ROYAL METEOROLOGICAL INSTITUTE

OF THE NETHERLANDS.

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THE TEMPERATURE OF THE SEA AT THE SURFACE NEAR THE SOUTH-POINT OF

AFRICA.

BY J. E. CORNELISSEN, R. D. NAVY,
DIRECTOR OF THE NAUTICAL DEPARTMENT.

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> Deze onze uiteenzetting wekke op tot het leveren van meerdere bijdragen; zij worde beschouwd als de dageraad van den morgen der kennis.
>
> Buijs Ballot. 1853.

Ocean currents (exclusive of the daily ebb and flow called tides and produced by the influence of the Sun and Moon) may be divided into proper sea-currents and sea drifts.

The former belong to the circulation system of the Ocean; the latter are caused by winds blowing for some length of time from the same quarter.

The circulation system of the ocean, like that of the atmosphere, depends on the heat the earth receives from the sun, especially on the inequality of heat received in low latitude above that in the polar regions.

Warm water flows in an upper current from lower to higher latitudes; cold water is driven back in an under current from higher to lower latitudes.

The direction of the currents depends on the diurnal rotation of the earth, the configuration of the coast and of the Ocean-bed.

Sea-drifts cannot always be clearly distinguished from Sea-currents and they often run into each other, or modify each other's course.

Only near the surface can they be distinguished; for, from what has been said of the origin of sea-drifts it is easy to account for their being found only at a small depth.

To judge of the currents we must moreover keep the following facts in view;

1st That, though water readily absorbs heat, it is a bad conductor.

2[d] That, as soon as a current rises in one part of the ocean, another current of similar volume arises in another part of the ocean and proceeds in an opposite direction.

3[d] That the currents, become warm or cool in their course in consequence of which they rise or sink, or run along side of each other.

4[th] Between the tropics every square metre loses from ten to twelve litres per day by evaporation. There are also two causes of variation of density.

a. The evaporation of sea-water by heat.

b. The change of concentration arising from evaporation.

An accurate knowledge of the sea currents, which play so important a part in the economy of nature, is of the utmost importance to the seaman as well as to science.

To arrive at this knowledge two methods present themselves; the first consists in collecting the accounts of the direction of the currents to be found in log books and which are inferred from the real or conjectured place of the ship; the second consists in a knowledge of the temperature of the sea and of its depth.

Each of these methods of investigation has its peculiar difficulties; so that in some cases the latter and in others the former leads to the most satisfactory results.

Mes[srs] VAN GOGH and ANDRAU, late Directors of the Meteorological Institution of the Netherlands, had from the observations of that time (which were scanty in comparison with what we have now,) determined the limits of the warm and cold currents at the south-point of *Africa*; [1]) they had sketched the influence of the Agulhas current on the climate, and acknowledged it to be the cause of the storms which so often rage here, and which in earlier ages were the occasion of this point's being called the Cape of Storms.

The large number of good observations the Institution continues to receive from Dutch seamen, — the more so, as all the observations taken from the logs are arranged according to time and place in boxes for every square degree according to the system of Dr. BUIJS BALLOT, — seemed to me to make a closer investigation of the currents about the Cape Reef desirable.

Some of the results of this investigations I now proceed to communicate.

The observations of the temperature at the surface of the sea in Celsius degrees, made at four in the morning, twelve at noon, and eight in the evening were arranged in tables for every square degree between 15° and 35° E long: and from 30° S lat: for every month in the year, and the mean temperature was then ascertained for each square.

The observations made at the said hours were selected because at those hours every Dutch Captain without exception makes them.

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1) Onderzoekingen met den Zeethermometer.

Observations, frequently added by several seamen, at other hours are of avail only for purposes of comparing them with those places where few observations have been made and for controlling the said observations. They were not allowed to weigh on the said mean, in order that no logbook might have an undue influence.

Thus a temperature Chart was made for every month, while from the aggregate of the monthly temperatures, a chart of the annual temperature was drawn up.

Having ascertained the mean temperature of every square for a month, or for a whole year, the square in the same latitude were combined and the mean calculated of every stripe of latitude; viz — between 38 and 39; — 39 and 40.

All this is represented in six separate charts.

Chart I. Represents the annual mean temperature at the surface, deduced from 28582 observations and on which the isothermal lines are drawn.

