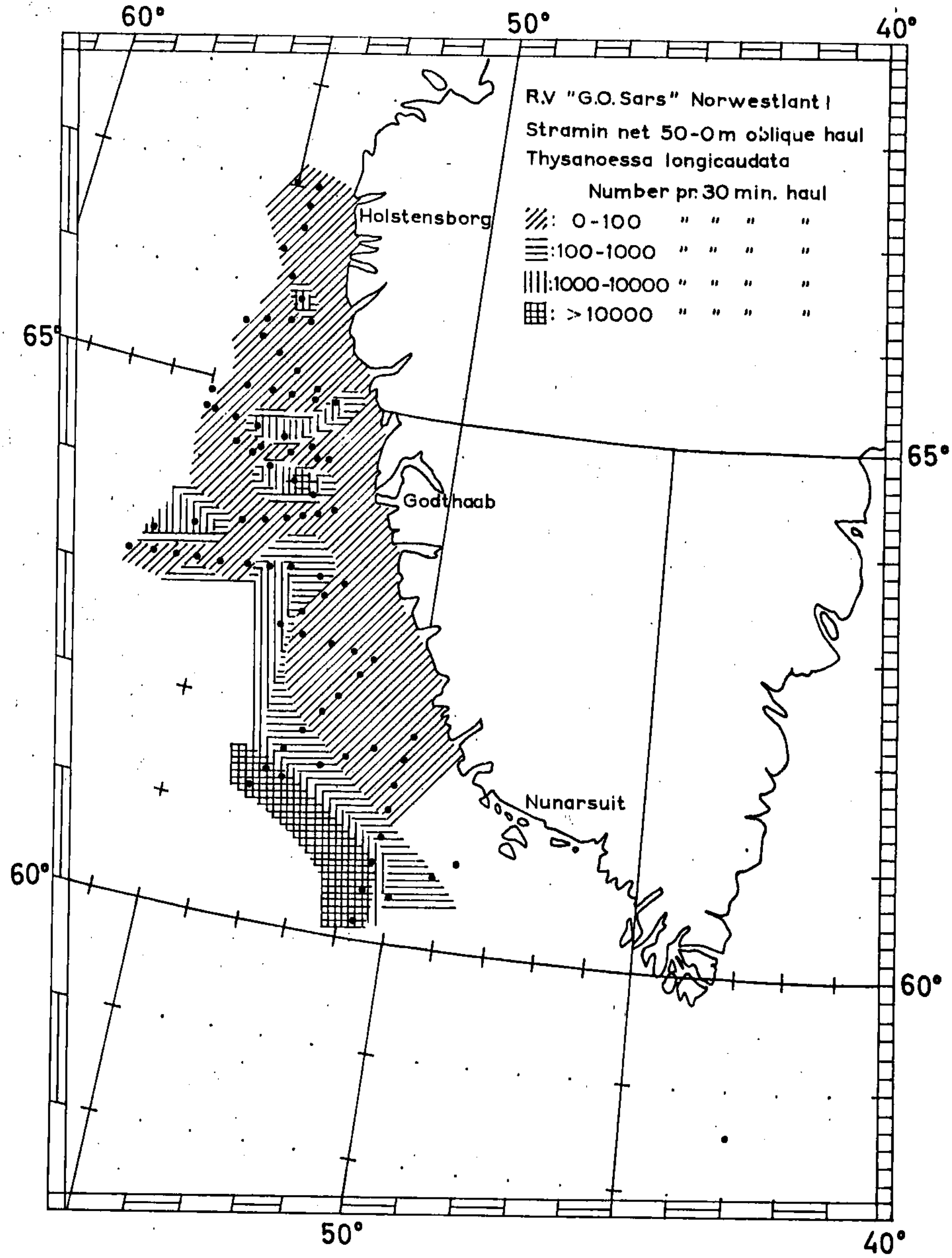


Fig. 33. "G.O. Sars", West Greenland, April 1963. Distribution of Thysanoessa longicaudata. Numbers. 2m stramin net.

