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AIR MINISTRY

METEOROLOGICAL OFFICE

Geophysical Memoirs No. 100
(EIGHTH NUMBER, VOLUME XII)

WORLD DISTRIBUTION OF ATMOSPHERIC WATER VAPOUR PRESSURE

BY

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LONDON: HER MAJESTY'S STATIONERY OFFICE

1958

Decimal Index
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Geophys. Mem., London,
12, No. 100, 1958

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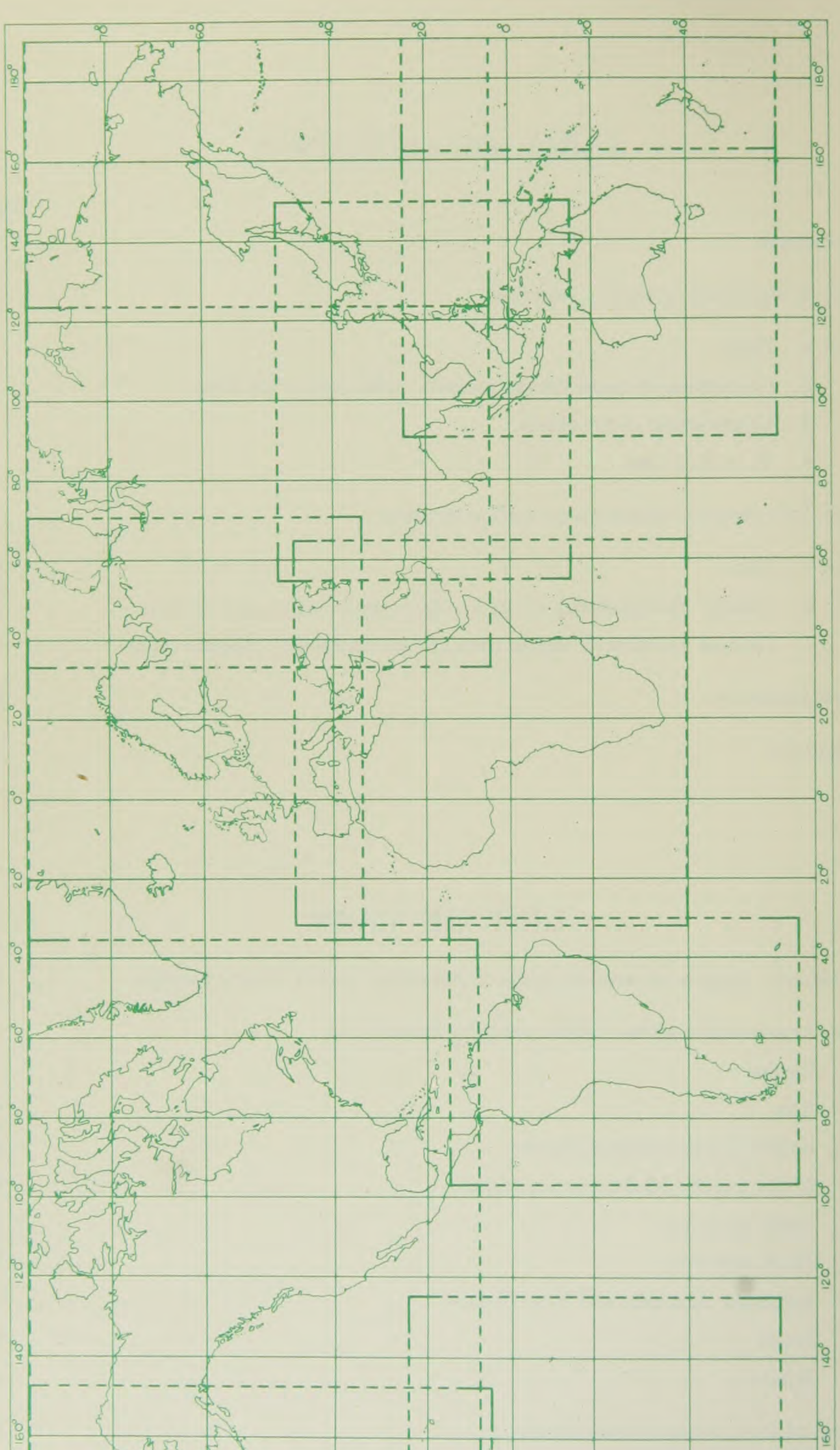


REGIONS COVERED BY MAPS OF ATMOSPHERIC WATER VAPOUR PRESSURE

WORLD DISTRIBUTION OF ATMOSPHERIC WATER VAPOUR PRESSURE

INTRODUCTION

The Meteorological Office has in recent years received a large number of inquiries regarding atmospheric humidity in many parts of the world. To meet this increasing demand, data for most of the land areas of the world have been assembled and are here presented in the form of charts (see pp. 6-49) showing the distribution of mean vapour pressure, reduced to sea level, for the mid-season months of January, April, July and October. The aim of this memoir is to present the data in a useful form and no scientific discussion of the charts is attempted.

In the last part of the work a short account of the diurnal variation of vapour pressure is given based on an analysis of hourly averages for a selection of stations distributed over the world.

The data were collected from many sources, the main one being the large collection held in the library of the Meteorological Office, London. The work has been greatly helped by the international exchange of meteorological year books and other publications. A number of British Commonwealth and foreign meteorological services have provided data, often in manuscript form, in response to special requests. There are no data from ships, and the only data at all representative of the sea areas are those from certain small oceanic islands.

PART I—WORLD MAPS OF VAPOUR PRESSURE

§ 1—DATA

As far as possible the data for any station cover a period of 10 years; but data for longer periods were used if readily available. It was, however, found impossible to keep to a standard period. No allowance was made for trends and the data were not smoothed; nevertheless, the isopleths are very smooth, indicating that the trends were probably unimportant for the purpose in hand.

Means based on 24-hourly values of vapour pressure, temperature and relative humidity, or dry-bulb and wet-bulb temperatures, were available only for observatories and a small number of first-order observing stations. These provided reliable values for comparison with, and possible adjustment of, the much larger number of data from stations making observations at only a limited number of hours each day.

Where there is only a limited period of hourly values, but a longer period of less complete observations, the hourly values were used to correct the data of longer periods.

Adjustments were made to allow for any known significant changes in the time of observation or site of station. If, however, the change in the time of observation was less than half an hour, or the change in site less than 10 min. in latitude or longitude, it has been ignored. Any such adjustments made by local services have been accepted. Local estimates of daily mean values from observations at fixed hours have also been used. For some areas data are rare, and it has been necessary to use considerable judgement in order to arrive at reasonable estimates of the charted and tabulated values.

There are two main types of error. The first is that in which a value stands out as high or low in an area with a fairly uniform distribution of mean vapour pressure. High values are most common and were discounted, as most systematic errors in the wet-bulb temperature lead to high vapour-pressure values. It is usual to discount very low values, but this was done only after very careful scrutiny.

The second type of error is widespread and is due to some general cause; e.g., when a high water-table near a river or lake increases the upward diffusion of water vapour, producing higher values than those in the free air flowing over the region near by. High values of vapour pressure are obtained also from dry-bulb and wet-bulb temperatures observed near warm seas, owing to salt contamination. Where these effects were clearly widespread the values have been accepted, but where localized they have been discounted. One result of this procedure is that high gradients of mean vapour pressure appear near some tropical coasts.

The basic data were derived mostly from readings of screened dry-bulb and wet-bulb thermometers or hair hygrometers. These instruments can yield reliable results, but errors are difficult to avoid at very high and very low temperatures, and will also arise if a high standard of management is not maintained. Careful scrutiny and checking of all the basic data were therefore essential. This was a very laborious process, but the outcome was a reasonably consistent collection of values which enabled the charts to be constructed without undue difficulty.

§ 2—CALCULATION OF MEAN VAPOUR PRESSURE: REDUCTION TO SEA LEVEL

When temperature and relative humidity or wet-bulb temperature data are being used to derive vapour-pressure averages, difficulties arise from the non-linearity in the relationships between the observed and derived functions. These have been dealt with by the method described by Sumner and Tunnell.[1]*

To facilitate interpolation on the charts the vapour-pressure averages have been reduced to sea level. The method of reduction has been discussed by Tunnell,[2] who showed that long-period averages follow an almost universal law in their vertical variation except where there exists a very deep inversion, as for example, in the winter over north-west Canada and Siberia.

The reduction formulae are:

$$e = e_0\,(1-0{\cdot}00025h)$$

for stations up to 1,300 m. above mean sea level, and

$$e = e_0\,10^{-0{\cdot}000128h}$$

for higher stations, where h is the height of the station above mean sea level (in metres), e is the mean vapour pressure at station level and e_0 is the corresponding mean vapour pressure reduced to sea level.

§ 3—CONSTRUCTION OF THE CHARTS

Data for areas between 61°S. and 75°N. have been plotted on Mercator charts. For high latitudes circumpolar charts on a polar zenithal equidistant projection have been used.

The isopleths were drawn at variable intervals chosen in the way judged best for reproducing the important features of the distribution, but having regard also to the availability of the data.

The large Mercator charts have been divided into sections (see Frontispiece) convenient for publication and ease of handling. Where it has been necessary thus to divide a large continental area, consideration has been given as far as possible to the climatic unity of the area depicted in each section, e.g. the monsoon region of southern Asia (pp. 18-21).

The broken lines give suggested distributions and are shown only for convenience in interpolation. On the arctic circumpolar charts the isopleths have been drawn after a study of other climatic

* The index numbers refer to the bibliography on p. 52.

elements to give a suggested distribution consistent with the widely scattered data. This has not been possible for the antarctic charts.

Spot values have been plotted for islands and these may be used for any rough interpolations over the sea. It is found that in general these island values do not differ greatly from nearby ships' observations. For the present purpose island data are superior to ships' data in that they are homogeneous with mainland data and free from the drawbacks arising from the variable positions, irregular availability in time, and difficulties of measurement.

The plotted values have been reduced to mean sea level so that interpolations may be independent of height variations. To find the average vapour pressure at a specific position and height, the sea-level value is read off the map, and then by means of the appropriate reduction formula (p. 4) it may be adjusted to the required level. The result obtained is an estimated surface value, and does not apply to the free air.

The unit of pressure used in all the maps is the millibar.

§ 4—TABULATED DATA

The basic data (for about 3,500 stations) used in compiling the charts of mean vapour pressure have been listed in the form of tables which show, for each station:

(i) Latitude and longitude in degrees and minutes.

(ii) Height above sea level.

(iii) Mean vapour pressure for January, April, July and October at station level.

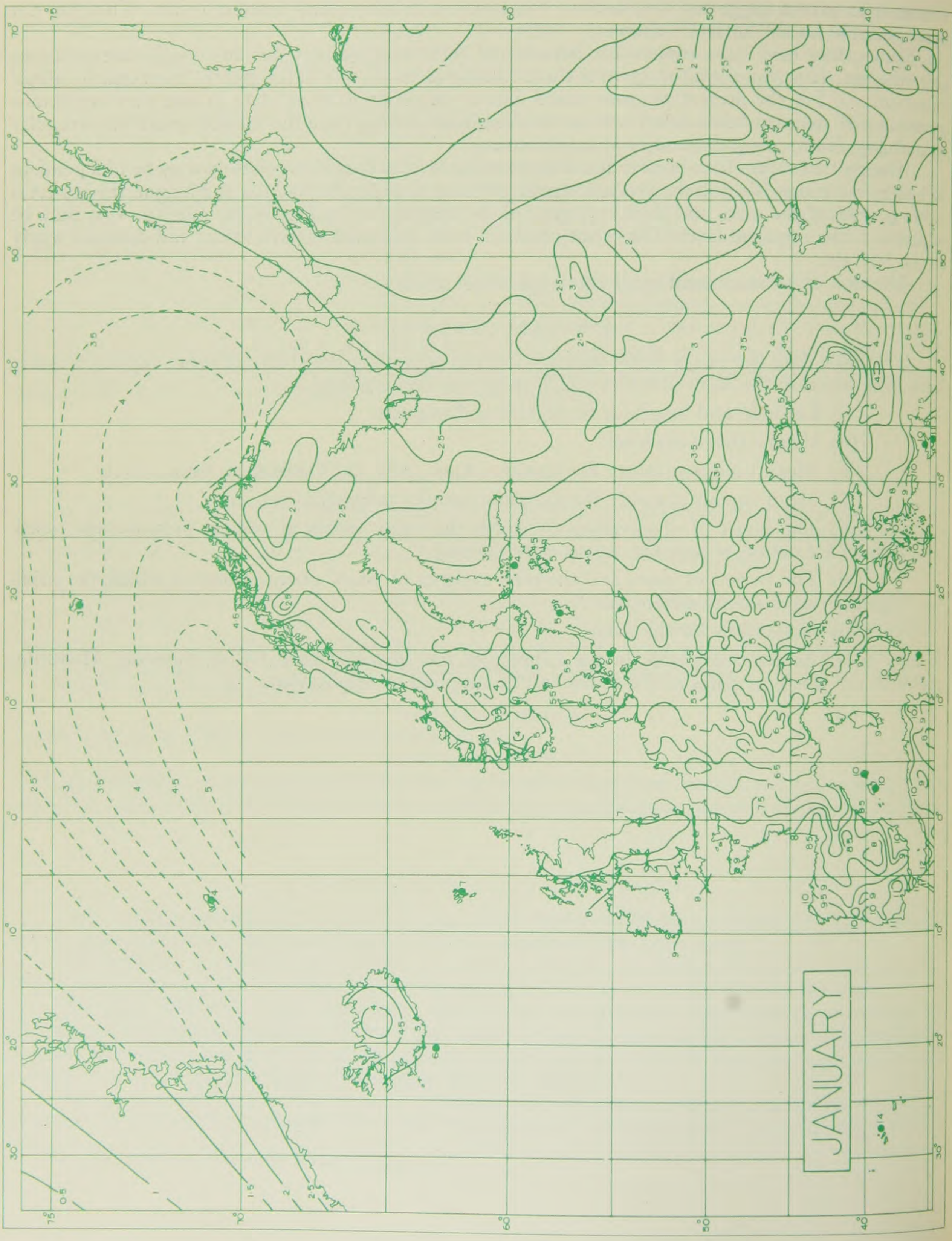
(iv) Mean vapour pressure for the same months reduced to sea level.