Chart II. Again represents the annual temperature at the surface; here the stripes of latitude are added together, averaged and the difference taken between the said average and the individual numbers belonging to each square marked with red ink, while the black line indicates the height of the average of the stripes of latitude.

The isothermal lines on Chart I show the annual course of the warm current; these lines indicate that the northern barrier of the current which passes along the coast and over the shallowest part of the Reef is detained, and the southern barrier is driven northward by a polar current.

Twice we see the warm current deflect southwards, or run into the polar current; the first time in 37° S: between 29° and 32° E. before it is, as it were, pent up in a narrow bed between the cold stream and the coast of *Africa;* — the second time to the west of 25° E in 37° S, when its bed is again narrowed by the well known Cape Reef.

The forms of the line show moreover that the warm current has a prodigious task to perform to pass over the Reef, which it accomplishes at the cost of both velocity and heat.

We meet thus with two currents, one current which, proceeding from low latitude, runs along *Madagascar* and the South and East coast of *Africa*, and spreads out towards the south; and a second stream, which proceeding from the pole drives the warm current towards the coast of *Africa*, of which current it may be considered as a moving bank.

Whenever these currents meet they alternately encroach on each other's domain, while the prevailing winds and storms give birth to sea-drifts which still more disturb their respective limits.

It is obvious that these limits are in reality not so regular as it would appear from our charts; for, as the mean temperature has everywhere been taken, in consequence of which the extent of deviation is not traced; but the sinuous course of the currents and the encroachments they make on each other's domain are plainly indicated.

A glance at Chart II plainly proves what has been already said; Viz, that the warm current runs twice into the cold one; the first time between 29°, 30″, 31° East and as far as 41° S; the second time between 19—25° E as far as 44° S.

The high temperatures, which westward of 25° E. stream most to the south spread, out towards the east, in consequence of the diurnal revolution of the earth, and of west winds which give birth to sea-drifts in these parts.

On comtemplating these Charts a question arises as to what may be the cause of the warm current's having in both places sufficient force to run so deep in to the cold current, while it loses this power entirely between 25—28 E.

If the annual course of the stream is the cause of this phenomenon, it must be made out from the temperature charts of the different seasons, in which the details will all have to appear.

Chart III. Represents the mean temperature in June, July and August.

(Southern Winter) inferred from 7400 observations.

Chart IV. September, October, November (Spring), inferred from 6199 observations.

Chart V. December Jan. Feb. (Summer) inferred from 6612 observations.

Chart VI. March, April, May — (Autumn,) inferred from 5917 observations.

This classification has been made according to the same principle as Chart II.

It strikes us at once that the lines, which cross the averaged stripes of latitude are similar in shape; and that along the west and south coast the temperature of the sea water is much lower than along the east coast.

Just as in the Chart of the mean annual temperature, we find in every one of our special Chart the warm current twice running southwards and nearly at the same place in some of then in a more strongly marked manner.

The largest number of deviations are found in the lines which indicate the left barrier of the warm current.

In Chart III representing the Southern winter, we see indeed the warm current twice running Southward, but the first time it but slightly penetrates the cold current, the warm current is then confined in a narrow bed to the east of 30° E, but spreads out between 25—30° E and as far as 37° S.

The powerful polar current spreads out Eastward of *Africa* but between 25—30 E the warm currents keep it a degree more southward than in other seasons.

Chart IV. Representing the distribution of temperature in spring; the warm current resumes its domain eastward of 30 E. the polar current is driven back; but between 25° and 30° E, the latter again runs into the warm current, and as far spreads out as 36° S.

In summer of which the temperature is indicated by Chart V the warm current eastward of

20 E, forcees the polar current as far back as 41° S; but between 26° and 27 E it forces it further back then 37° S.

In Chart VI Indicating the autumnal temperature we find the currents again encroaching on each other, yet the poler current gradually resumes its own domain.

The seasons are thus the sole cause that the warm current spreading itself out more or less to the *south* Eastward of 30° E; or that the Polar current runs like a wedge into the warm current till 37°—38° S between 26—27° E and, according to the season, spreads itself out more to the *east*.

The monthly temperature Chart, then, merely indicate with more or less accuracy the encroachments of the cold current in that latitude, between the longitudes mentioned.

I would venture to suggest that this encroachment of the cold current may be owing to the configuration of the Ocean bed.

