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International Council for the
Exploration of the Sea

CM 1968/C:21
Hydrography Committee

A comparison between computed and hand drawn sea surface temperature charts

by

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Introduction

During the 1967 Statutory meeting of the ICES, the sub-committee on synoptic charts recommended that the U.S. Fleet Numerical Weather Facility, (FNWF) Monterey, should be asked to produce examples of monthly sea surface temperature (S.S.T.) anomaly charts for the ICES area, and that the usefulness of these charts should be discussed at the next Council Meeting. It was subsequently suggested at Lowestoft that a better assessment of the value of the FNWF charts could be obtained if a set of manually drawn charts were prepared from our ICES standard route data for various suitably chosen similar periods. These manually produced charts would have the extra precision, admittedly over a rather more limited area, offered by the higher density of sampling and inherently more accurate method of observation, and hence would provide a useful standard against which to compare FNWF charts, although of course they could not at present be prepared within the same time scale as the latter.

On receipt of the ICES request following from Council Resolution 1967/1: 16, FNWF arranged with U.S. Fleet Weather Central, Rota, Spain, for the production of 5, 10, 15 and 30 day S.S.T. mean and anomaly charts for the area covered by the ICES Atlas (Ref. 1) during the spring of this year. Subsequently, copies of these charts were also sent to Lowestoft, beginning with those for June 1968, and it is these which were used for our comparison. It was also brought to our notice that the British Meteorological Office at Bracknell produce 5 and 10 day S.S.T. charts on a synoptic basis prepared from virtually the same set of selected ship observations which are used by Rota. Thus we had the basis of a three way comparison. It was kindly pointed out to us at this stage by FNWF that Dr. Flittner at La Jolla had demonstrated that hand drawn charts compared very favourably with computer drawn products although it was to be expected in complex areas such as the North Sea that some subjective interpretation might be necessary. The aim of this paper is to help decide to what extent this subjective interpretation is presently necessary in the ICES area, and hopefully to stimulate discussion of the extent to which future numerical analyses might overcome this restriction.

Methods of chart production

(a) The Rota charts

These are produced by a computer driven incremental line plotter from a computer program which compares each new set of data systematically with recently analysed data (or where none exists, climatological base data) at each local point of a predetermined grid (25 miles in the case of the charts prepared for ICES). The program then amends the S.S.T. at each grid point based upon the temperature difference and distance to the grid point from the new data position and some in built quality control mechanism. The climatological base used is the ICES 1905-54 Atlas, and the source of data is primarily from W.M.O. selected ships using the bucket sampling technique, although data from any other available source, civilian or military, are accepted into the system including the surface reference temperatures from B.T. and X.B.T. observations. Clearly the accuracy of the charts produced depends on the reliability of the ICES Atlas as a climatological base - there must necessarily be some inherent spatial and temporal bias - and the grid size, the potential spacing being inversely dependent on the density of data available synoptically, as well as the computer program itself. The analyses are updated twice daily but sent to ICES every five days.

(b) The Lowestoft charts

These charts, which are not normally produced on a routine 10-day mean basis, have been drawn by hand after plotting the merchant ship, lightvessel and English coastal station data together with any British Ocean Weather Ship data collected en route to and from Ocean Weather Stations during the period. Contouring the data is subjective in that it is based on the background knowledge of the area possessed by the hydrographer sketching the contours. This is essentially the ICES mean chart for the time of the year supplemented by an awareness of recent research vessel findings, although data from this latter source have not been specifically used during the preparation. The frequency of sampling is approximately weekly by merchant vessels, twice weekly at coastal stations and every four days at lightvessels, and hence a period of 10 days will normally contain data from 1-2 crossings of each route, 3-4 observations from each coastal station and 2-3 observations from each of the lightvessels. In most cases surface temperatures are collected by means of a sampler containing a mercury thermometer which is attached to the ship's condenser intake but in the others by thermistors inserted into the intake. Thermistors and thermometers are calibrated regularly and are read to 0.1 deg C. Data reach Lowestoft between 1 week and 6 weeks later, (the weather ships and lightvessels being the extreme examples) as the forms recording the temperatures relate also to the salinity samples and await the completion of sampling, the return of the ship to its home port and the transmission of the salinity crates by rail. The bulk of the temperature data are corrected and available for plotting within about three weeks of the date of observation.

(c) The Bracknell charts

Five and 10-day sea surface temperature charts are prepared by the Meteorological Office, Bracknell. In the synoptic forecasting branch 10-day mean charts for the whole of the Atlantic and Arctic north of 40°N latitude are prepared from computed mean values for 1° rectangles. These are contoured subjectively by hand with isotherms drawn at 4°C intervals. Sea temperature anomaly charts are prepared in the same way in the long-range forecast branch using the differences between the computed 1° rectangle 10-day temperature means and normals obtained from U.S.N.O.O. publication H.O. 700. As these charts cover a large area and are drawn at a large contour interval we have thought it best for the purposes of this comparison to use the 5-day sea surface temperature charts also prepared by the synoptic forecasting branch for what is virtually the ICES Atlas region. These are hand-drawn using the data sent in by radio from the 'selected ship' network of observing vessels, the original observations being taken chiefly by canvas or insulated bucket with mercury thermometers. Since January 1968 sea temperatures have been reported to 0.1 deg C or 0.1 deg F, according to the nationality of the observing ship. No calibration corrections are applied to the thermometers, but only those with small errors are issued to the observers. The 5-day mean sea surface temperature charts are at present compiled for consecutive 5-day periods of each month and distributed to European meteorological offices by land-line facsimile broadcasts. In the near future overlapping 5-day means will be transmitted by radio facsimile.

Comparison of main features of charts

The charts which are compared in the following paragraphs were of course prepared completely independently of each other and hence provide a sensible basis for assessing their relative value.

The mean surface temperature chart for June has been reproduced from the ICES Atlas as Figure 1. It shows a cold tongue of water, < 11°C, extending down the north-east coast of the British Isles and then eastwards to the south of the Dogger Bank as part of the Dogger Bank swirl. There is generally evidence of warmer water along the British and continental coasts due to summer warming, a cold incursion of 12-13°C pushing eastwards in the Channel, and a pool of rather cold water, < 11°C, in the Irish Sea.

In Figure 2, the Lowestoft chart for the first ten days of June 1968, each of these features is reflected, the cold tongue along the east coast being prominent. In Figure 3 which is the Bracknell 5-day mean chart (in each case the Bracknell charts are centred on the middle of the 10-day Lowestoft and Rota charts) the cold tongue has equal prominence, although it is displaced slightly to the east. It does not, however, appear at all in the Rota chart for 1-10 June (Figure 4), and the water in the German Bight appears 4 deg C colder than on either the Lowestoft or Bracknell charts. Similarly the Rota charts indicate the surface temperature in the Channel to be 1-2 deg C colder than on the other charts, and place the 9°C isotherm in the Iceland-Scotland region on the 60°N parallel, and hence considerably further north than Bracknell. The colder pool in the Irish Sea is evident only on the Lowestoft charts and the coastal warm water is clearly shown because of the data from the English coastal stations. These features are absent from, or at least less evident on the charts from Rota and Bracknell.

Figures 5, 6 and 7 show the sea surface temperature as indicated by Lowestoft, Bracknell and Rota for the central ten days of June. On the Lowestoft chart the cold tongue along the north-east coast of England has been reduced, but the swirl is still indicated as on the Bracknell chart, although further to the north. Unfortunately this area was missing from the Rota chart. In the Channel the Rota charts appear to indicate 1 deg C lower, and in the Celtic Sea up to 4 deg C lower sea temperature than the Bracknell or Lowestoft charts. West of Ireland the 12°C and 13°C isotherms appear reasonably comparable, except again on the Rota chart where a lower temperature is indicated.

Figures 8, 9 and 10 show conditions at the end of the month. The Lowestoft and Bracknell charts agree reasonably well, except that temperatures would seem to be 1 deg C lower in the Celtic Sea in the former, but quite a different picture is presented in the North Sea by the Rota charts where a warm central core (> 13°C) is surrounded by gradually decreasing temperatures in all directions to the coasts. Again no evidence of coastal warming is apparent and there is up to 6 deg C difference where the 9°C isotherm runs parallel to the Danish coast on the Rota version, which again shows Channel temperatures some 2-3 deg C lower. Similar comparisons can be made for the first two 10-day periods in July which are shown in Figures 11-17, these being the most recent we have been able to prepare at the time of writing.

Discussion

There seems overall a better correlation between the hand drawn Bracknell and Lowestoft charts than between either and the Rota chart, which suggests that a considerable degree of subjective interpretation is required at this stage for the preparation of synoptic charts for the seas in the ICES geographical area. We were surprised that the Rota charts bore so little resemblance to the ICES chart for June (Figure 1) since this largely represents the climatological base for their analyses. We were further surprised that the Bracknell and Rota charts could not be more closely correlated since they have essentially the same source of data, viz., the selected ships service, and we would welcome comments from the Rota representatives on these points. We have been unable to discover the relative data density of the Rota and Bracknell charts but this could account for some of the differences, as could the difference in grid size (60 miles at Bracknell and 25 miles at Rota).

Since the Bracknell chart is reasonably close to the ICES chart for June and the effect of a smaller grid size should make the representation more accurate, it seems fair to infer either that the data density is not sufficient to justify the 25 mile grid or else the computer program used at Rota needs more development to cope with the complex nature of the environment in this area.