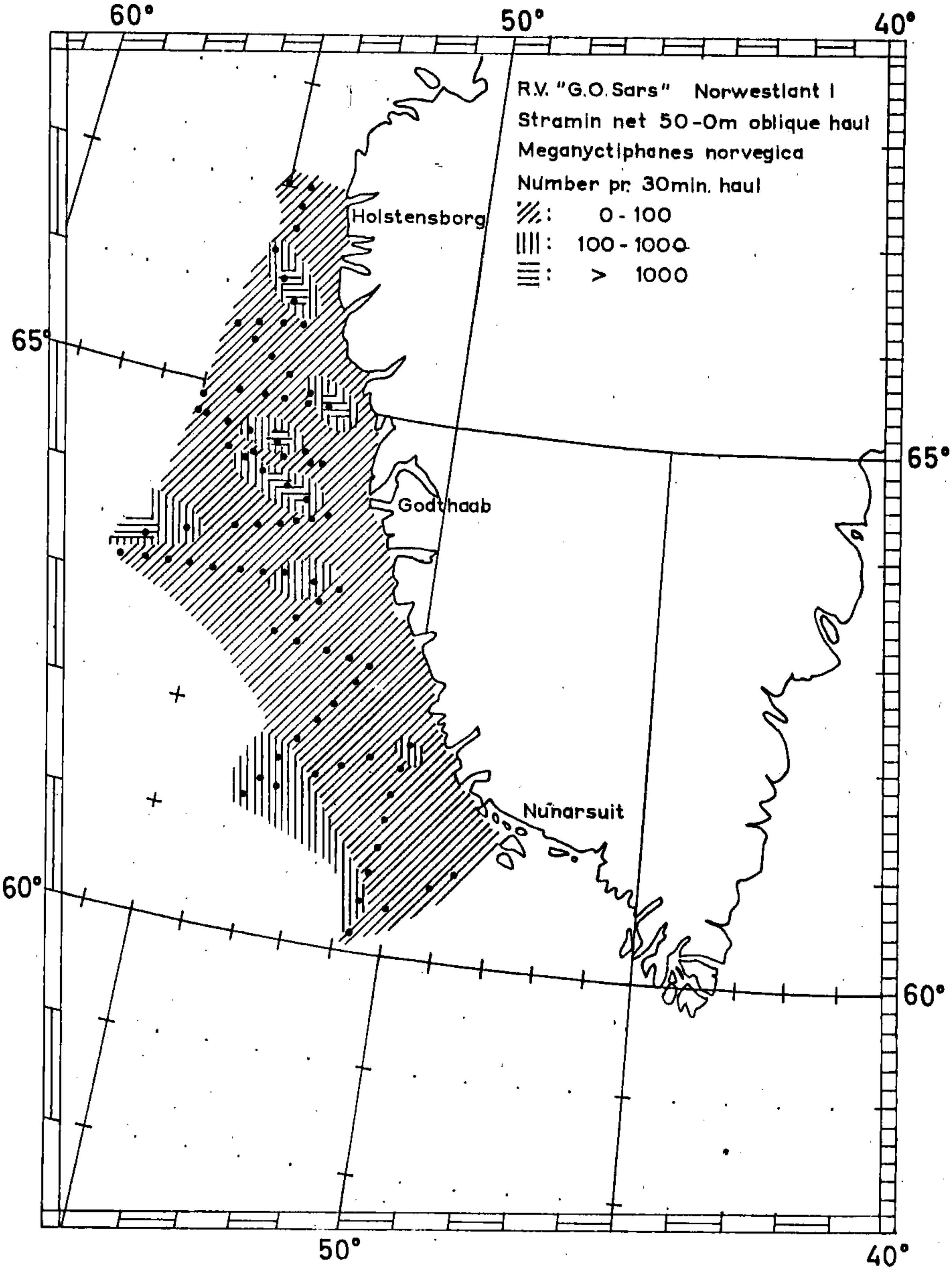


Fig. 34. "G.O. Sars", West Greenland, April 1963. Distribution of Meganyctiphanes norvegica. Numbers. 2m stramin net.