Suppose there was between 26° and 27° E. on 37° or 38° South Lat: a reef with a gentle slope to the south, and steep on the north and north-east side, the polar current would then easily reach the surface there, and press on the warm current in the depth along the steep north and north-east banks, and divide it.

I am not aware of any soundings having been taken there 1), I find stated in 23 different log-books that in this latitude and longitude the water grows considerably shallower.

In 1844 in particular several icebergs were noticed in this neighbourhood, though a little more to the south.

It was observed that they remained nearly two months in the same latitude. They may have grounded there and gradually melted.

This hypothesis is not yet a full proof, there are however many observation that make it probable.

From all these facts it occurs to me that soundings should be taken between 26, 27° E long, and 37°, 38 South Lat.

In consequence of this investigation, the Dutch government, (December 24th 1867,) issued orders for soundings to be taken there.

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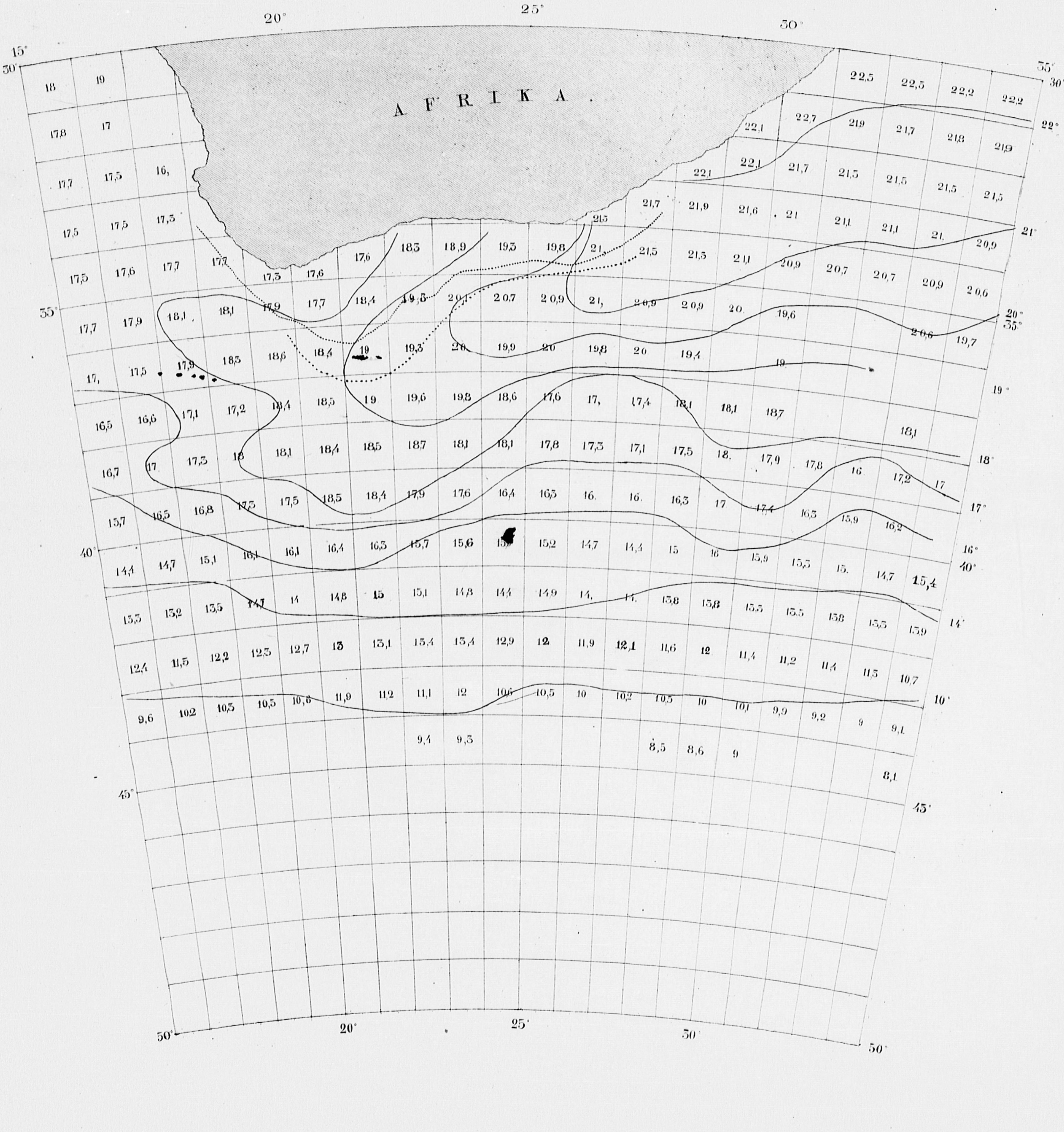
1) Look at the fine chart of the Cape of good Hope and adjacent coast compiled from the latest ADMIRALTY SURVEYS 1867.