In conclusion we would suggest that the Bracknell charts appear to give at present the most readily available and reliable synoptic service, and since these are received by European meteorological offices each five days, we would recommend that careful study should now be given by the Committee to (a) establishing the need for such a five day synoptic chart service and (b) the possibility of ICES reproducing and circulating these charts to members of the Hydrographic Committee, and biological colleagues who express an interest in receiving them.

Acknowledgments

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References

1. ICES, 1962. "Mean monthly temperature and salinity of the North Sea and adjacent waters from 1905 to 1954" ICES, Service Hydrographique, Charlottenlund Slot.

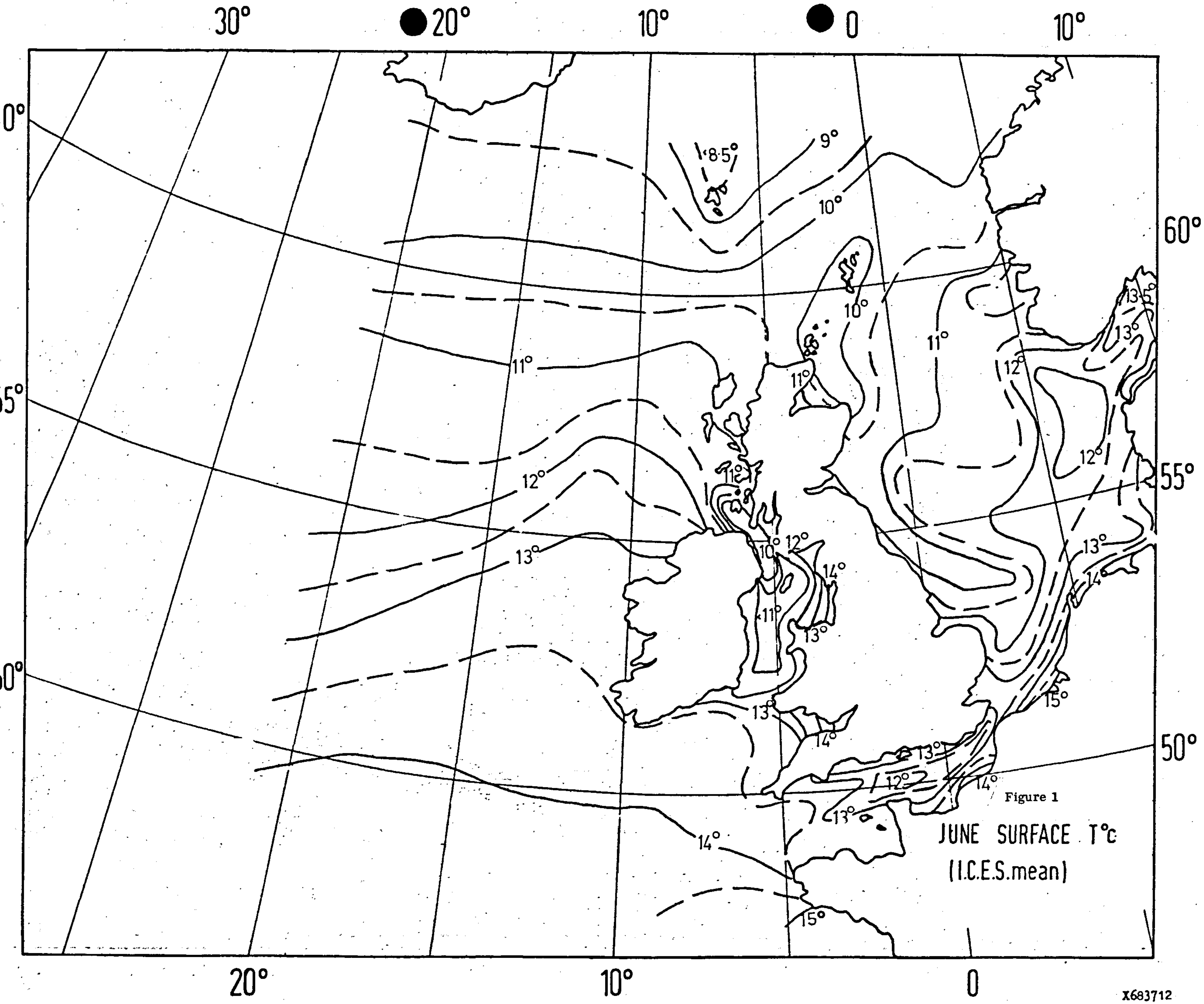


Figure 1

JUNE SURFACE T°c
(I.C.E.S.mean)

X683712

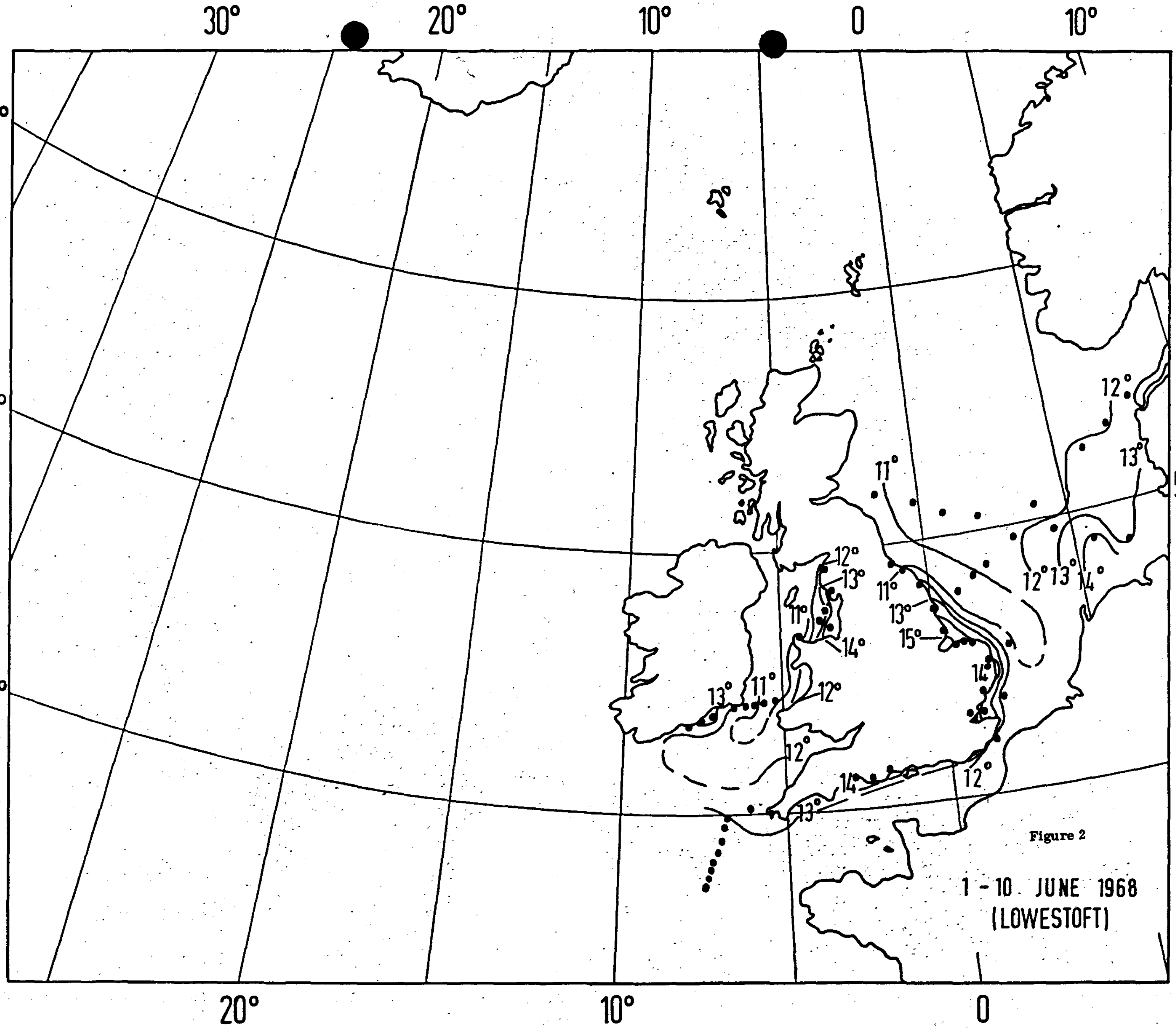
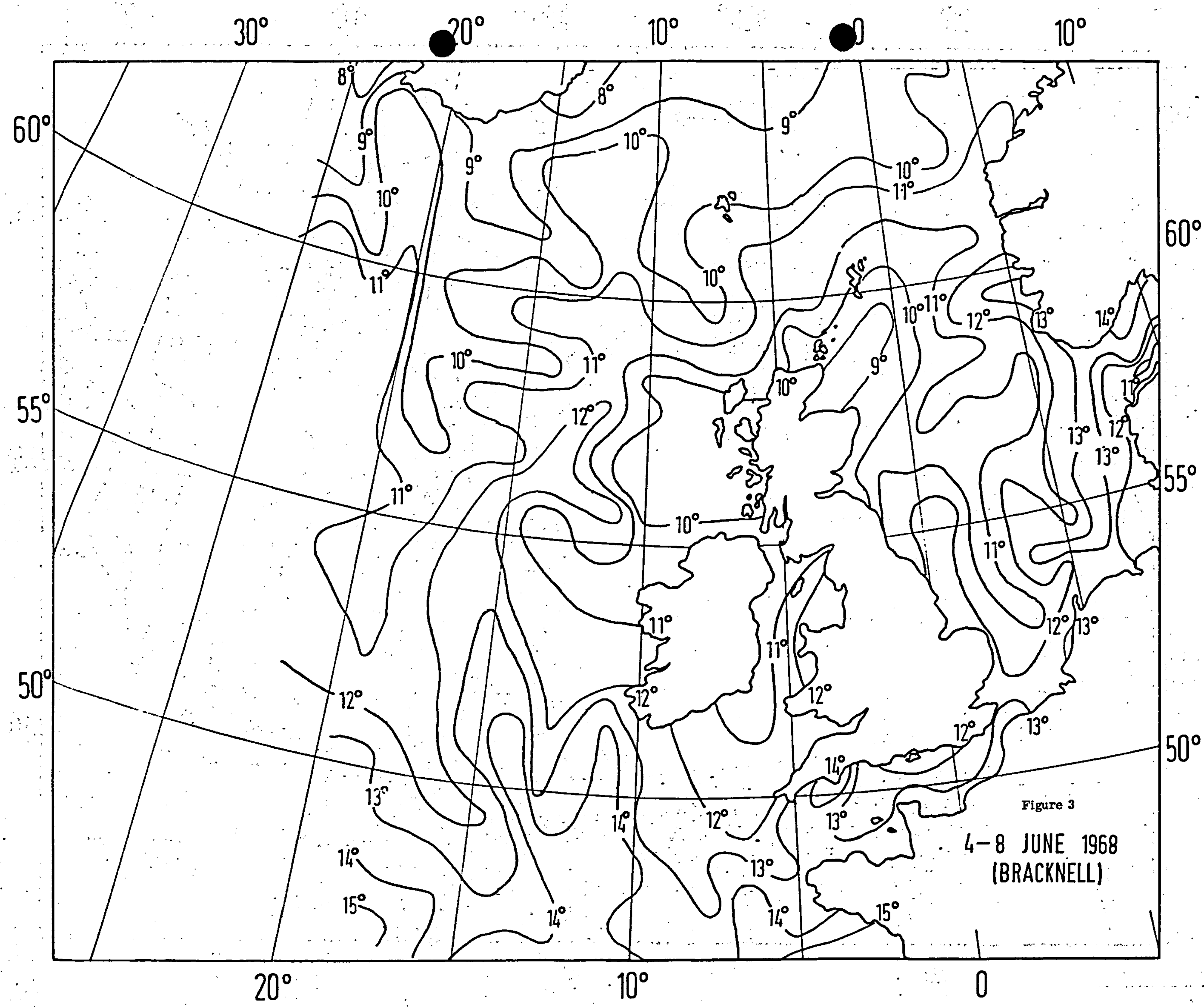