(v) The hours of observation on which the mean values of vapour pressure are based, with an indication of how the means were derived.

(vi) The period of years and the total number of years' observations on which the mean vapour pressures were calculated.

(vii) Authorities for the data.

A copy of the tables is available in the Library of the Meteorological Office, London. Microfilm copies of the whole or parts of the tables can be supplied on application.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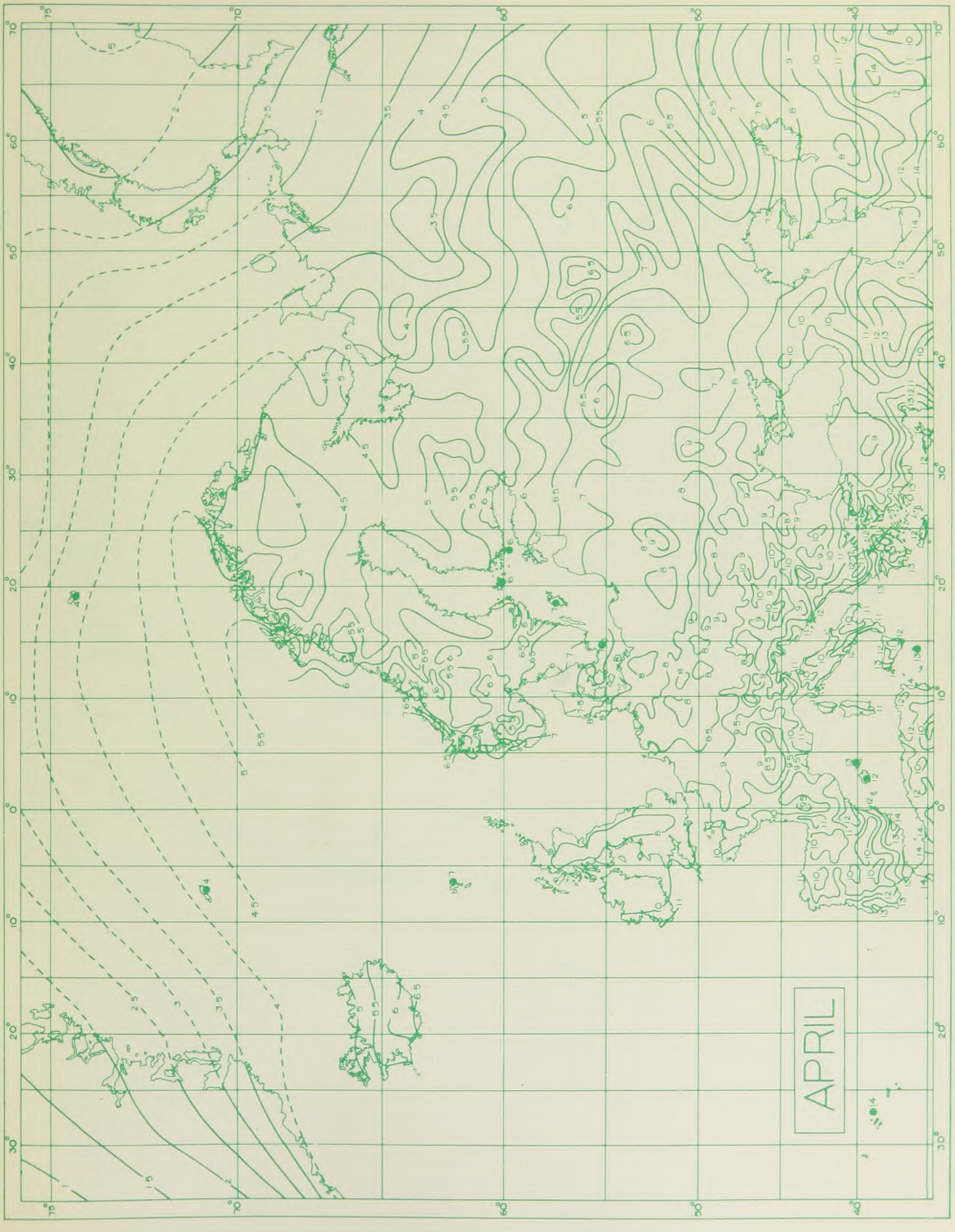
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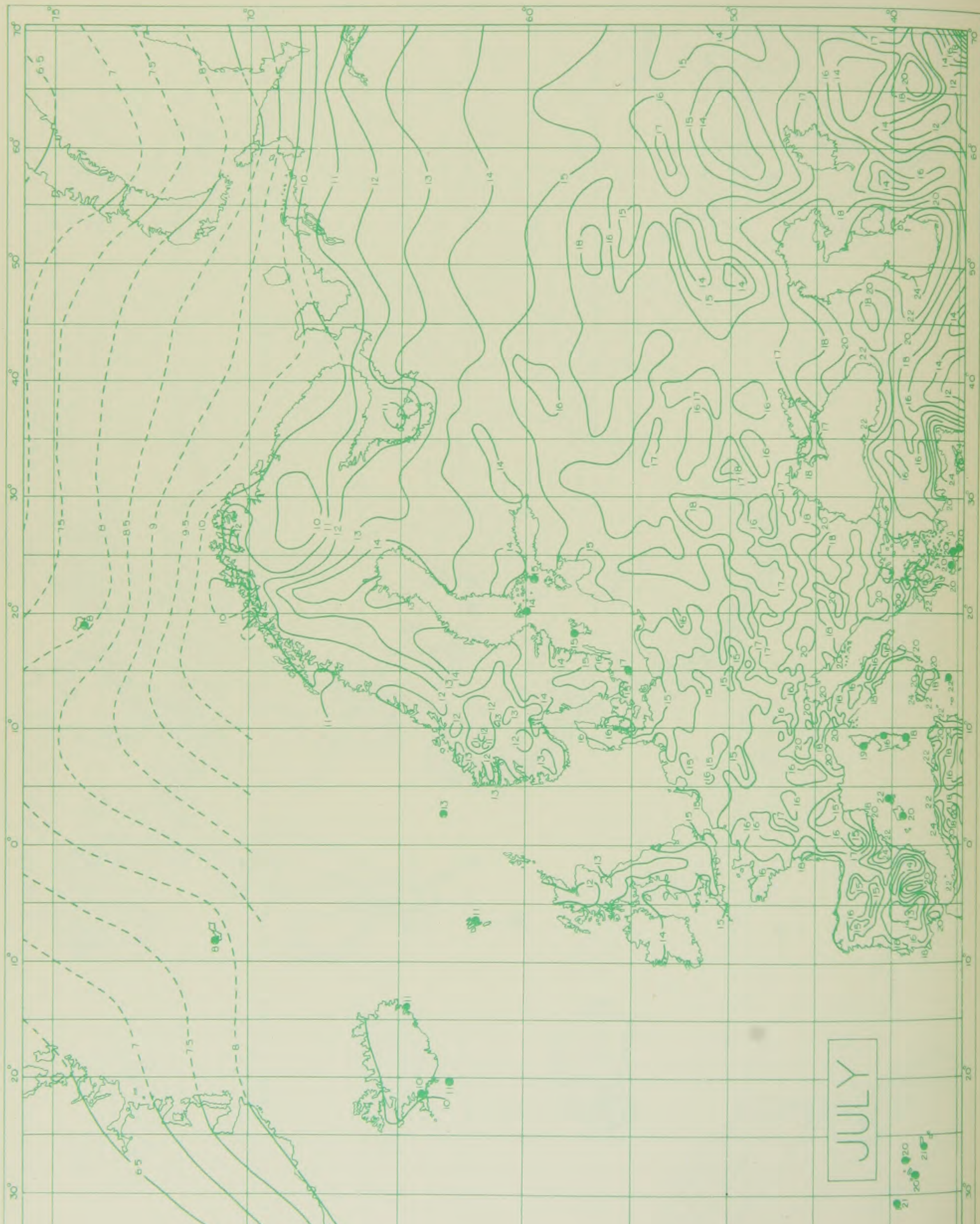
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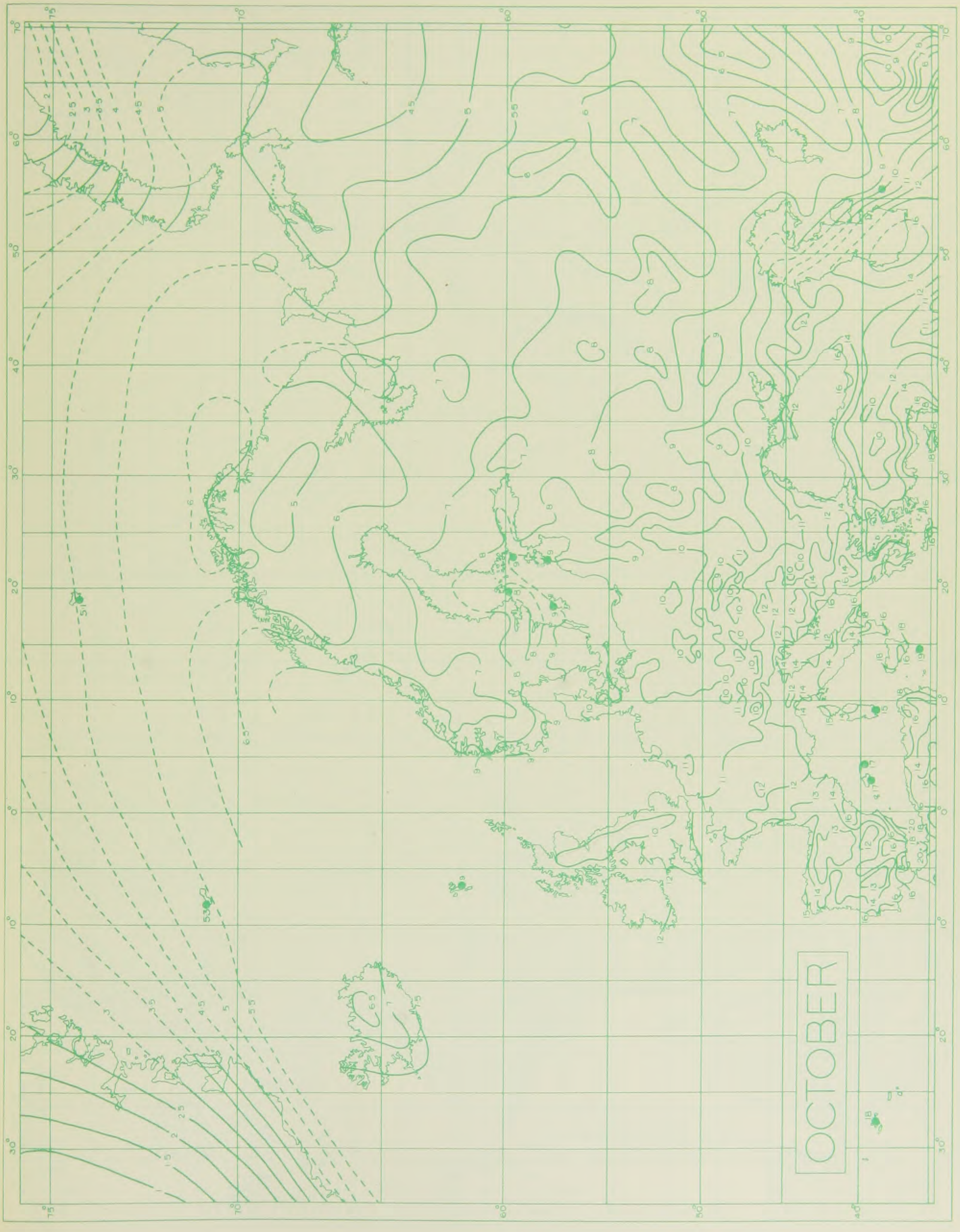
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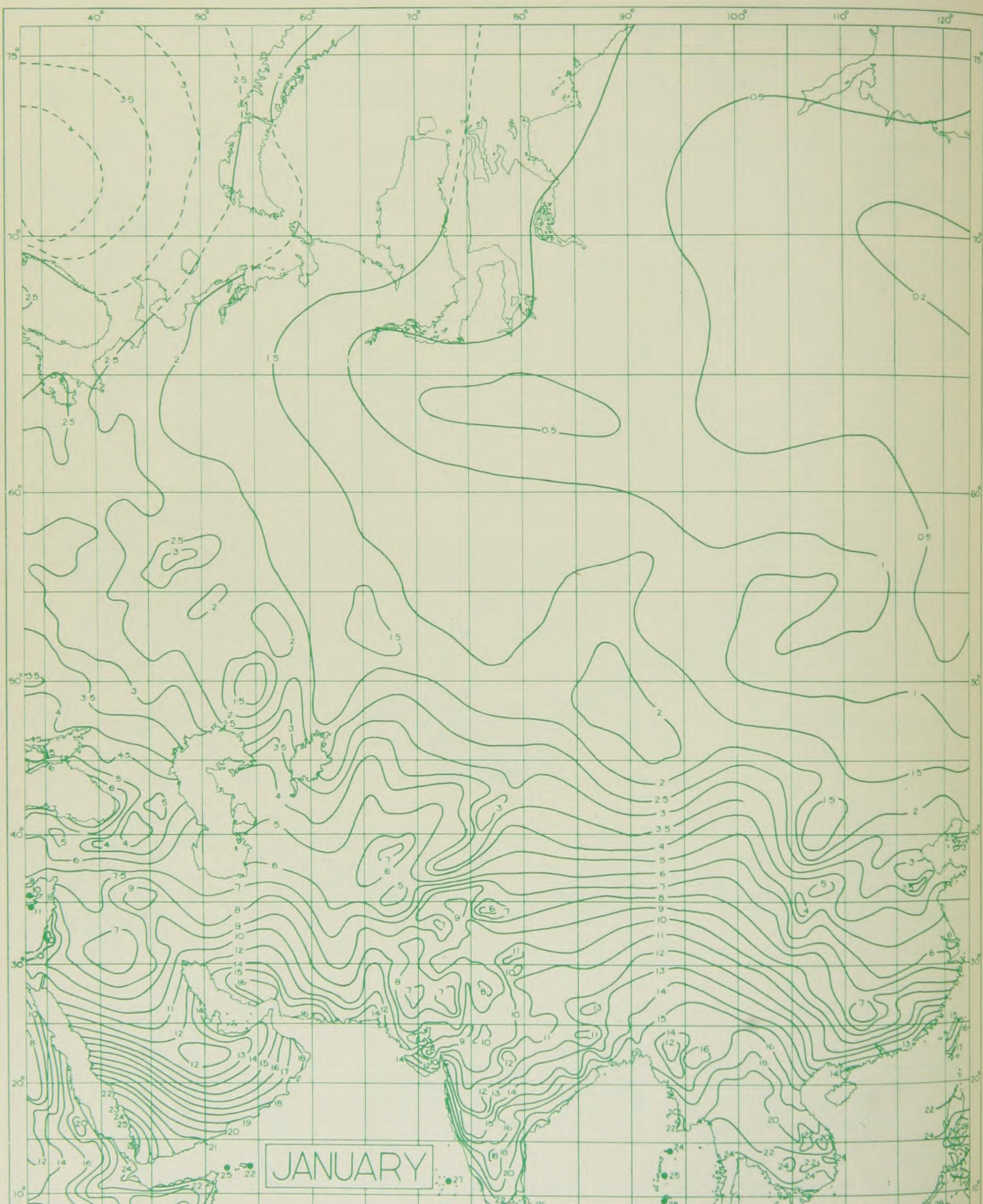