YEARLY MEAN TEMPERATURE

OF THE SEA AT THE SURFACE NEAR THE SOUTHPOINT OF AFRICA,

from **28582** observations.



YEARLY MEAN TEMPERATURE
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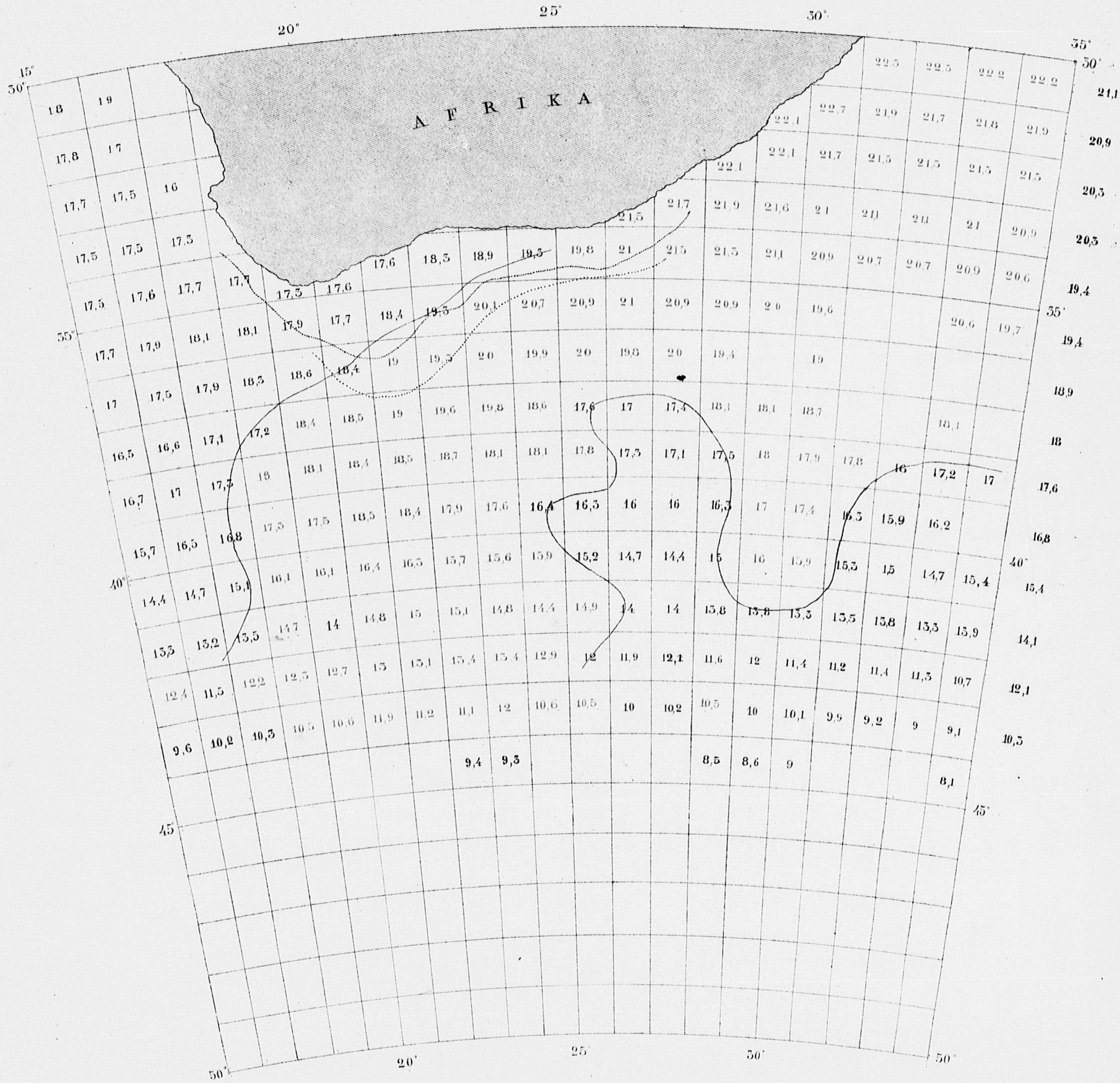
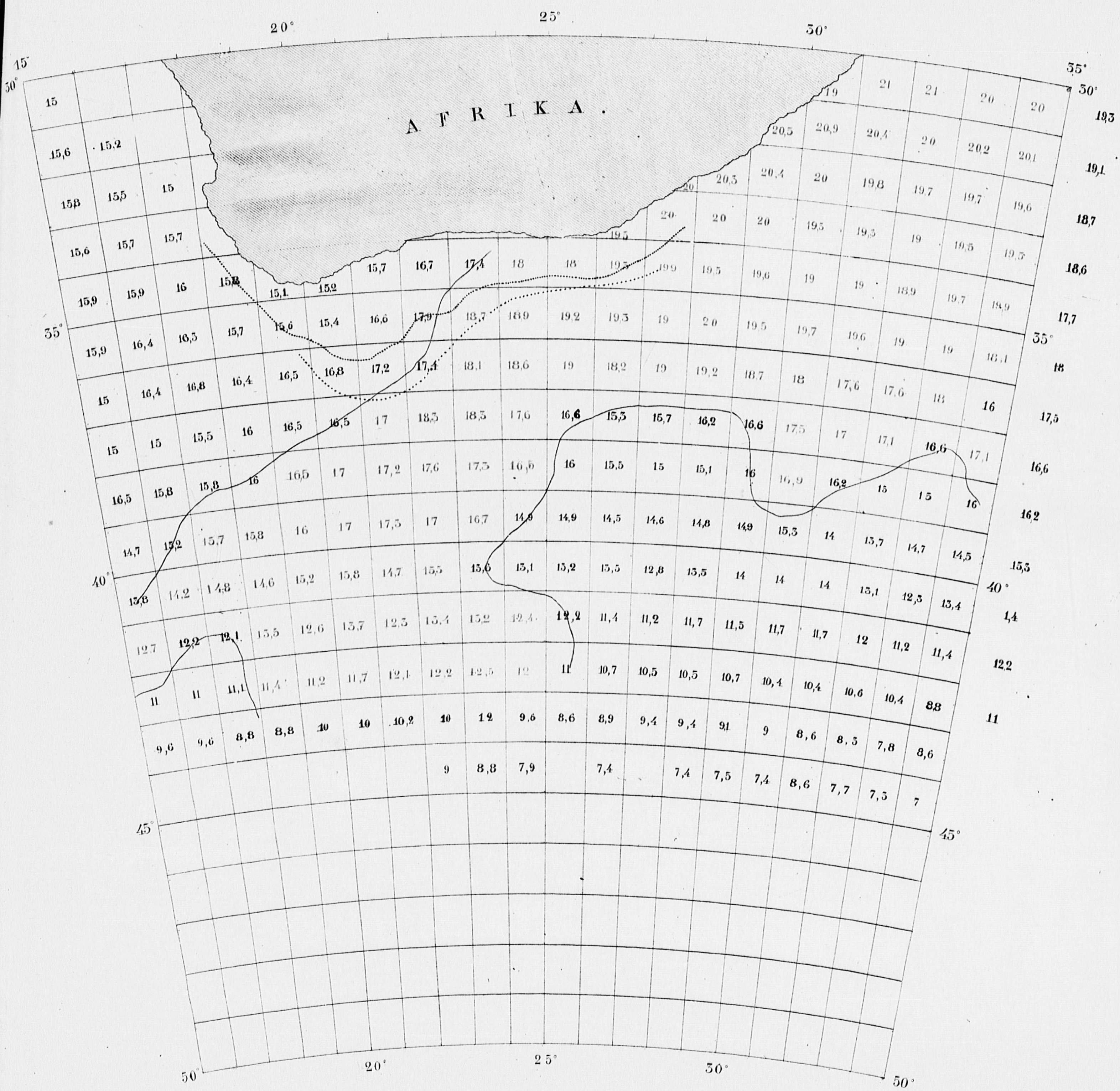


MEAN TEMPERATURE

OF THE SEA AT THE SURFACE NEAR THE SOUTHPOINT OF AFRICA,

WINTER

from **4700** observations.