Figure 2

1 - 10 JUNE 1968
(LOWESTOFT)

X683712



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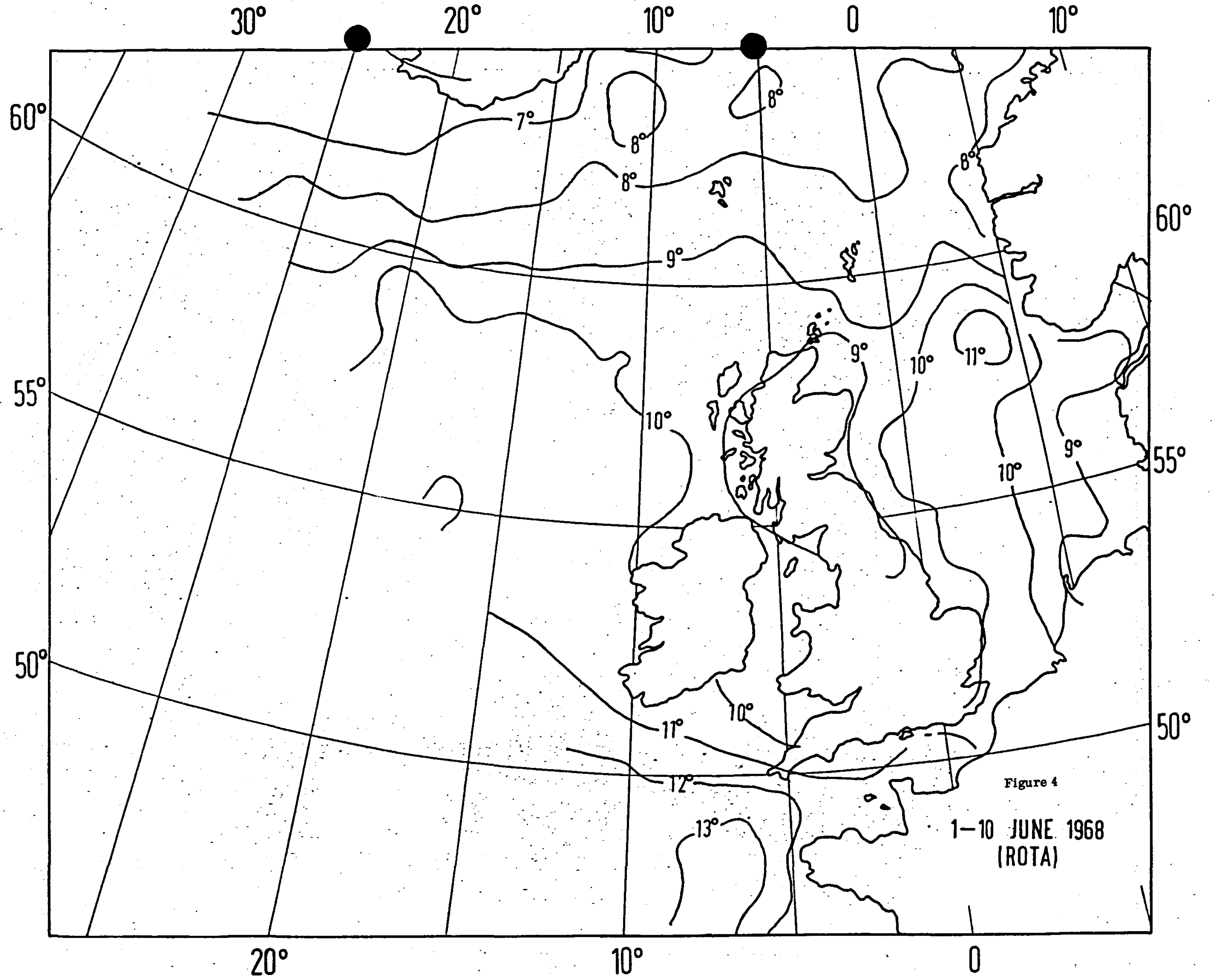

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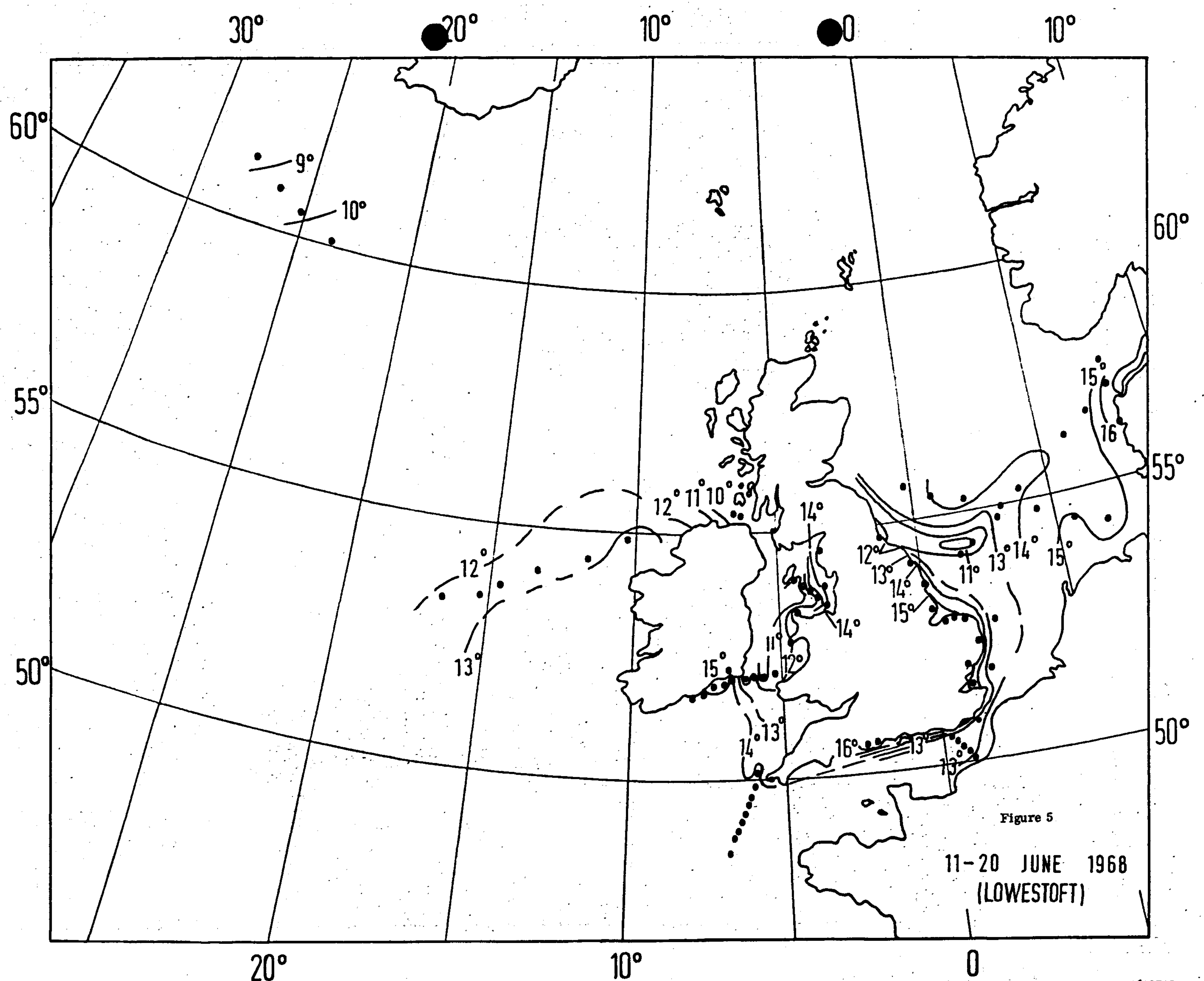