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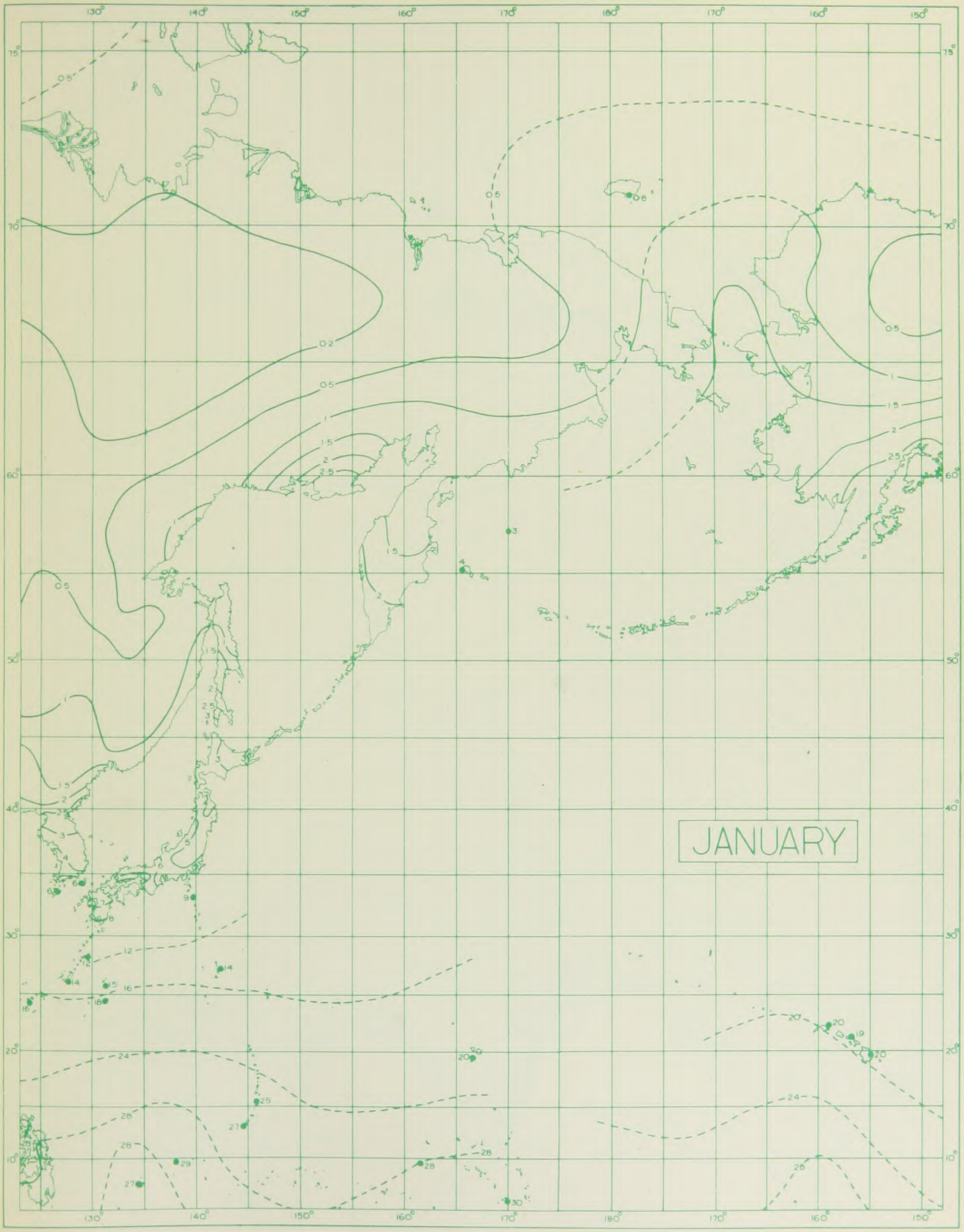
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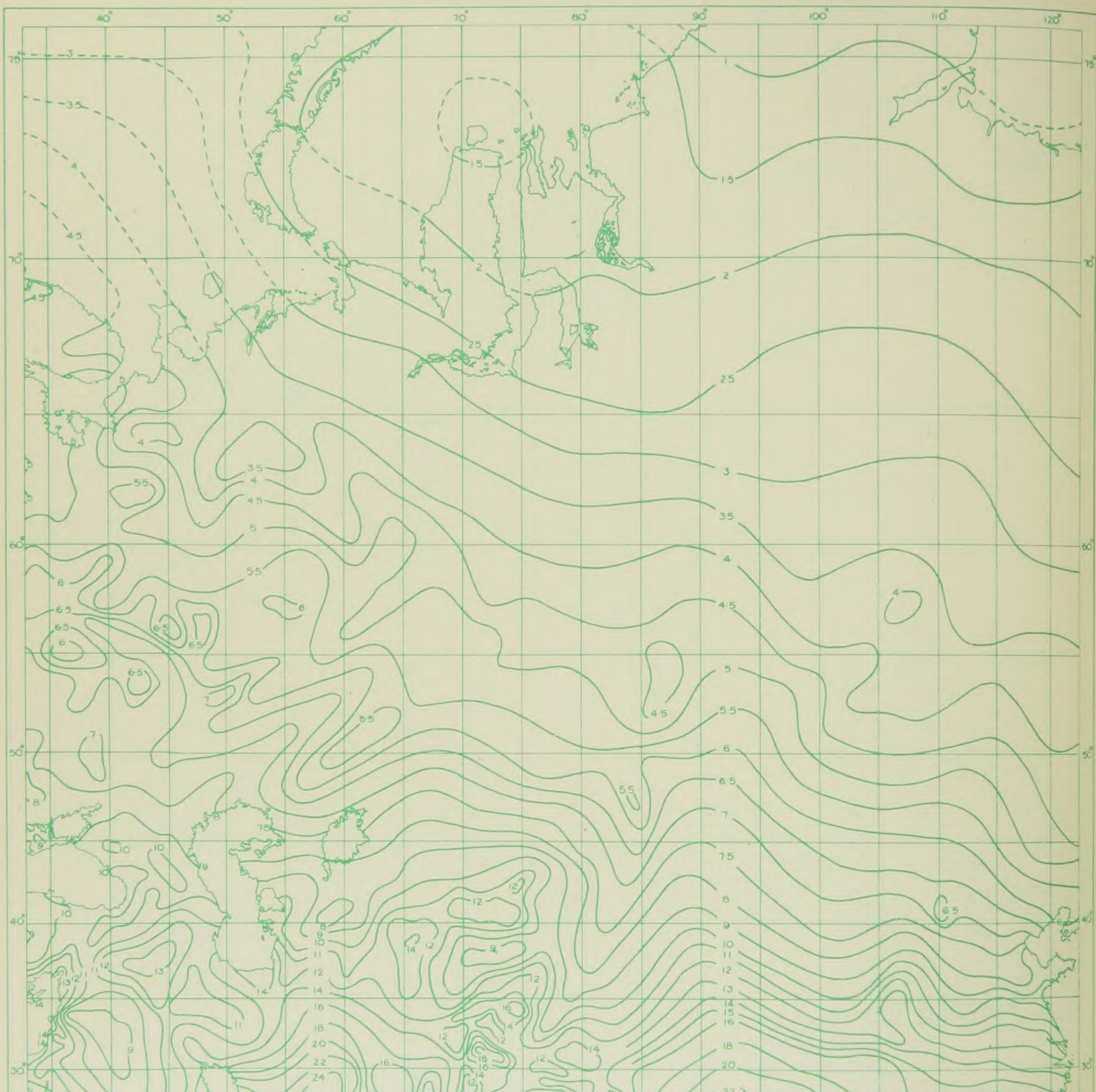
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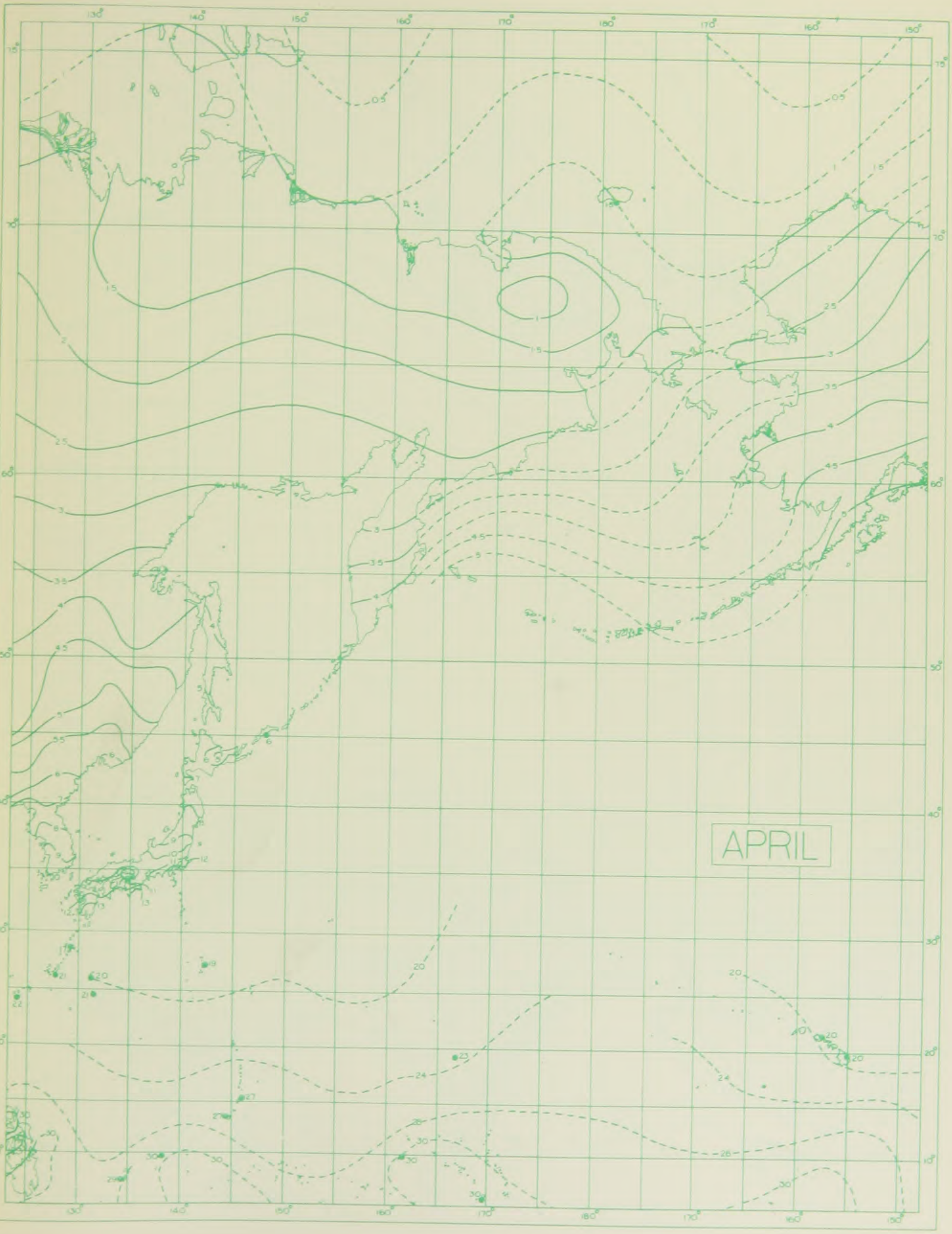
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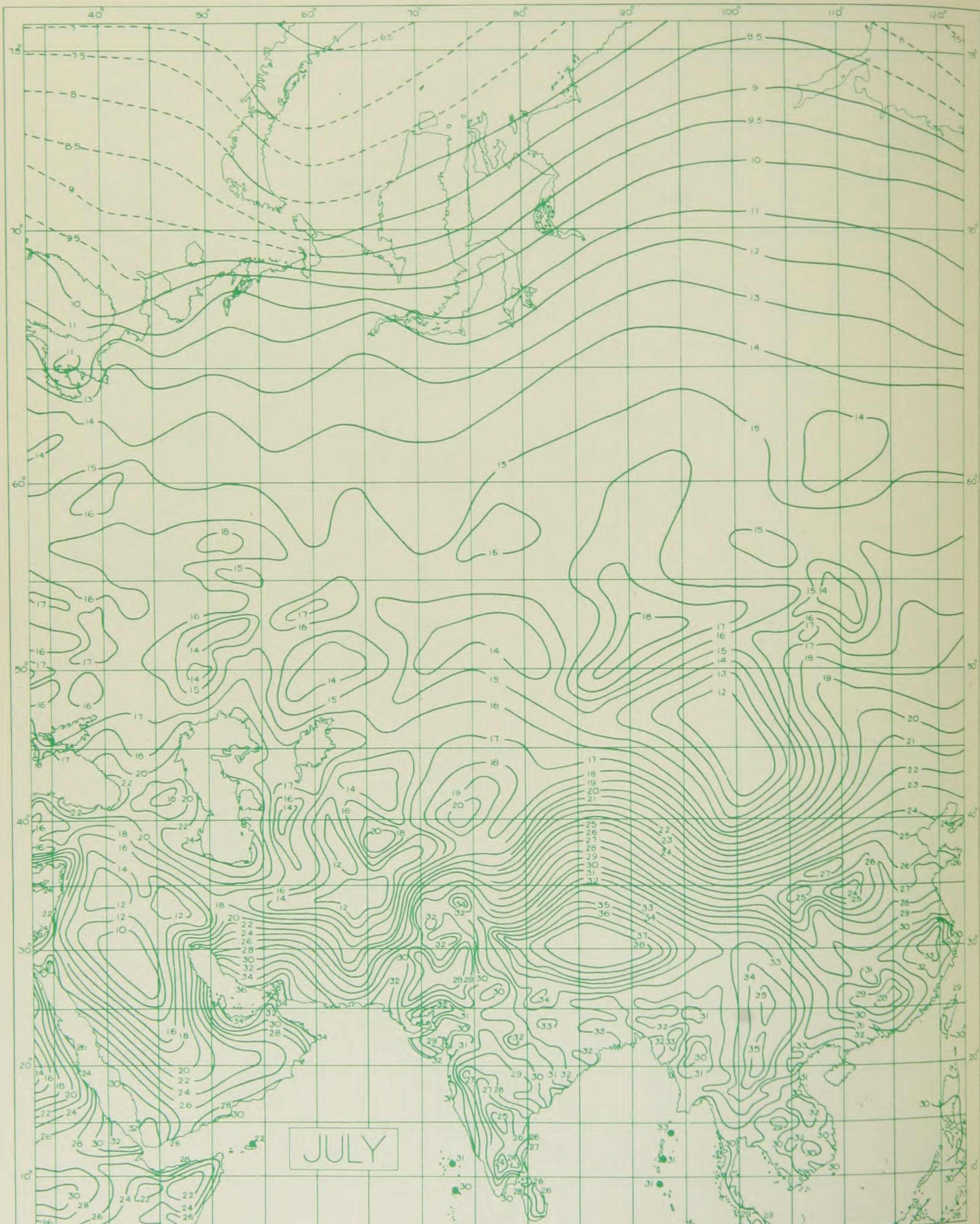
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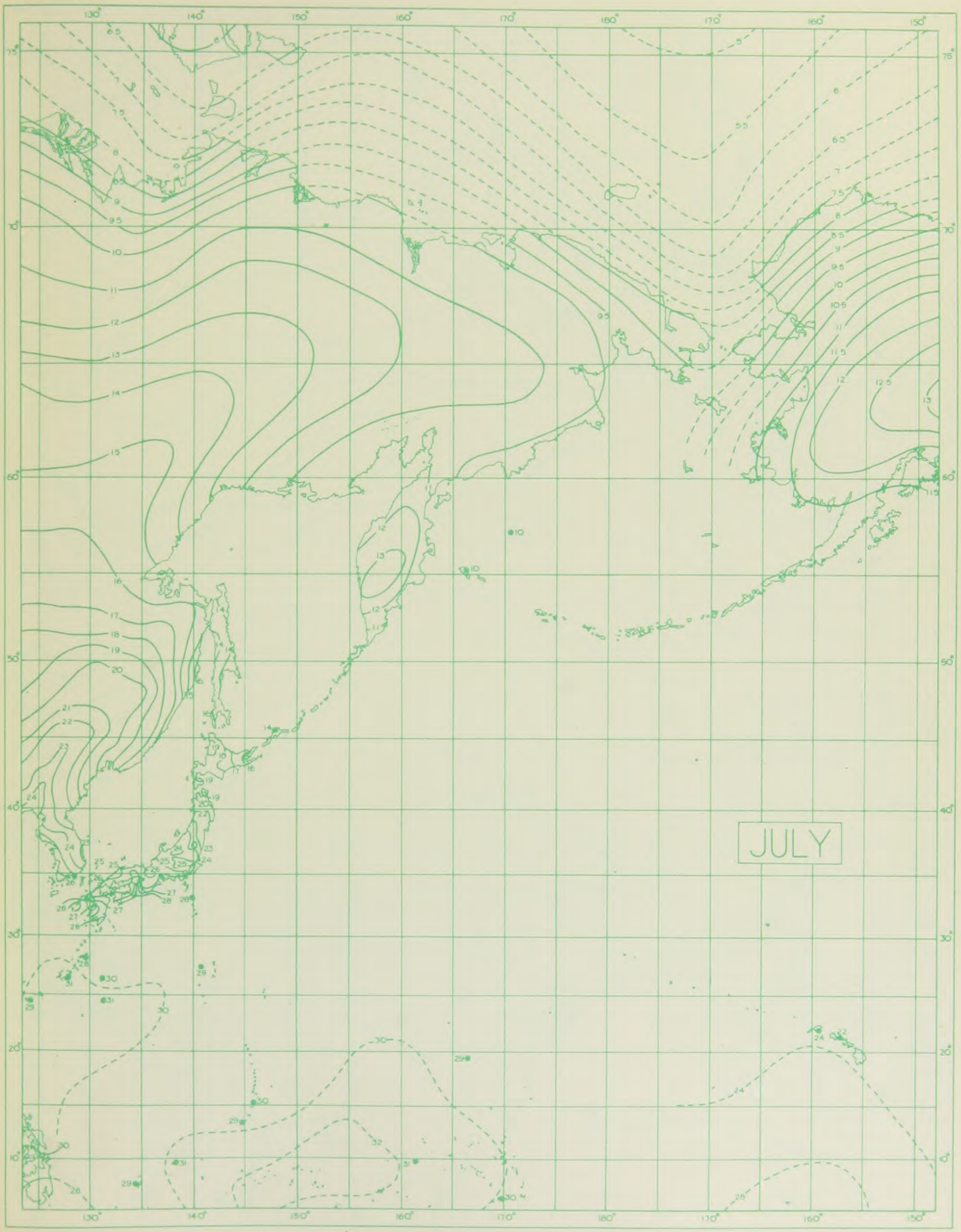