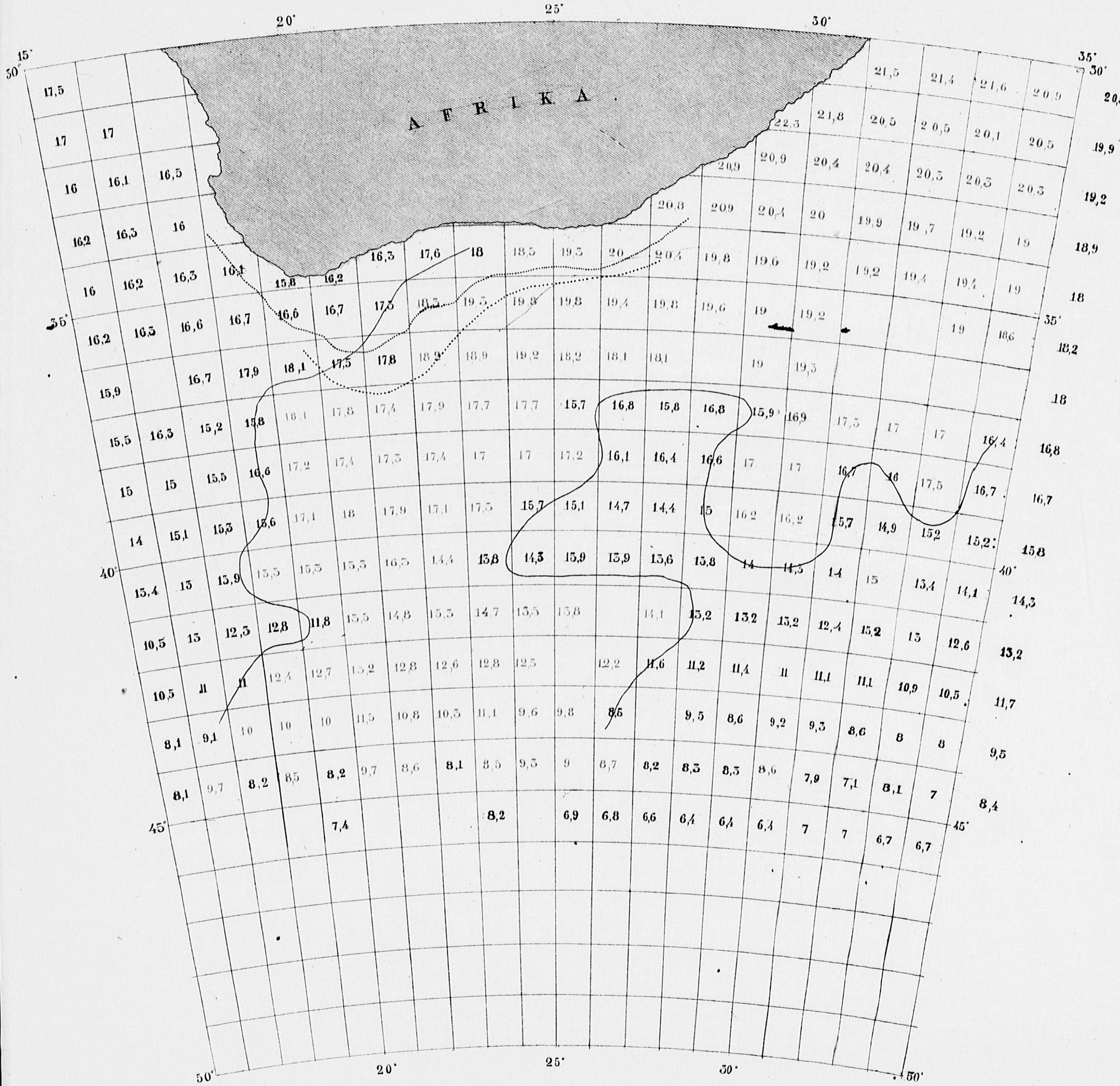


MEAN TEMPERATURE

OF THE SEA AT THE SURFACE NEAR THE SOUTHPOINT OF AFRICA,

SPRING

from **6199** observations.