Figure 5

11-20 JUNE 1968
(LOWESTOFT)

X683712

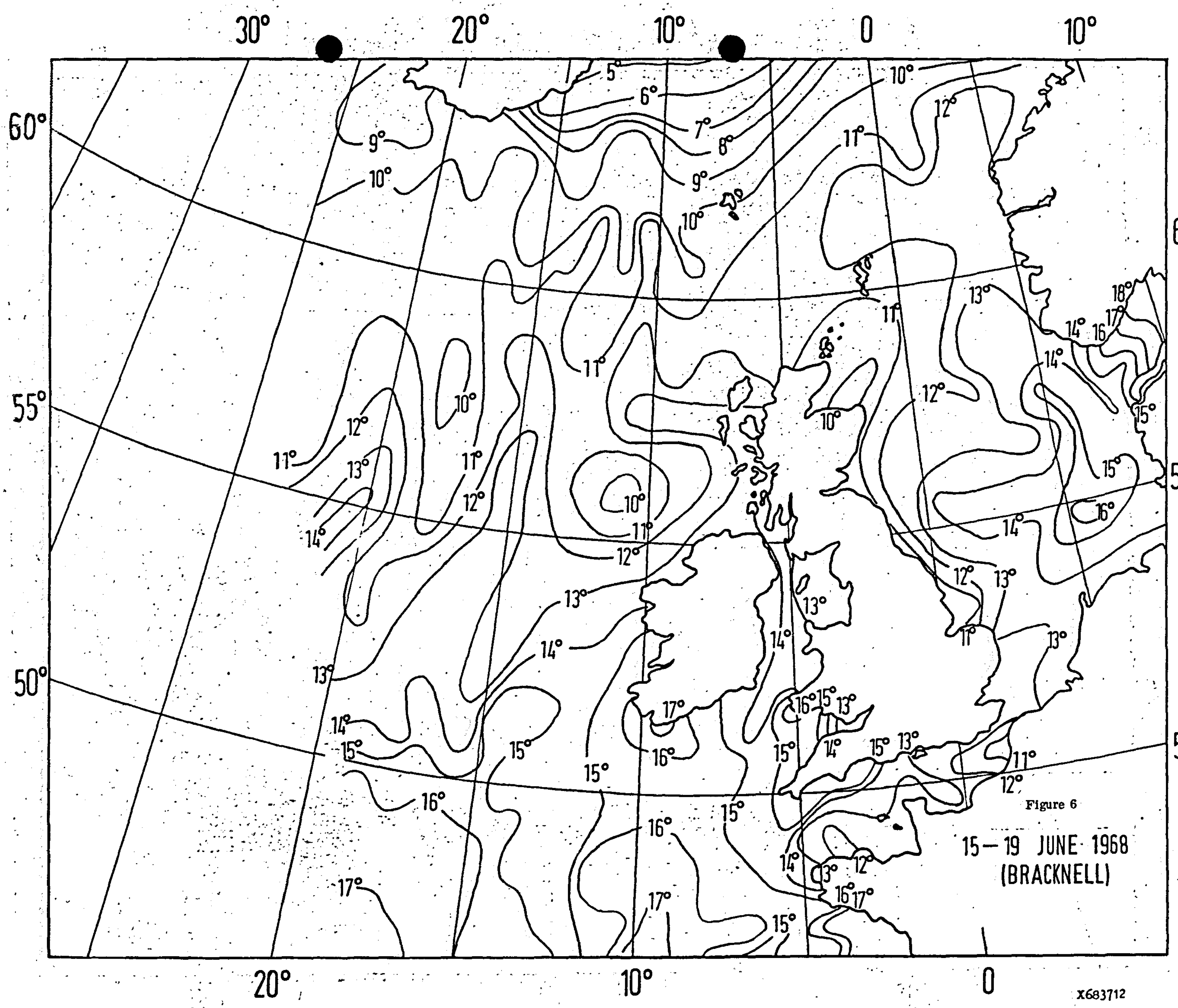

Figure 6

15 – 19 JUNE 1968
(BRACKNELL)

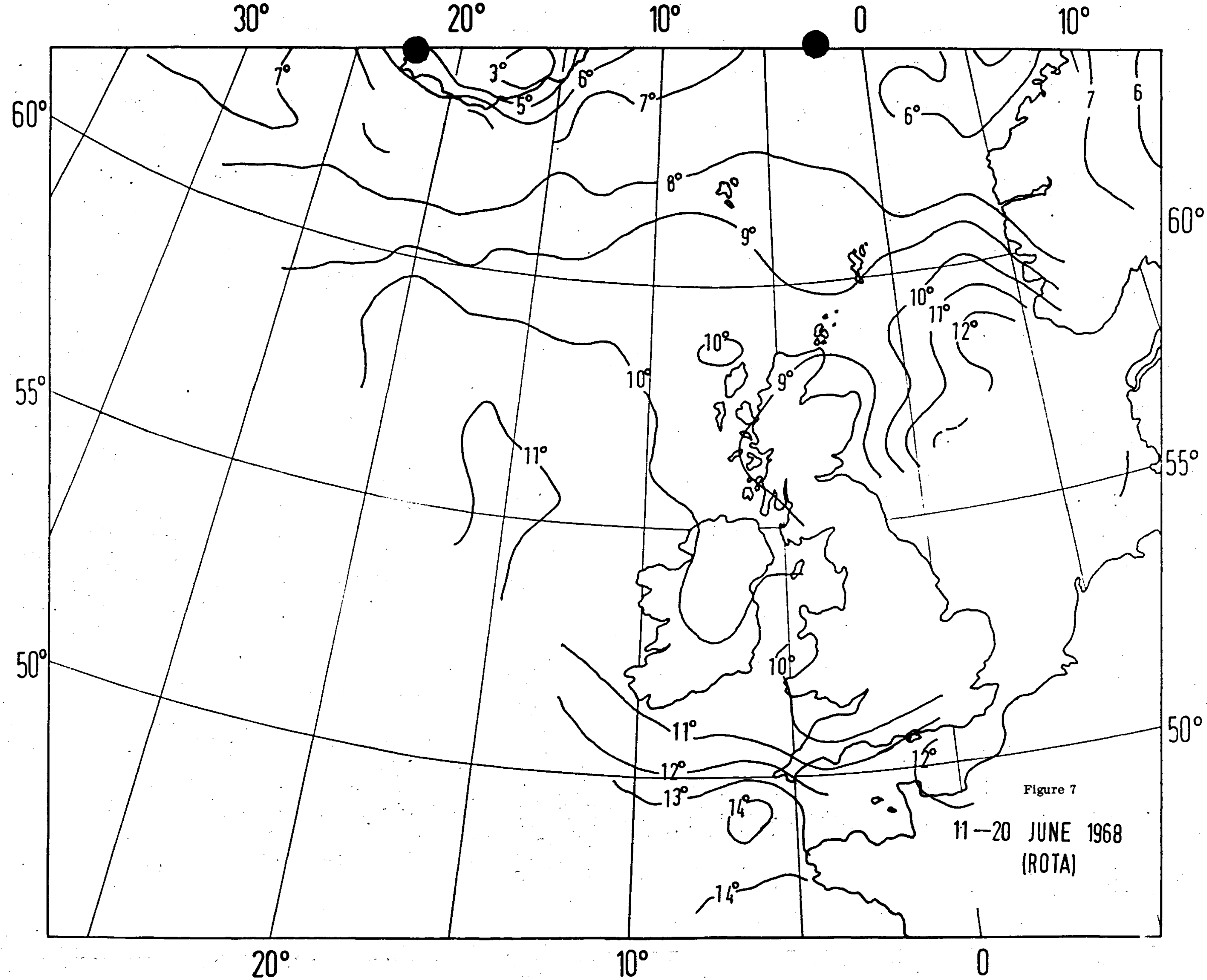

Figure 7

11—20 JUNE 1968
(ROTA)