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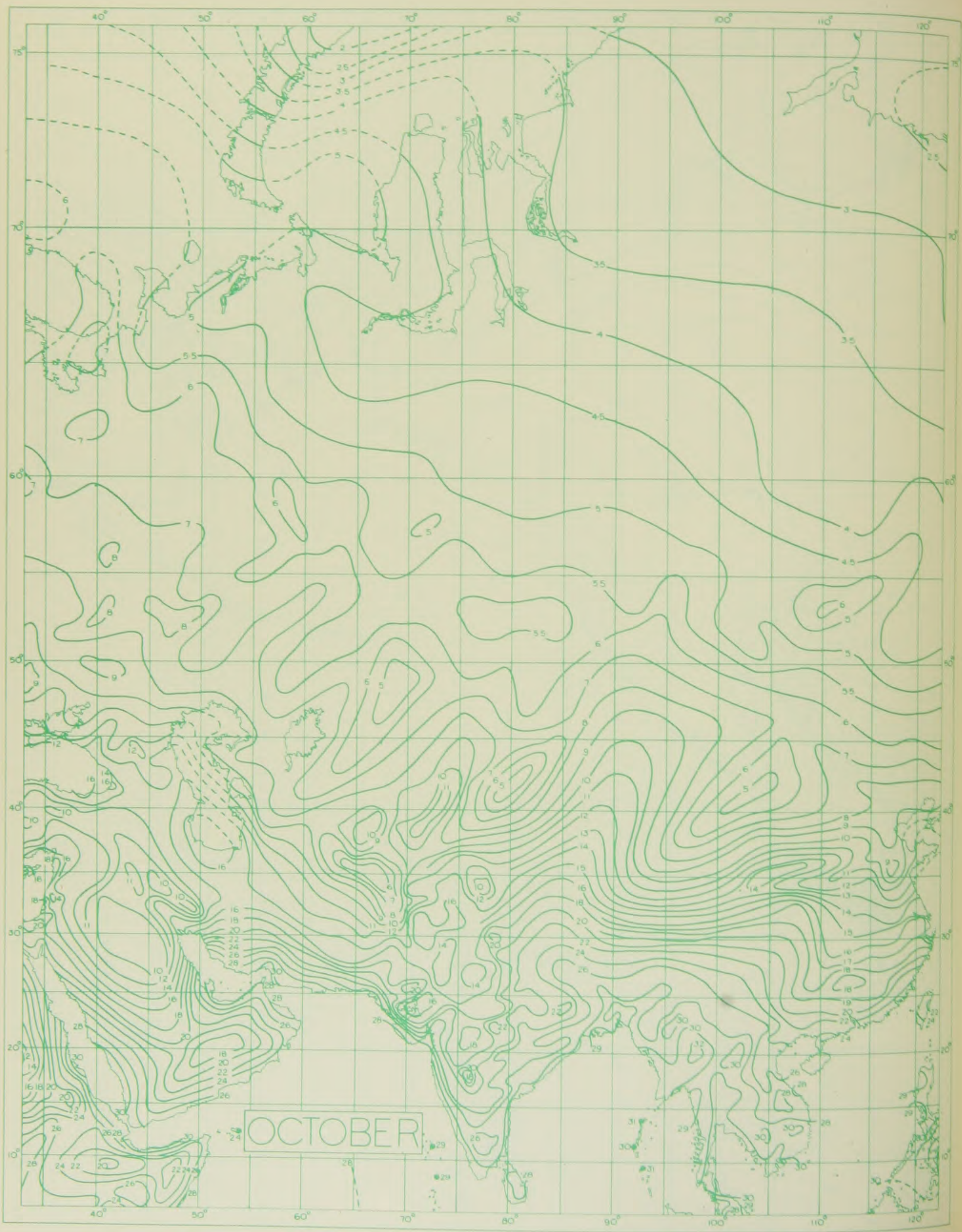
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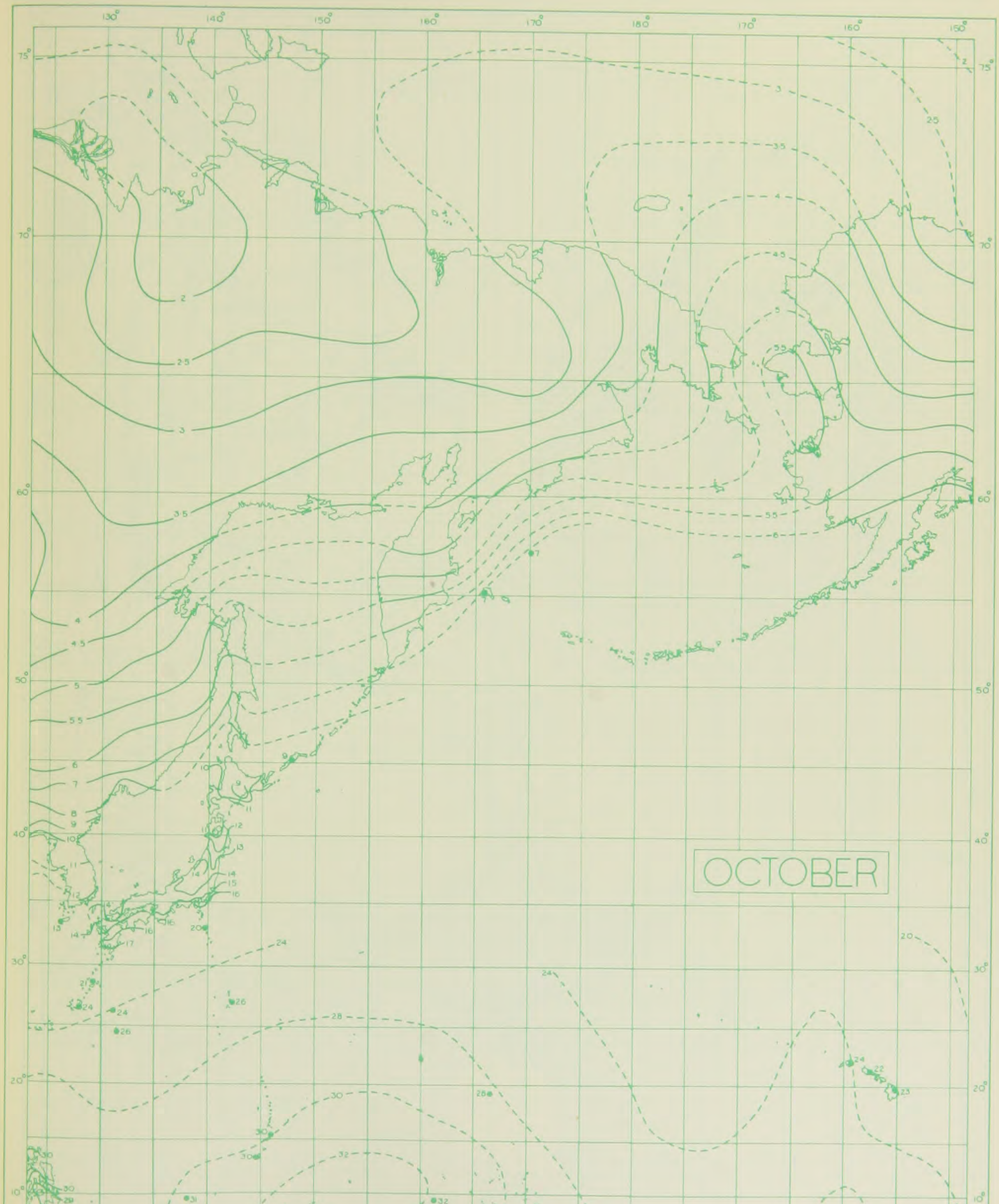
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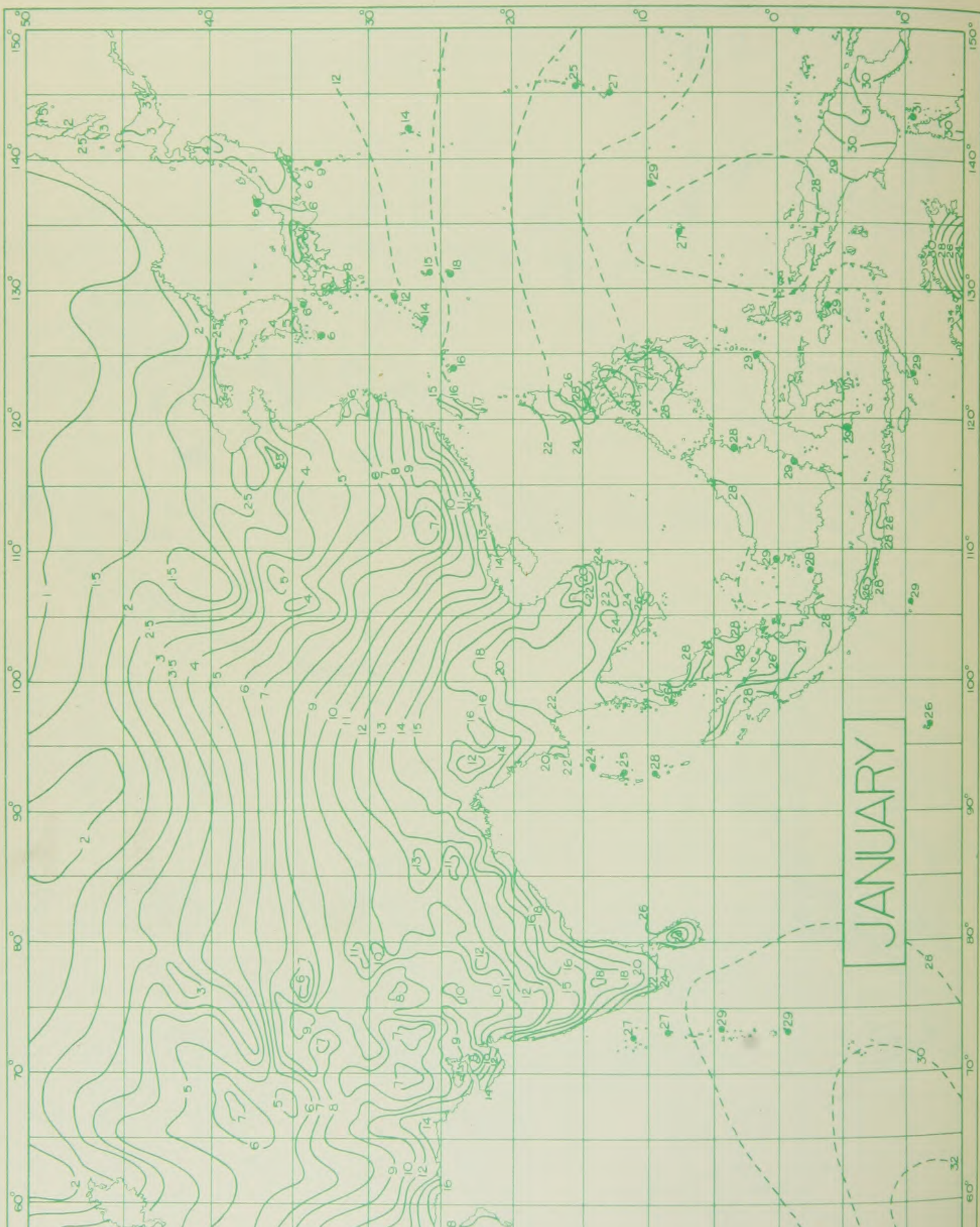
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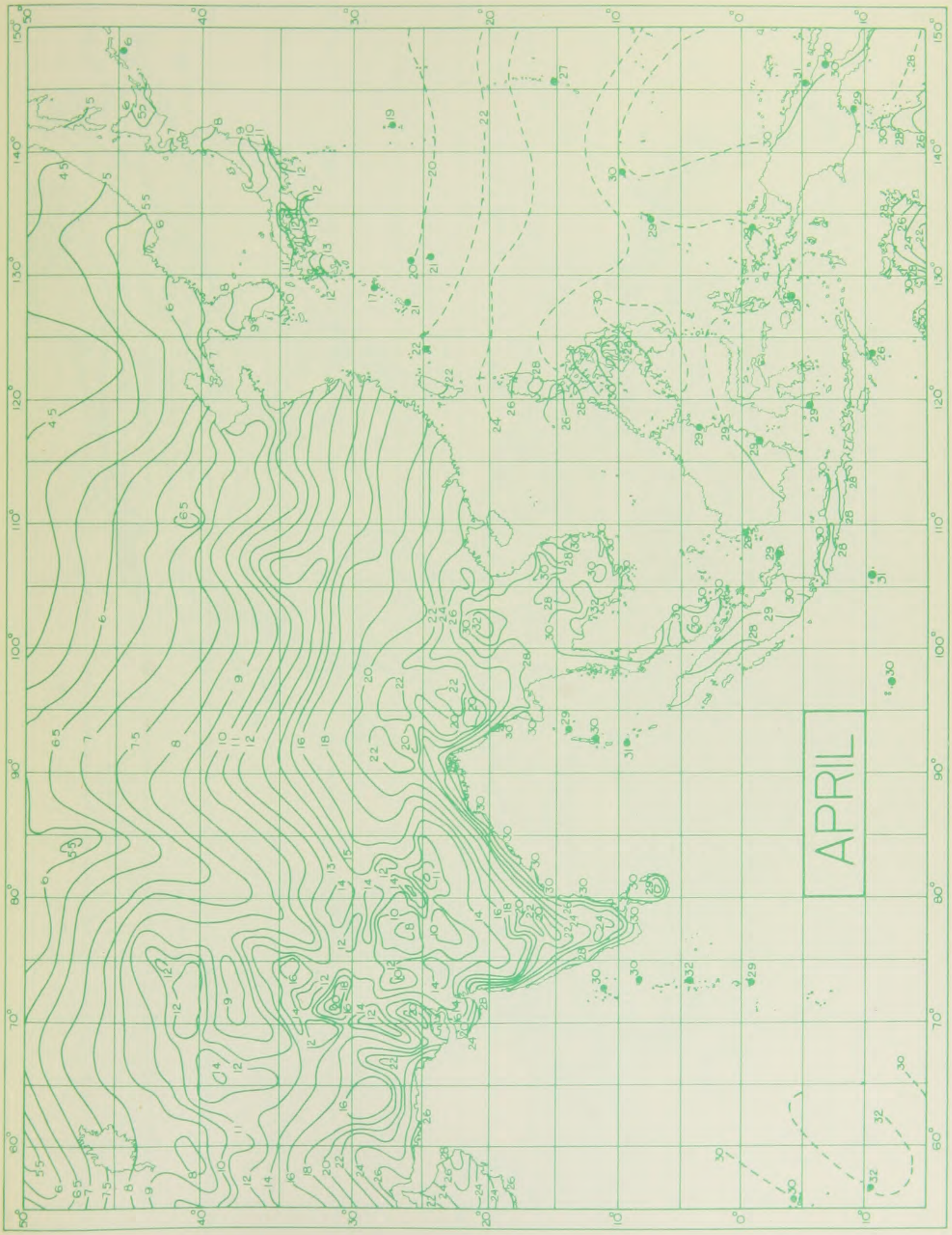