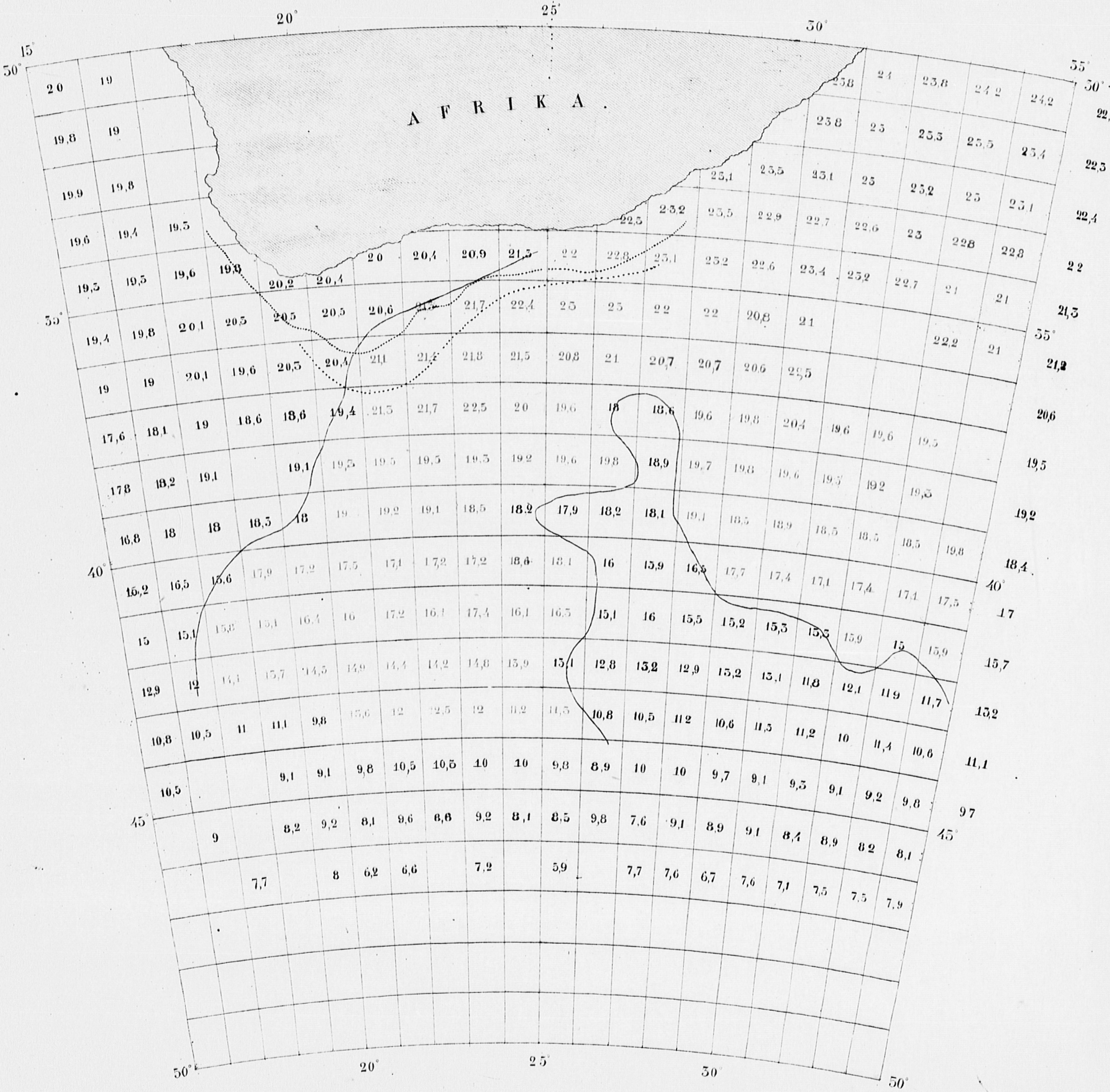


MEAN TEMPERATURE

OF THE SEA AT THE SURFACE NEAR THE SOUTHPOINT OF AFRICA,

SUMMER

from **6612** observations.



MEAN TEMPERATURE
OF THE SEA AT THE SURFACE NEAR THE SOUTHPOINT OF AFRICA,
AUTUMN
from **5917** observations.