X683712

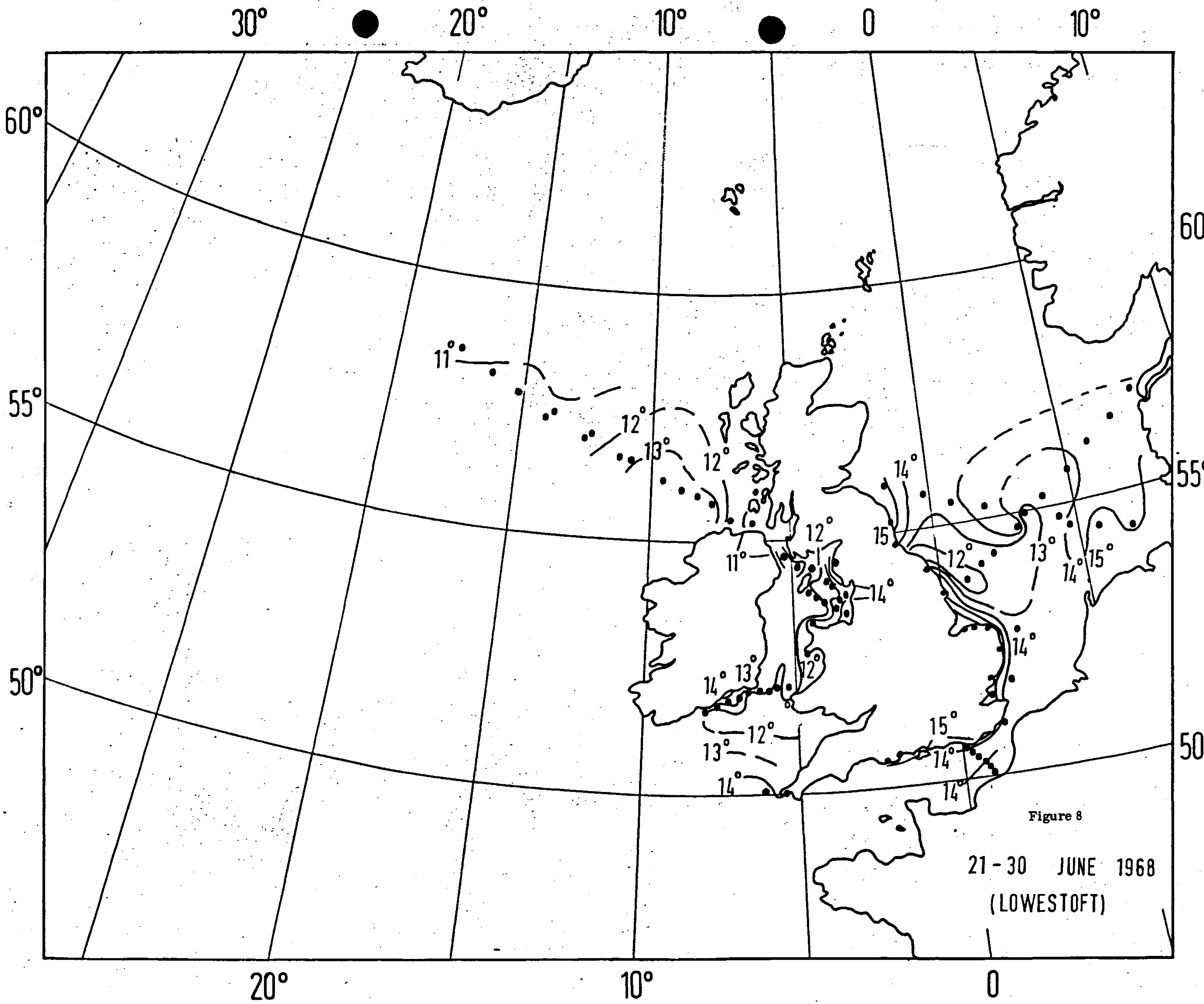

Figure 8

X683712

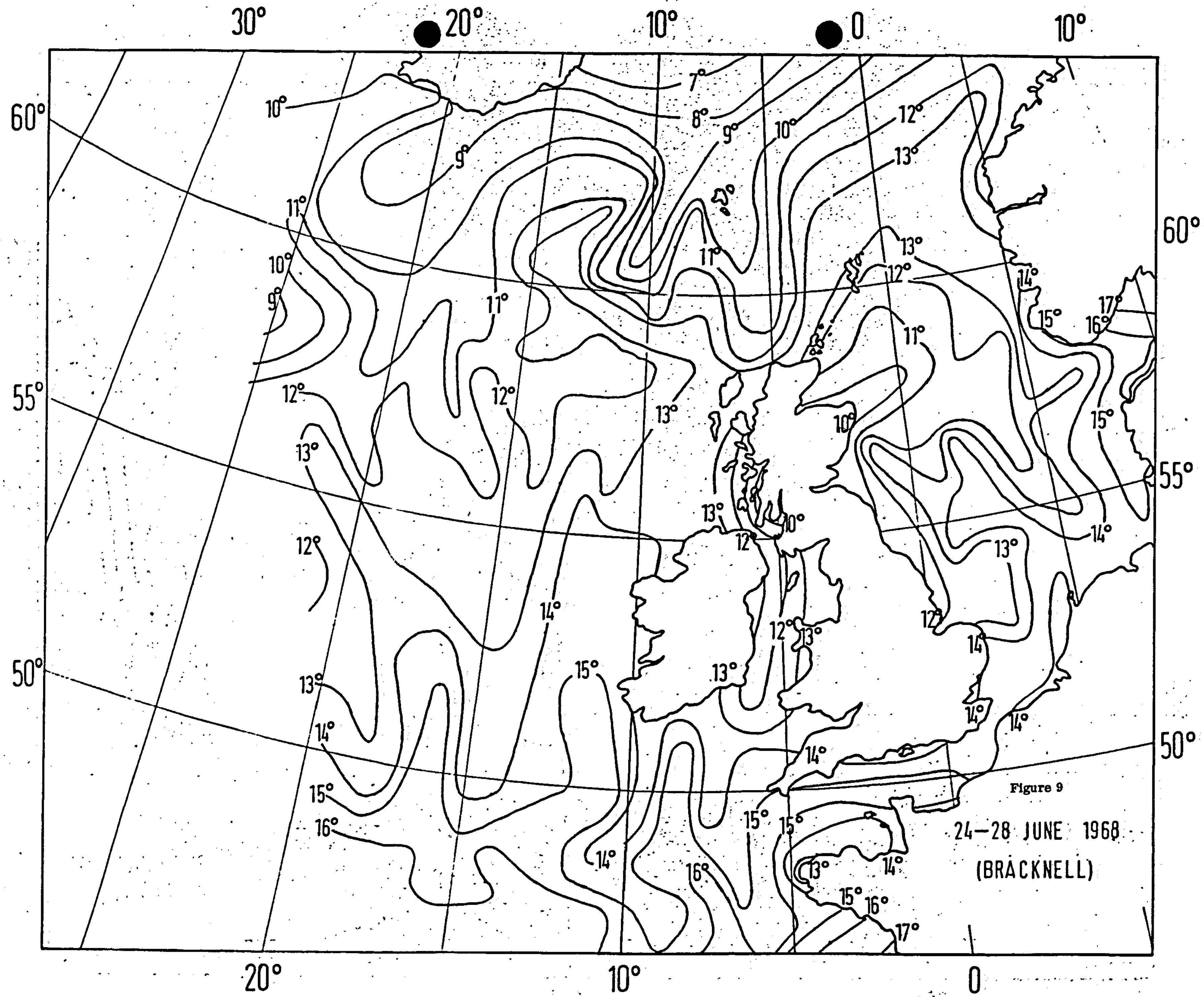

Figure 9

24–28 JUNE 1968

(BRACKNELL)

X683712

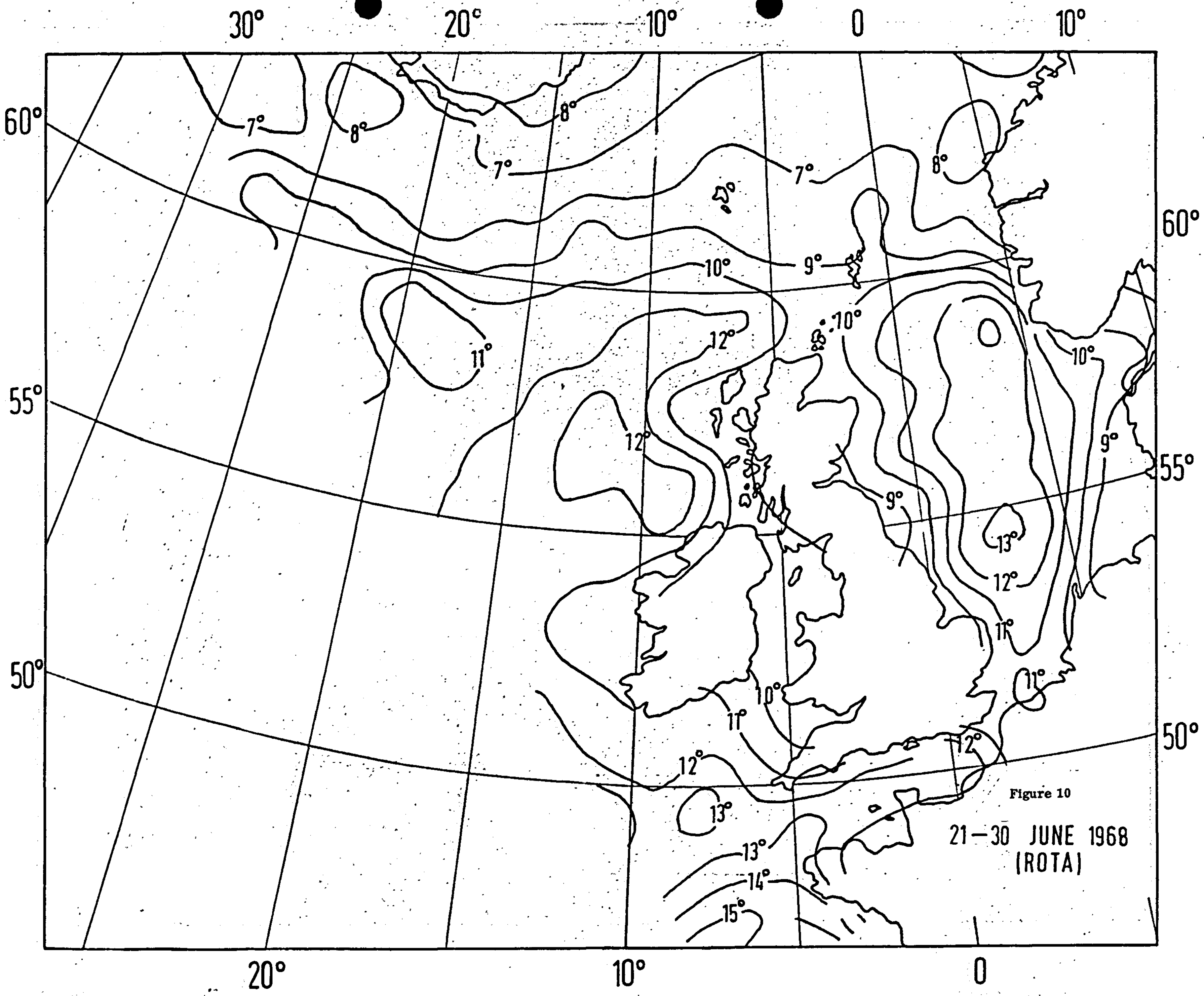

Figure 10

21–30 JUNE 1968
(ROTA)