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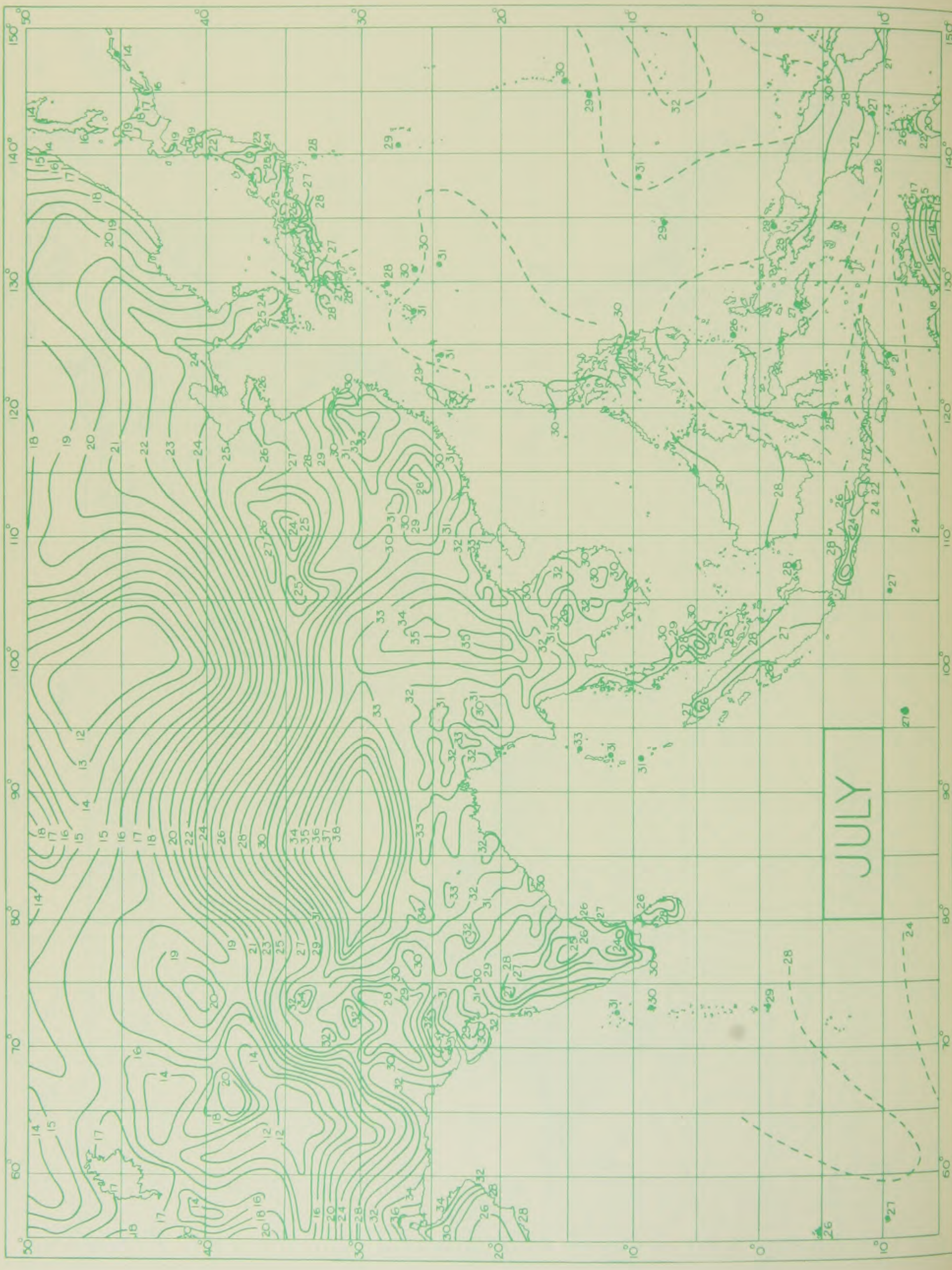
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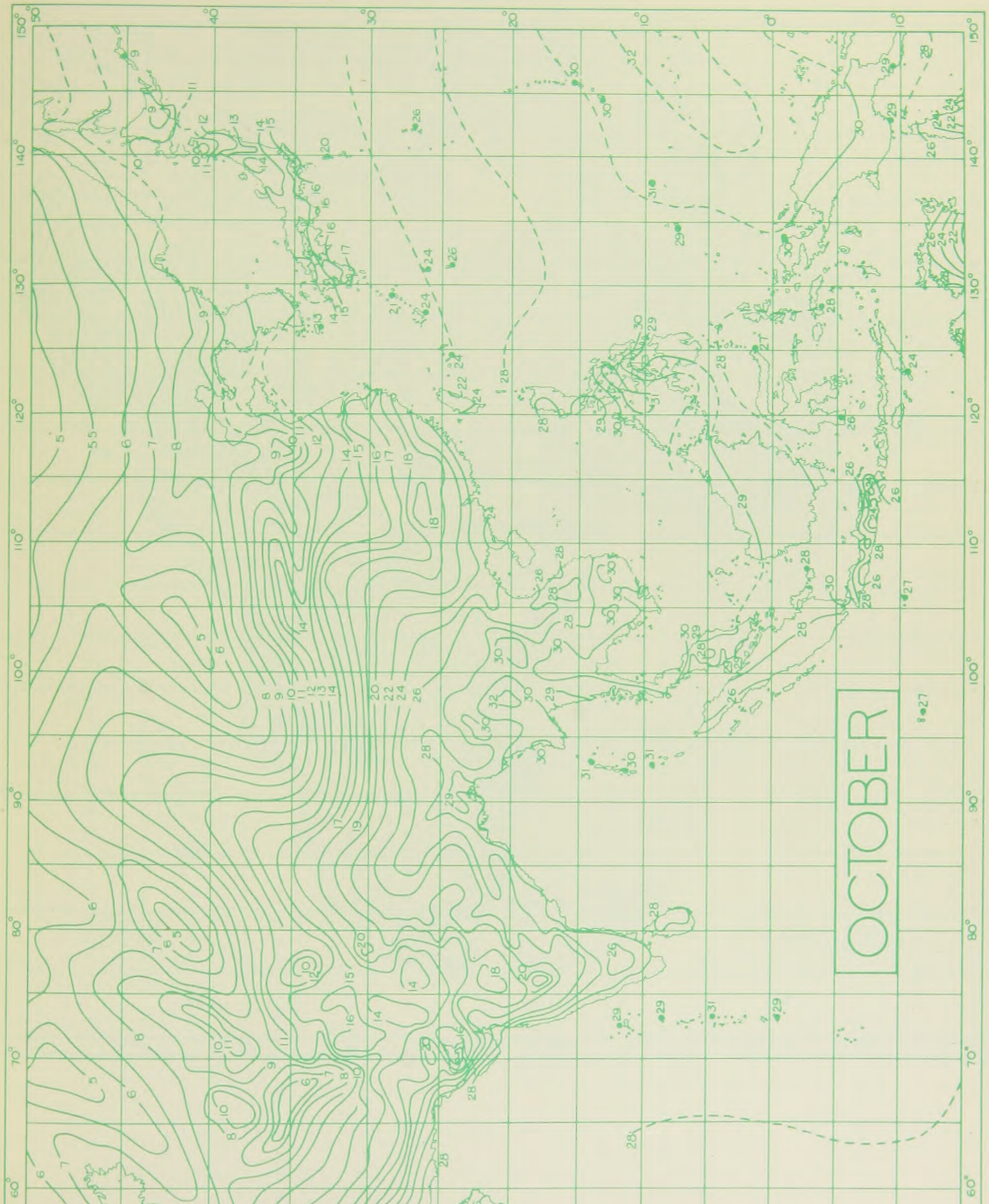
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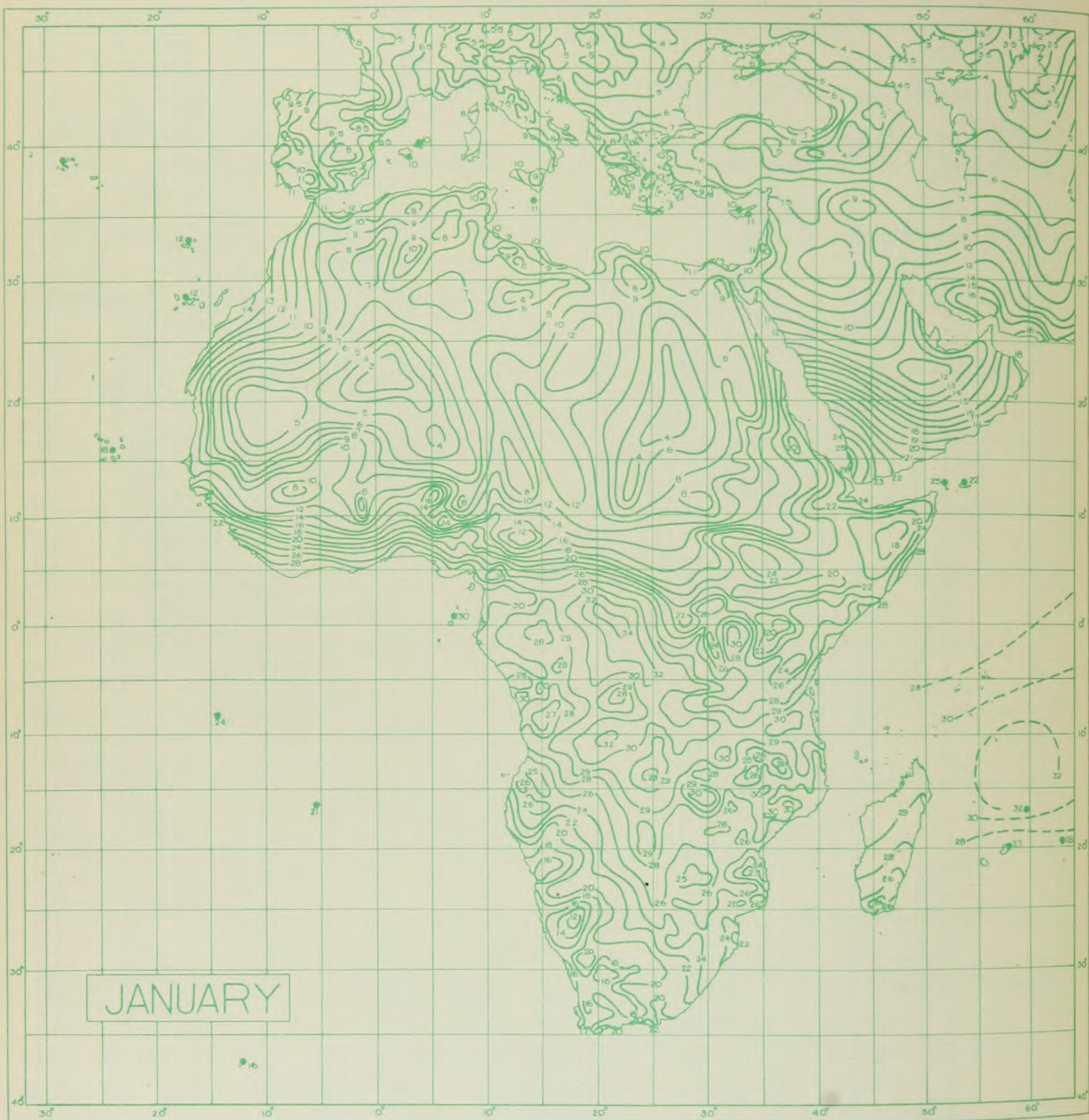
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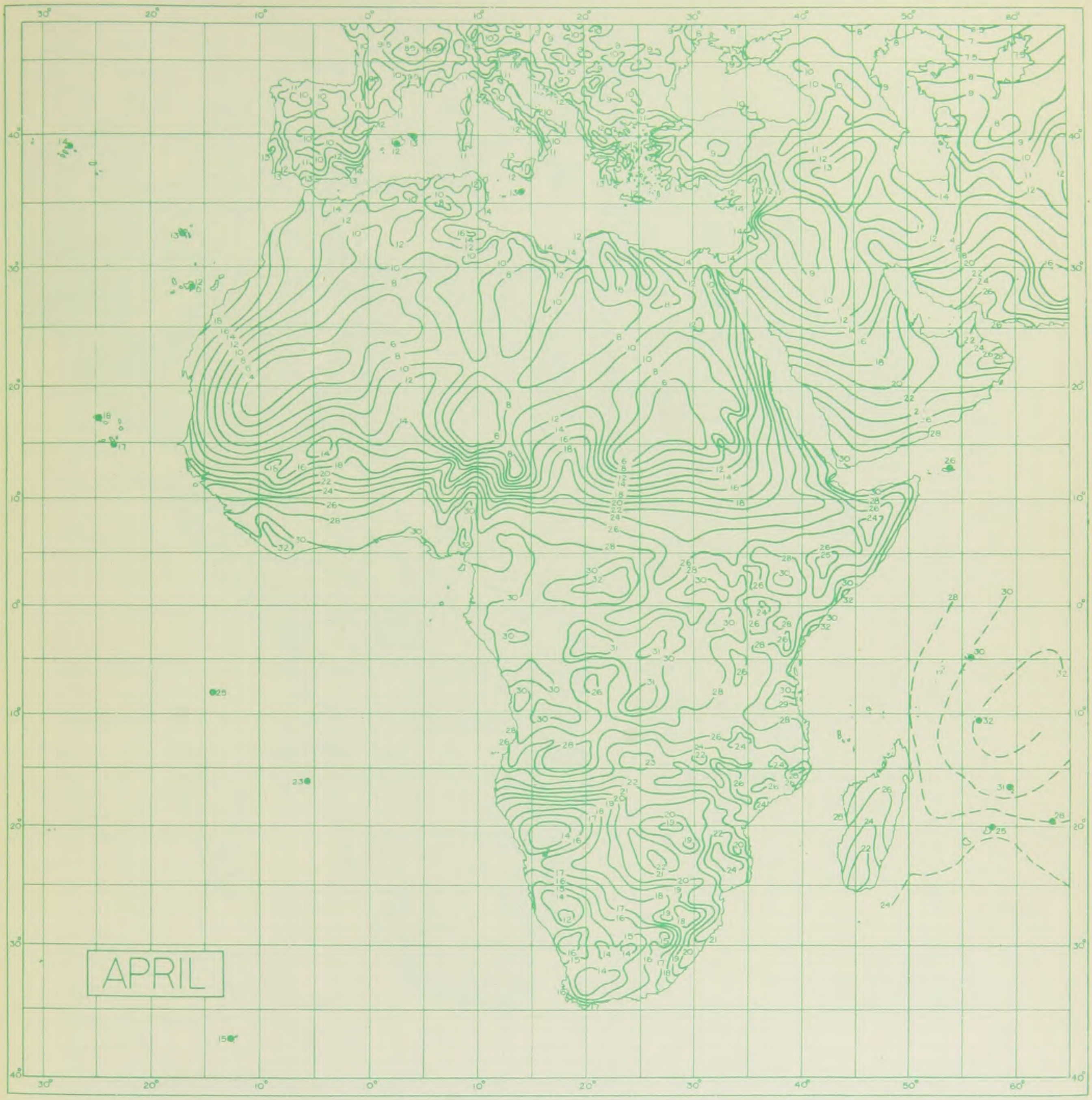
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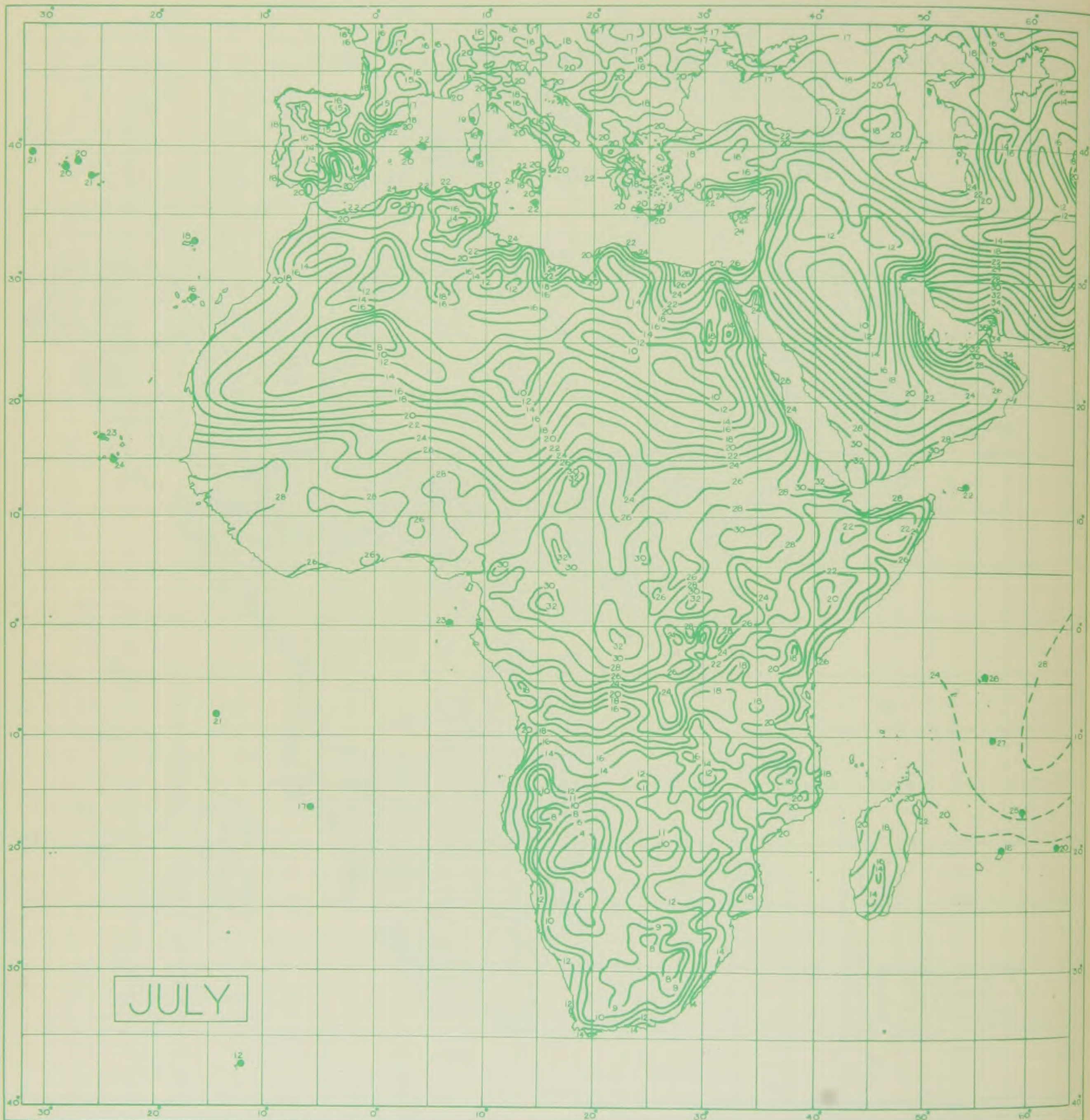