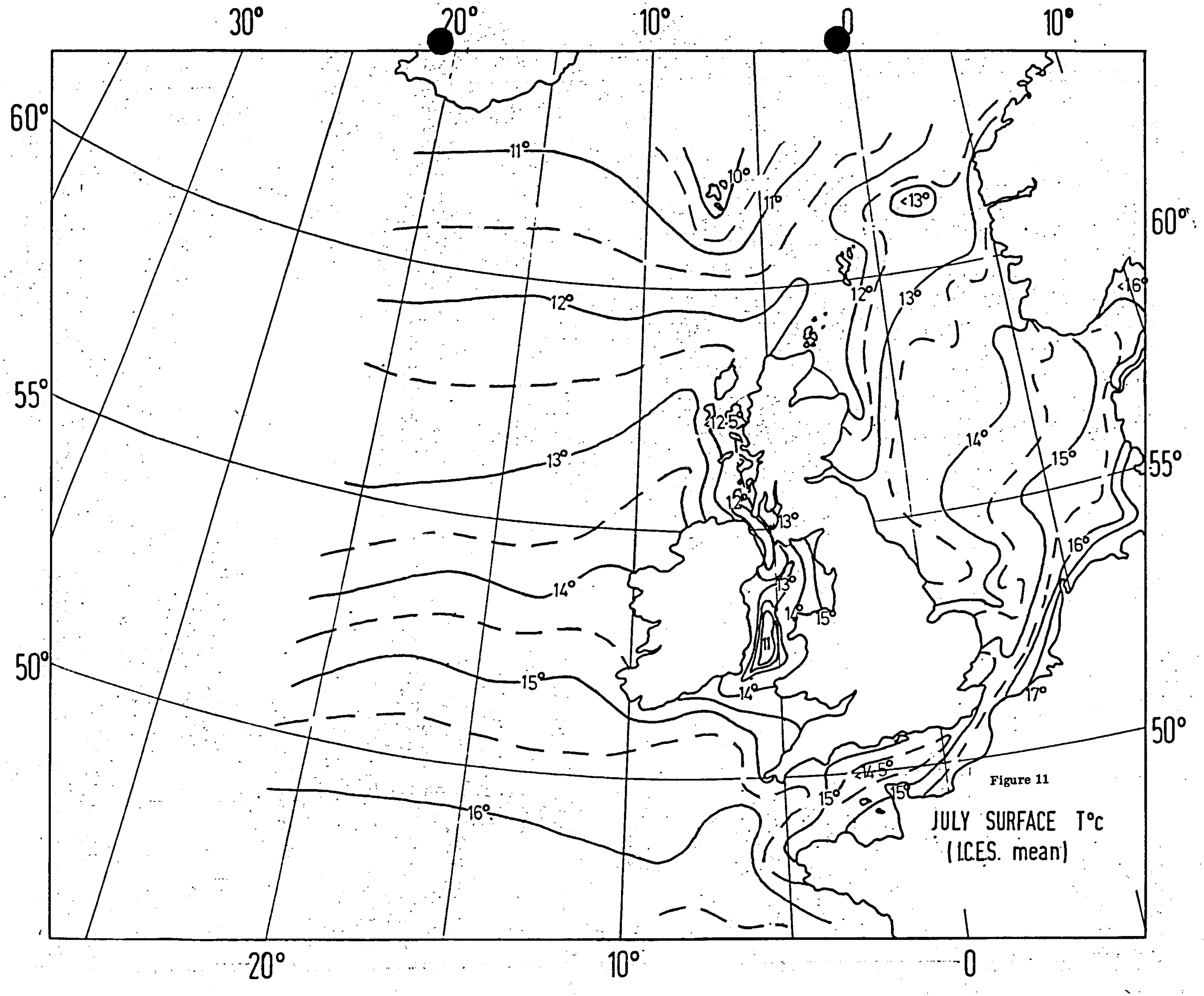

Figure 11

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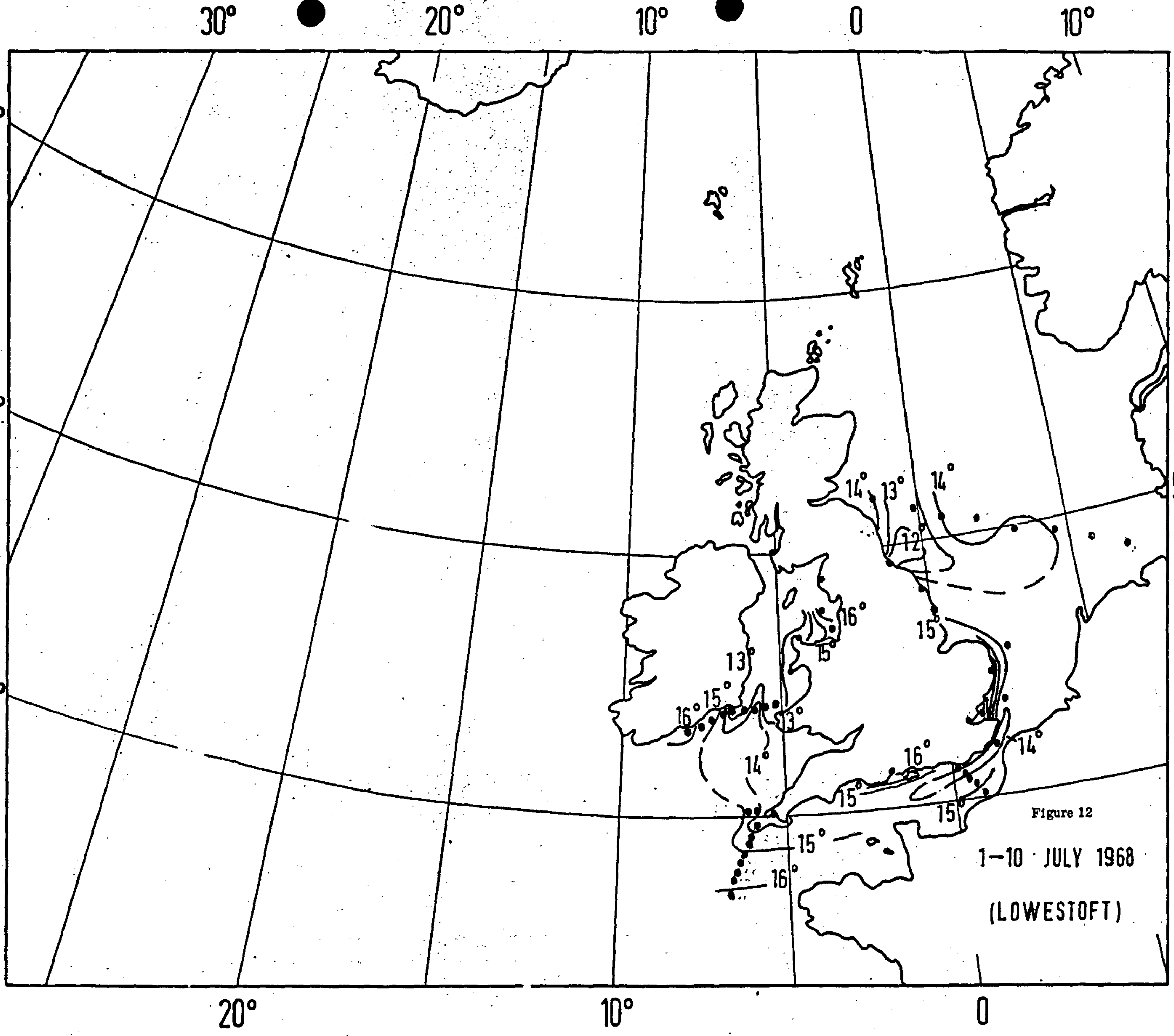

Figure 12

1–10 JULY 1968

(LOWESTOFT)

X683712

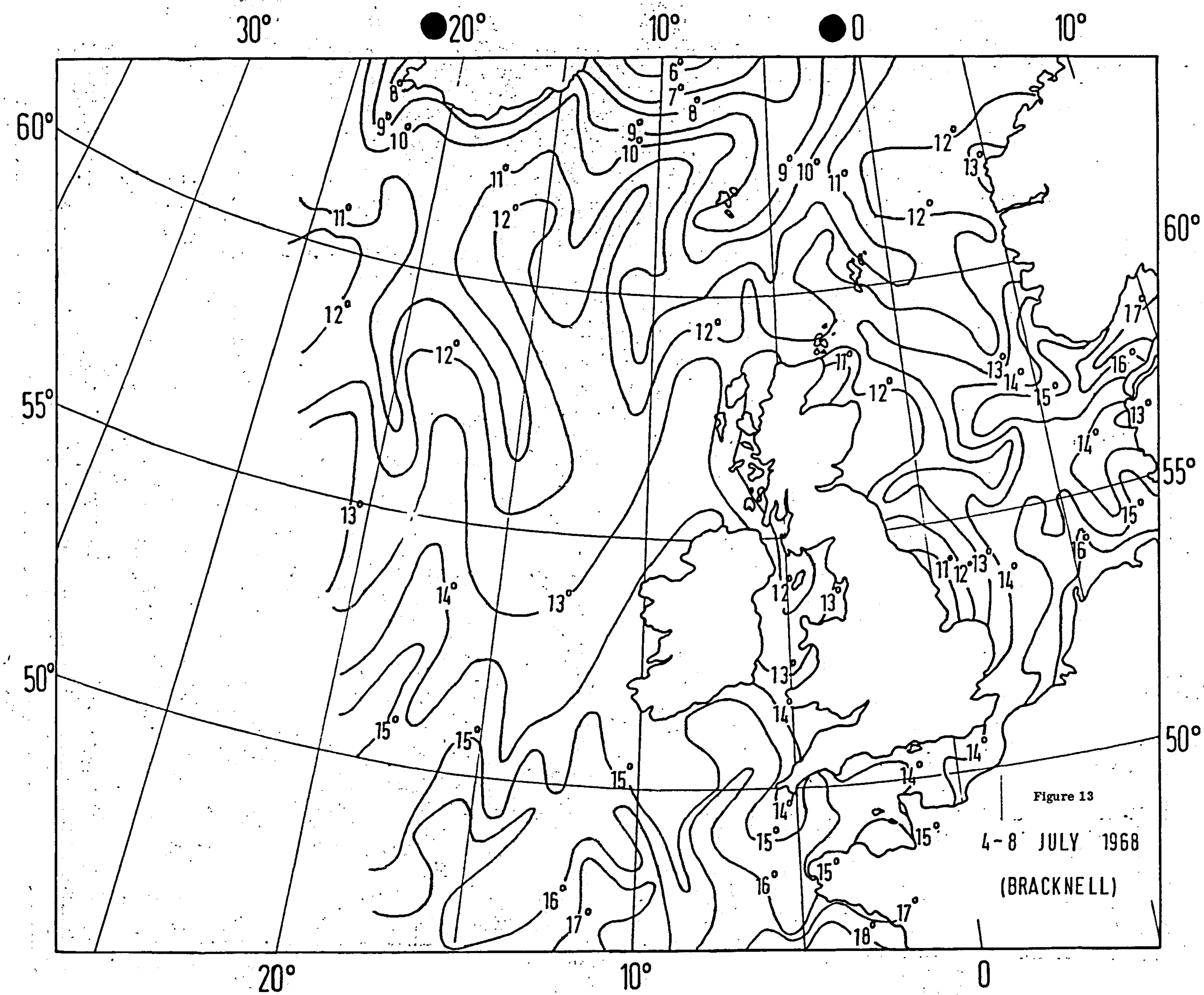

Figure 13

4 - 8 JULY 1968

(BRACKNELL)

X683712

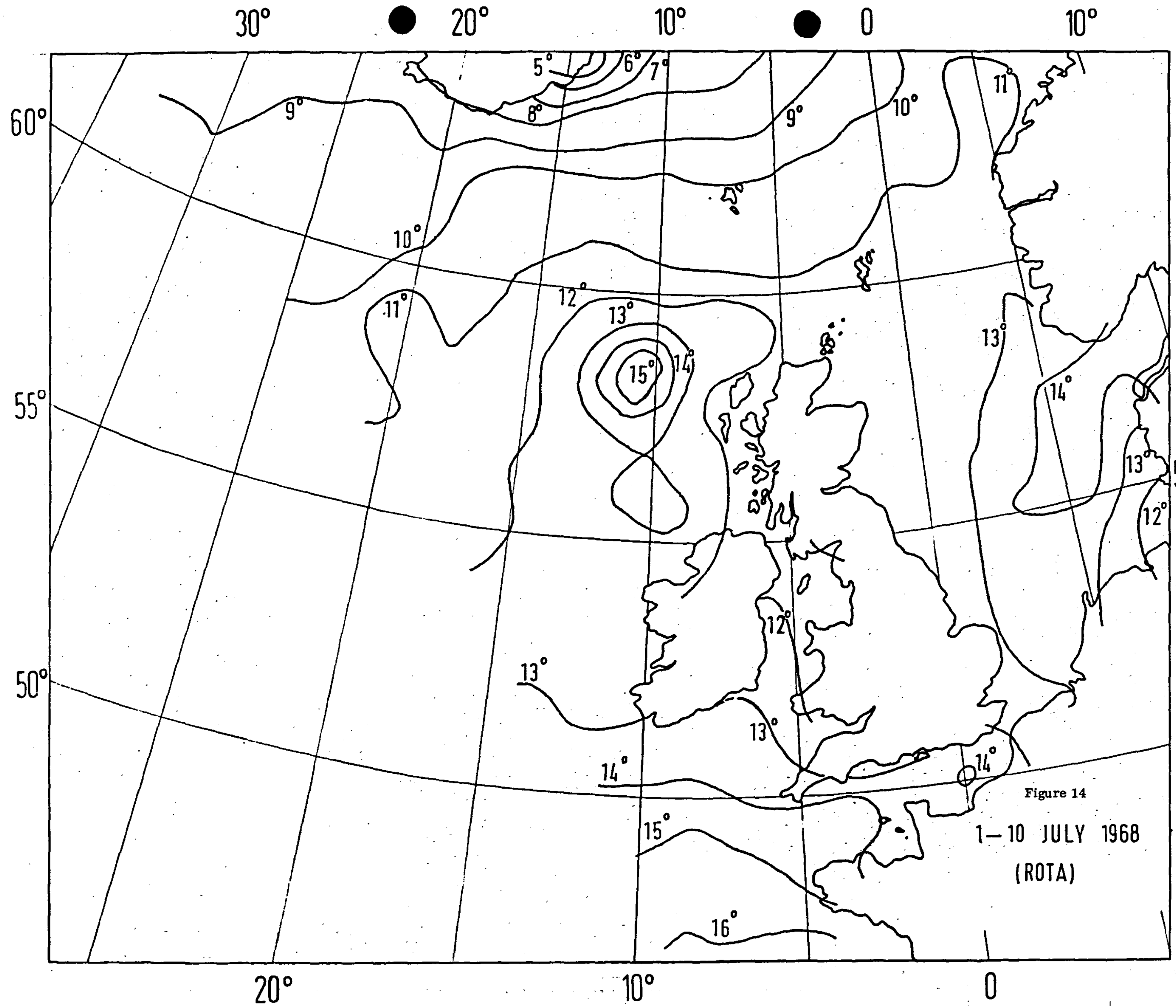

Figure 14

1—10 JULY 1968
(ROTA)