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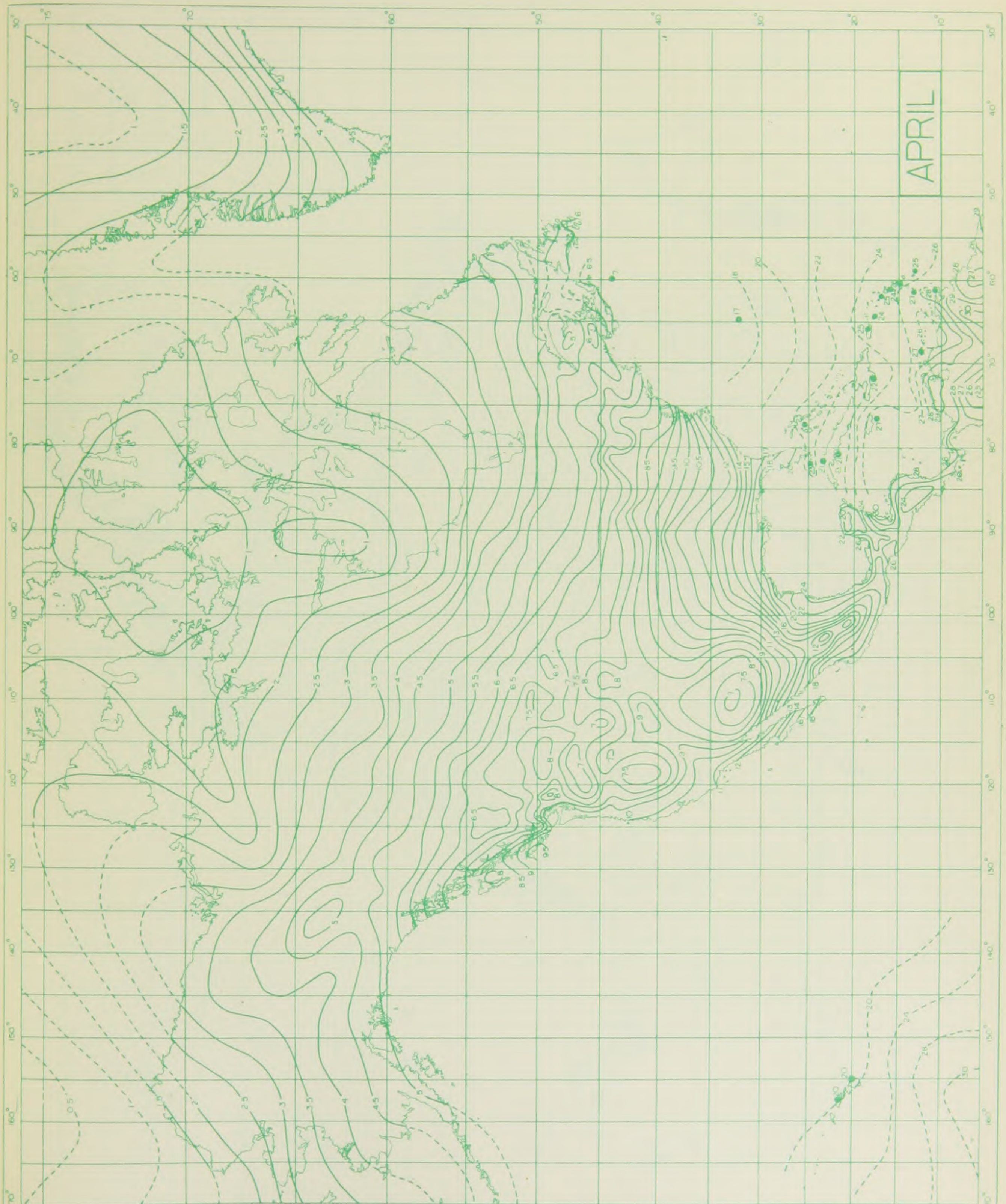
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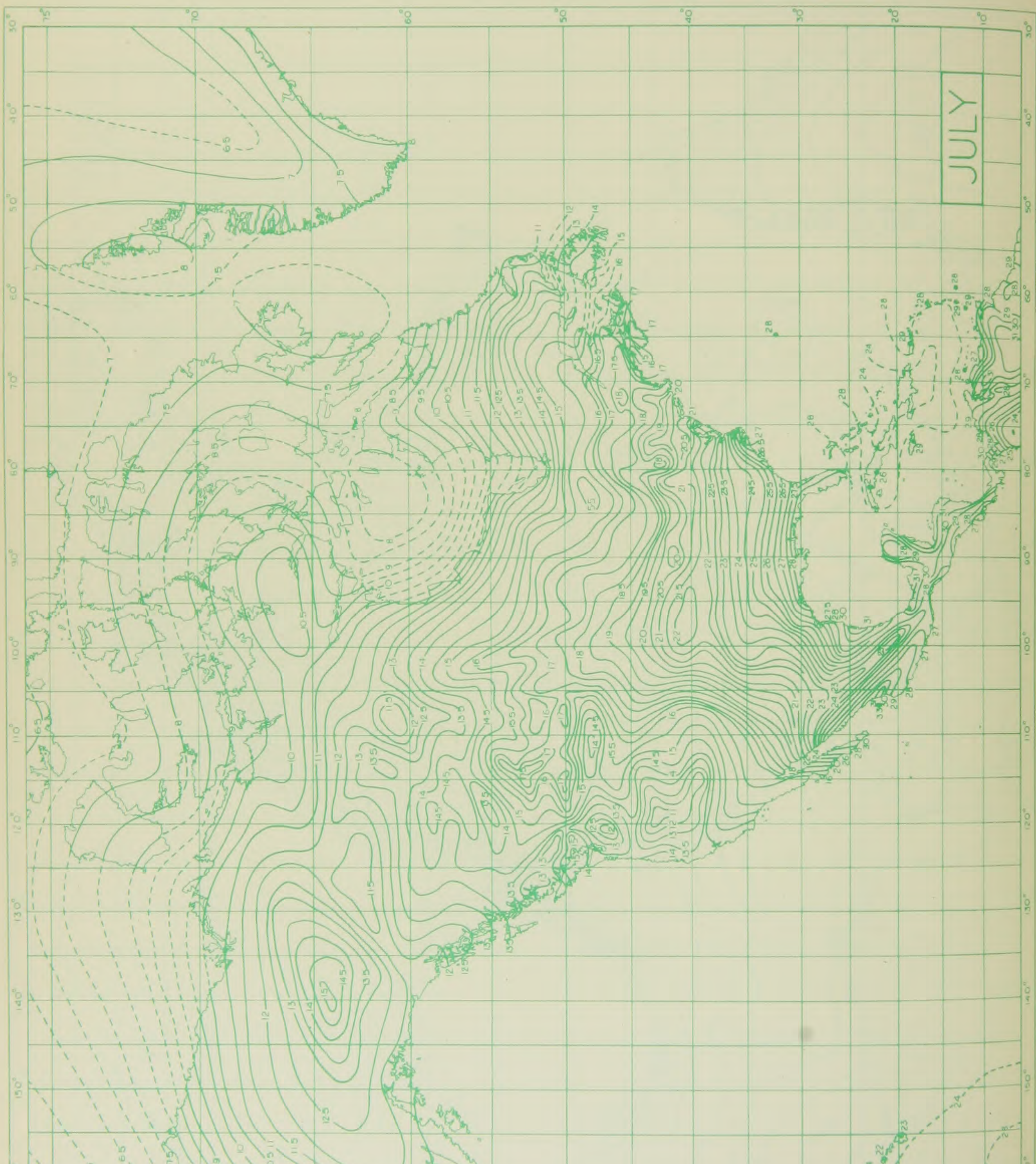
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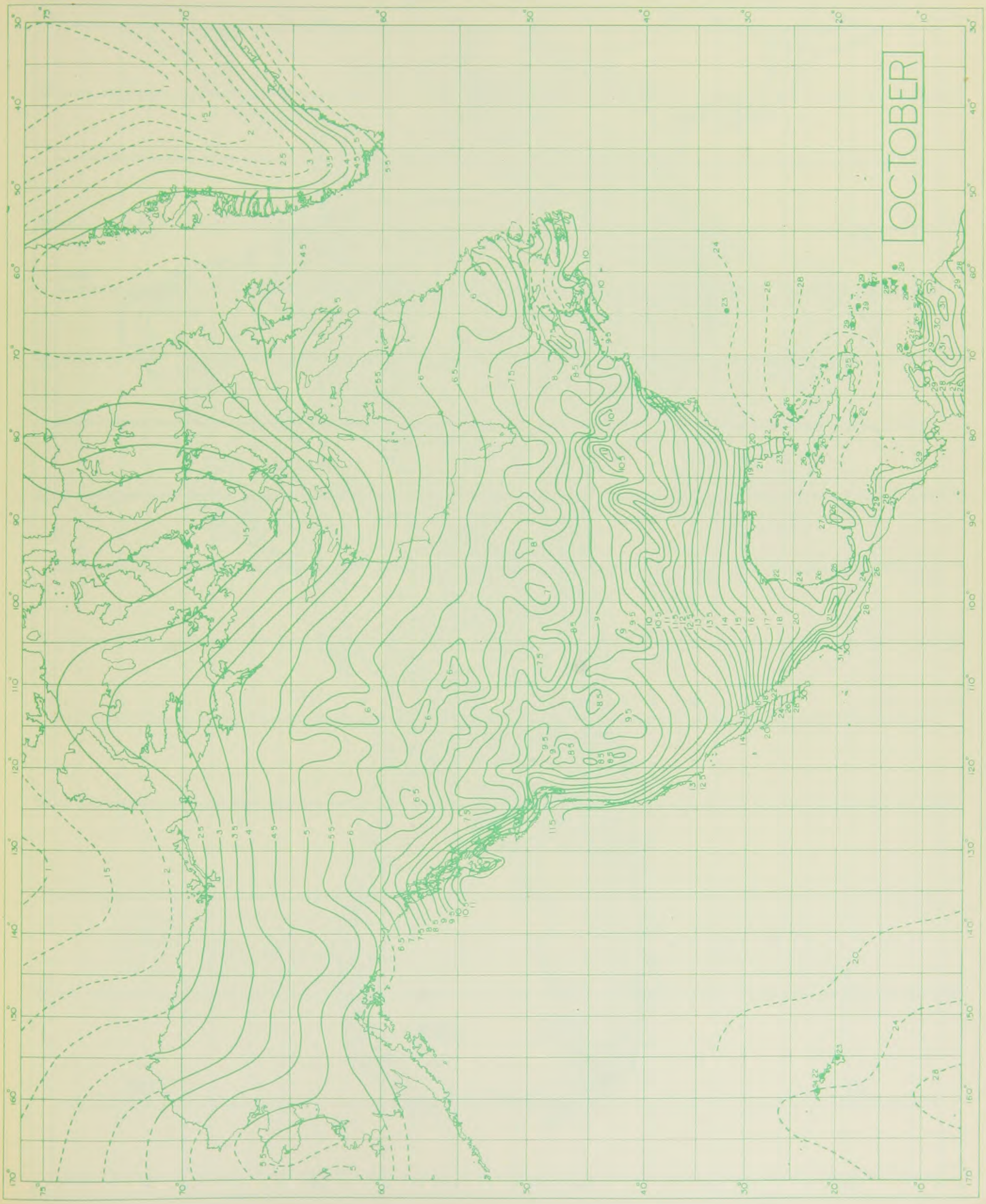
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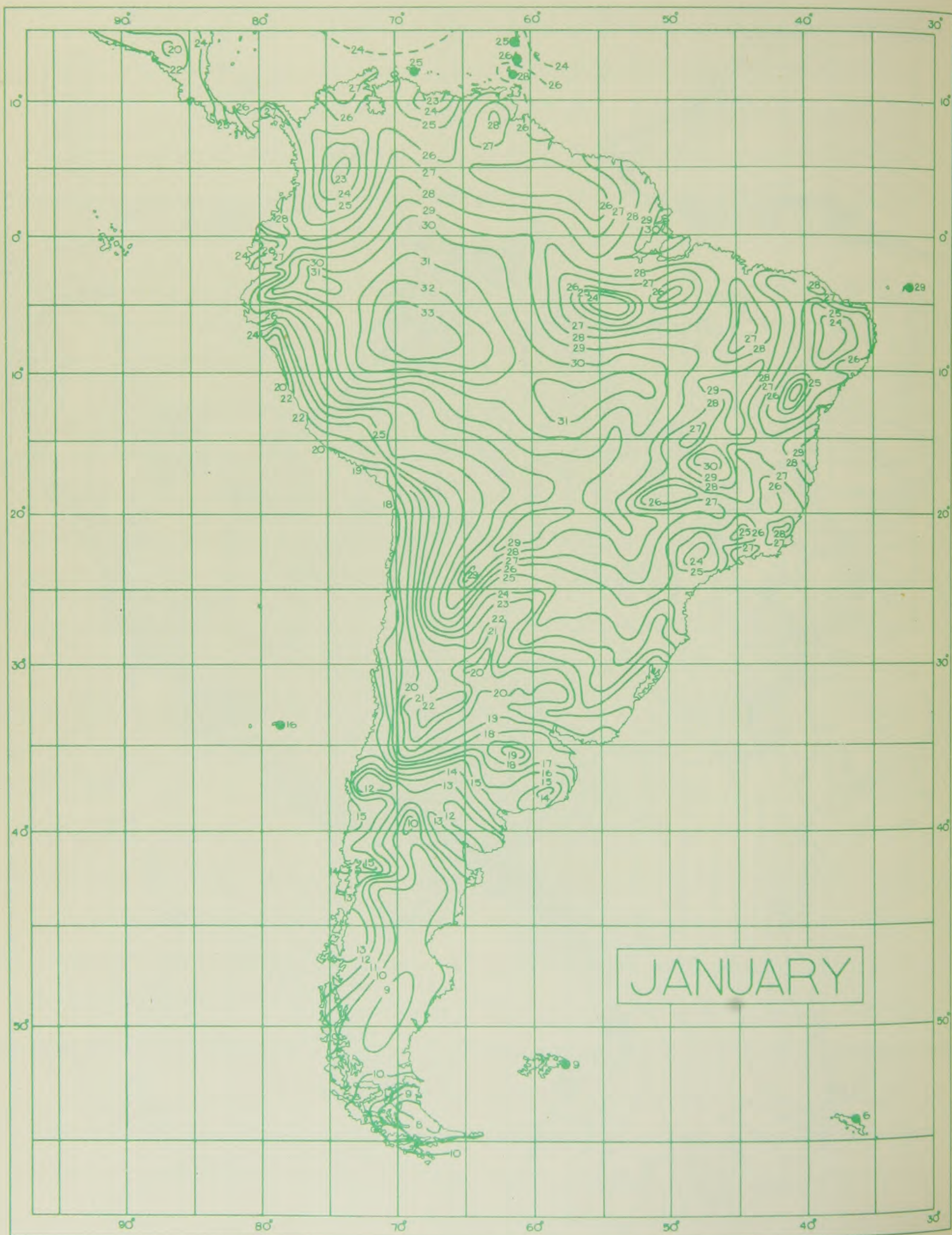