X683712

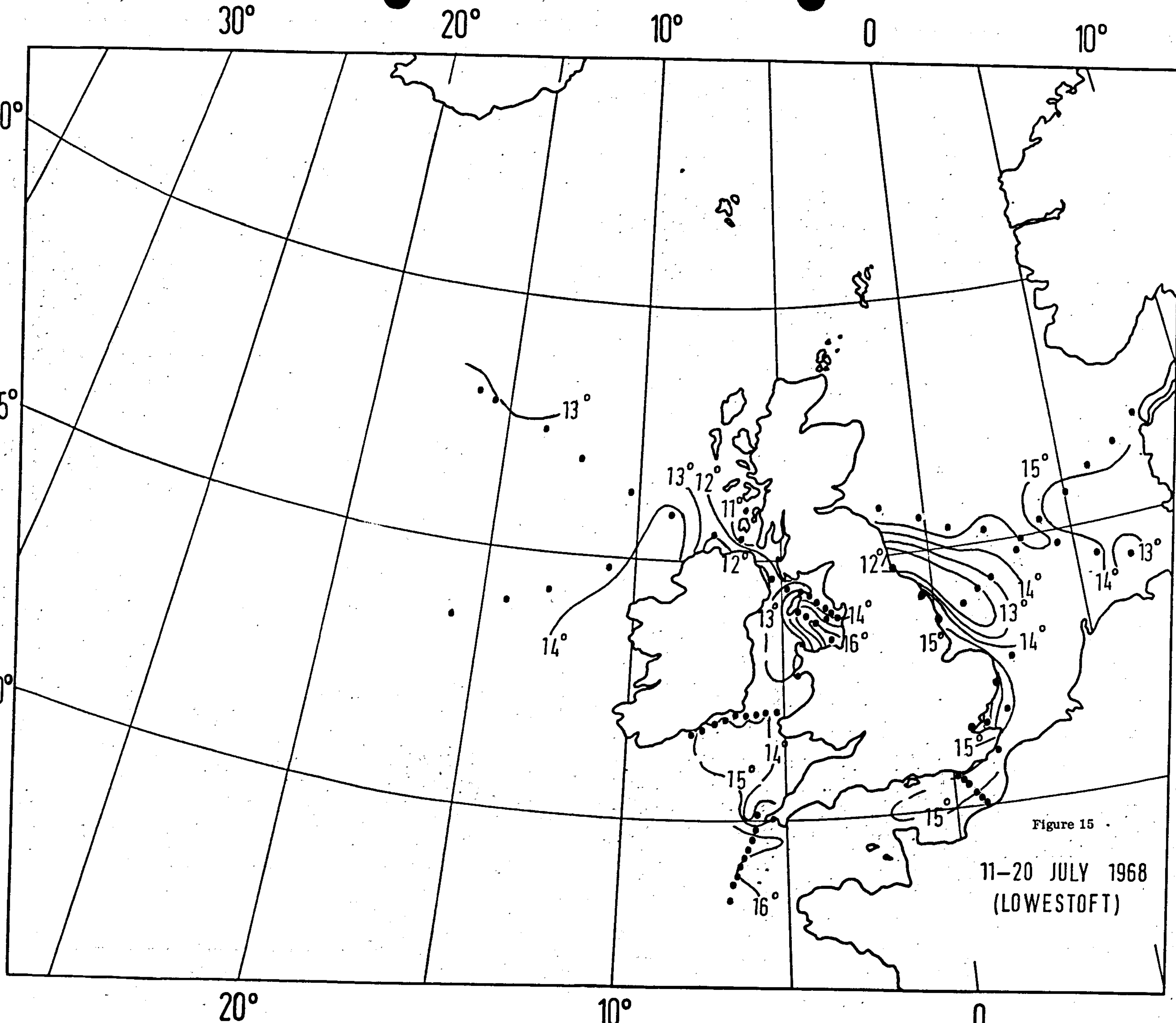

Figure 15

11–20 JULY 1968
(LOWESTOFT)

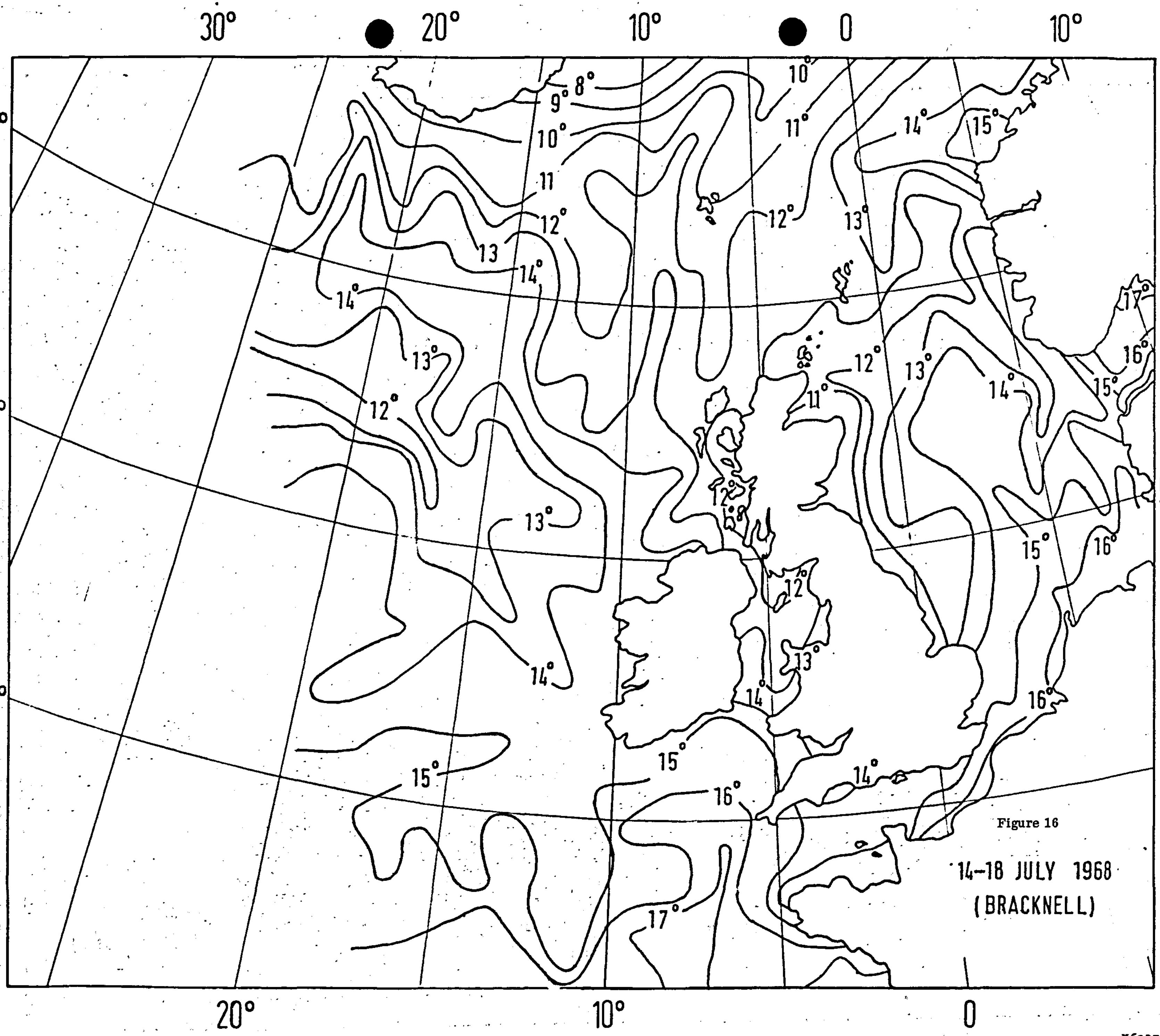

Figure 16

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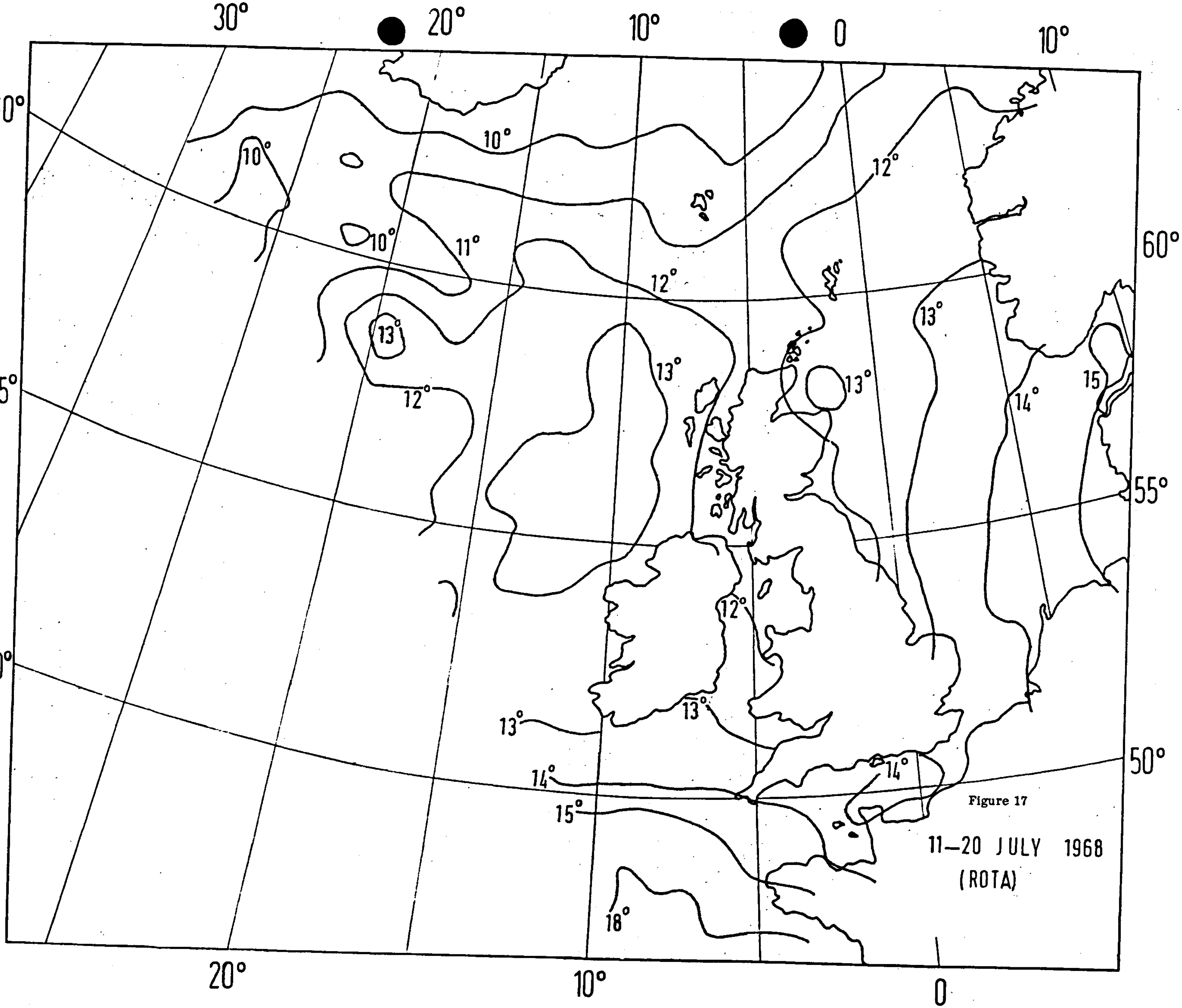

Figure 17

X683712