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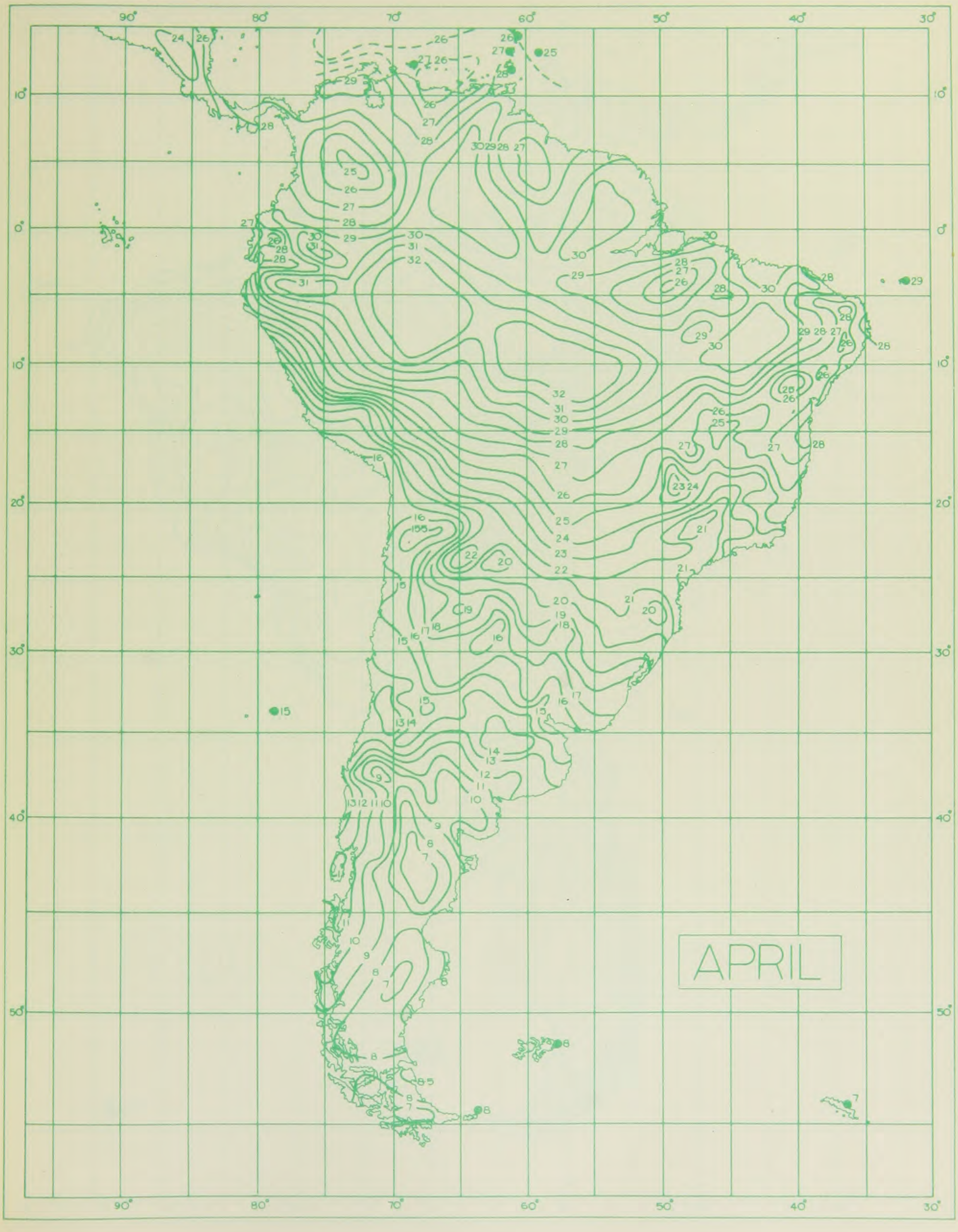
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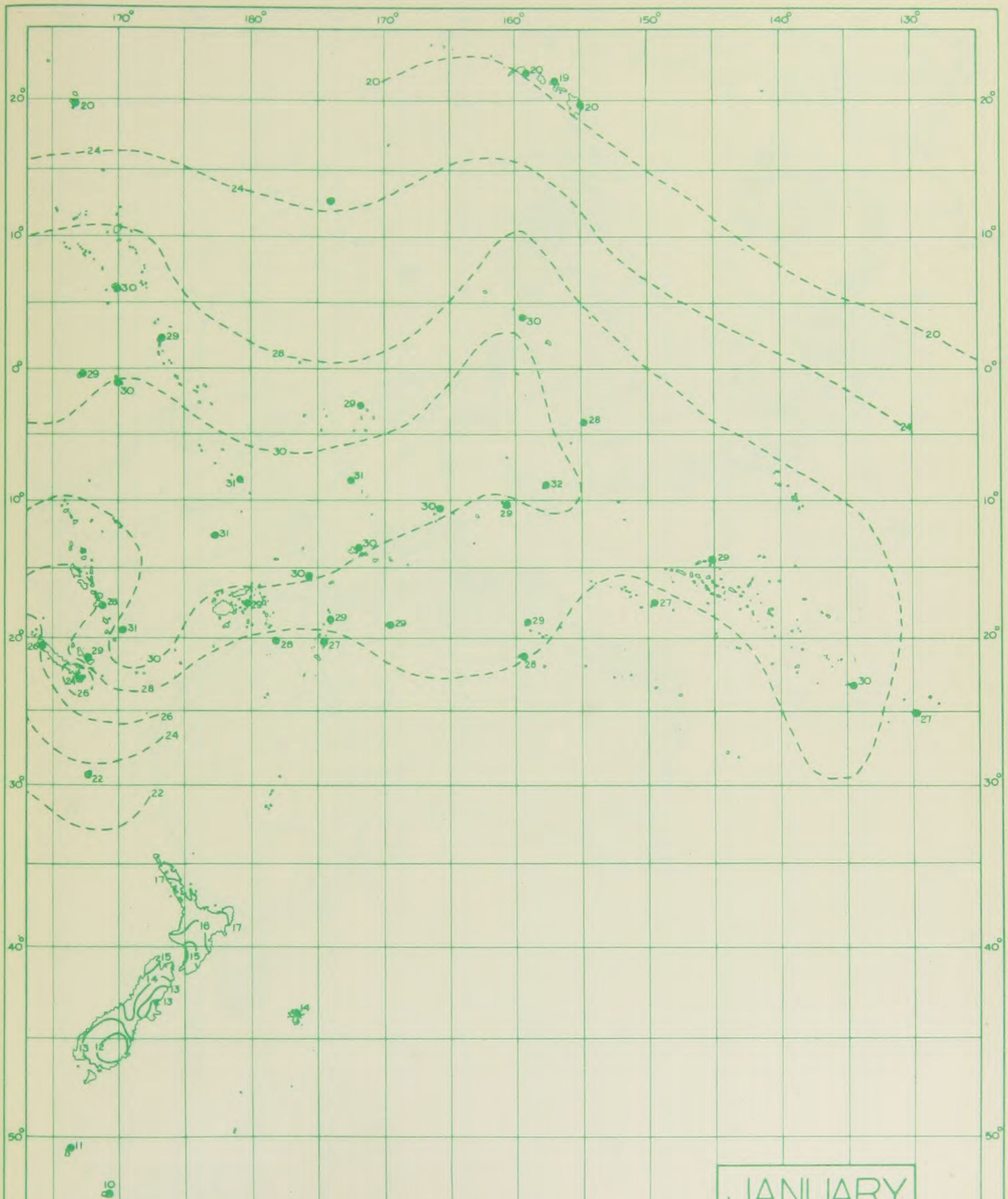
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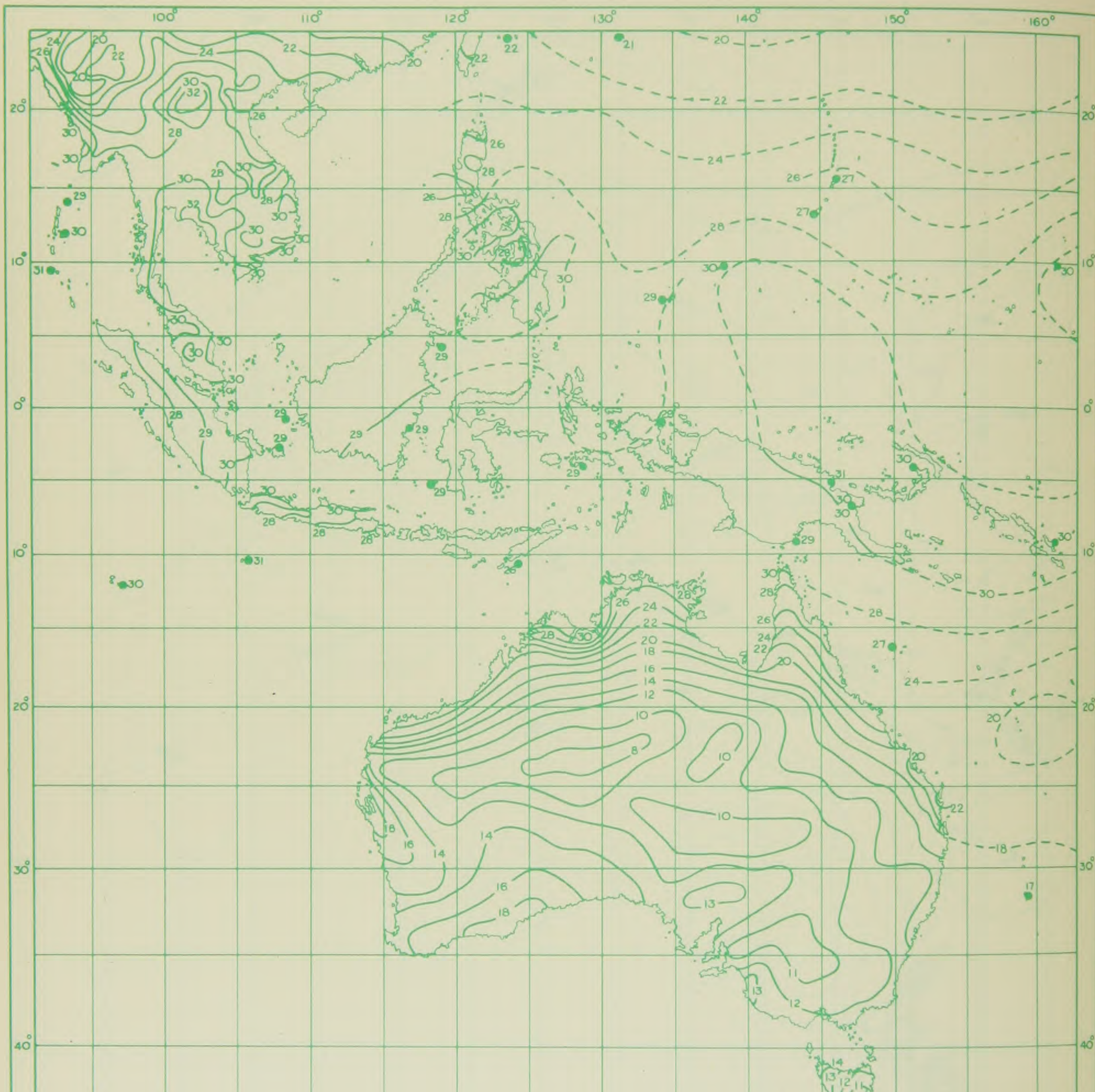
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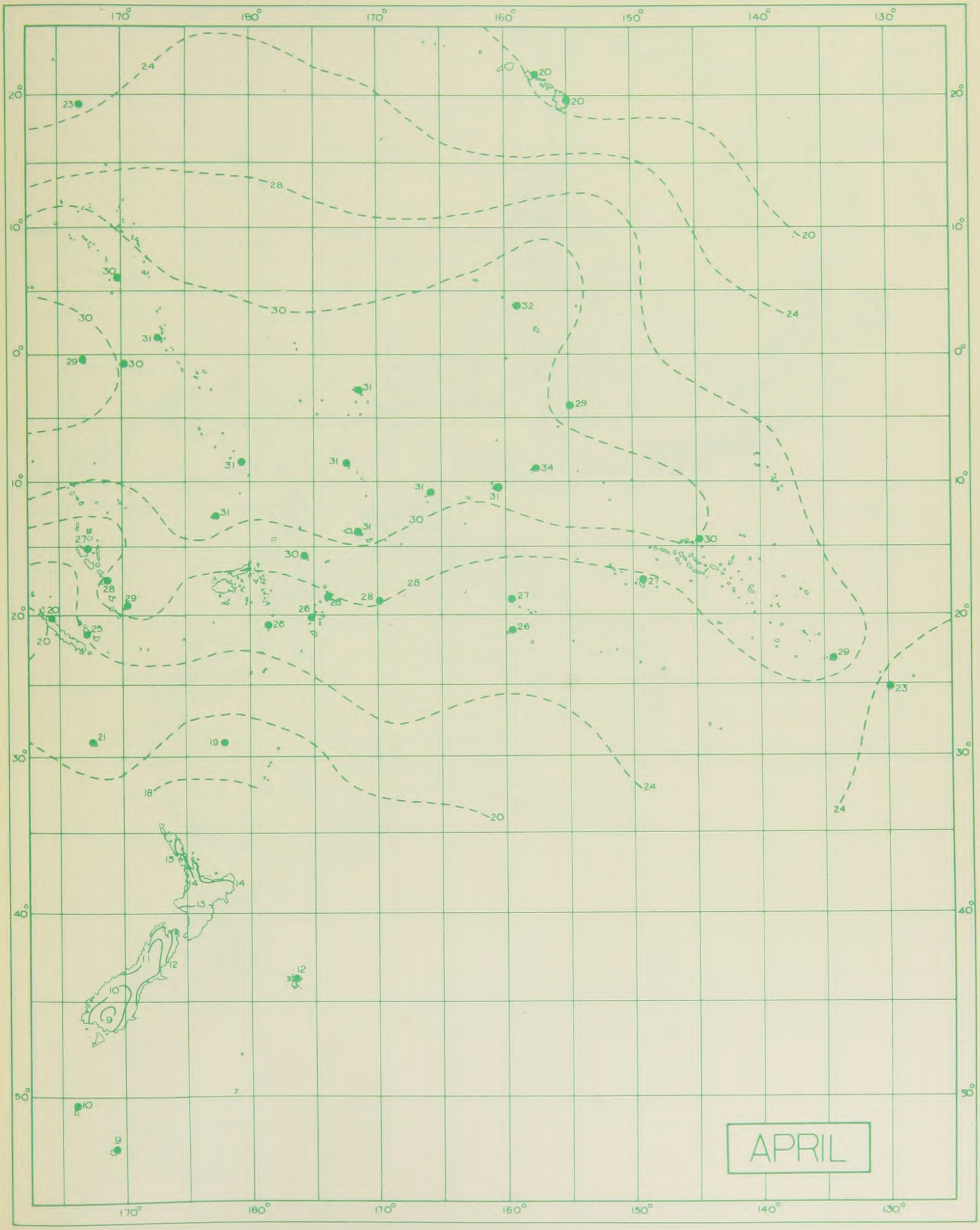
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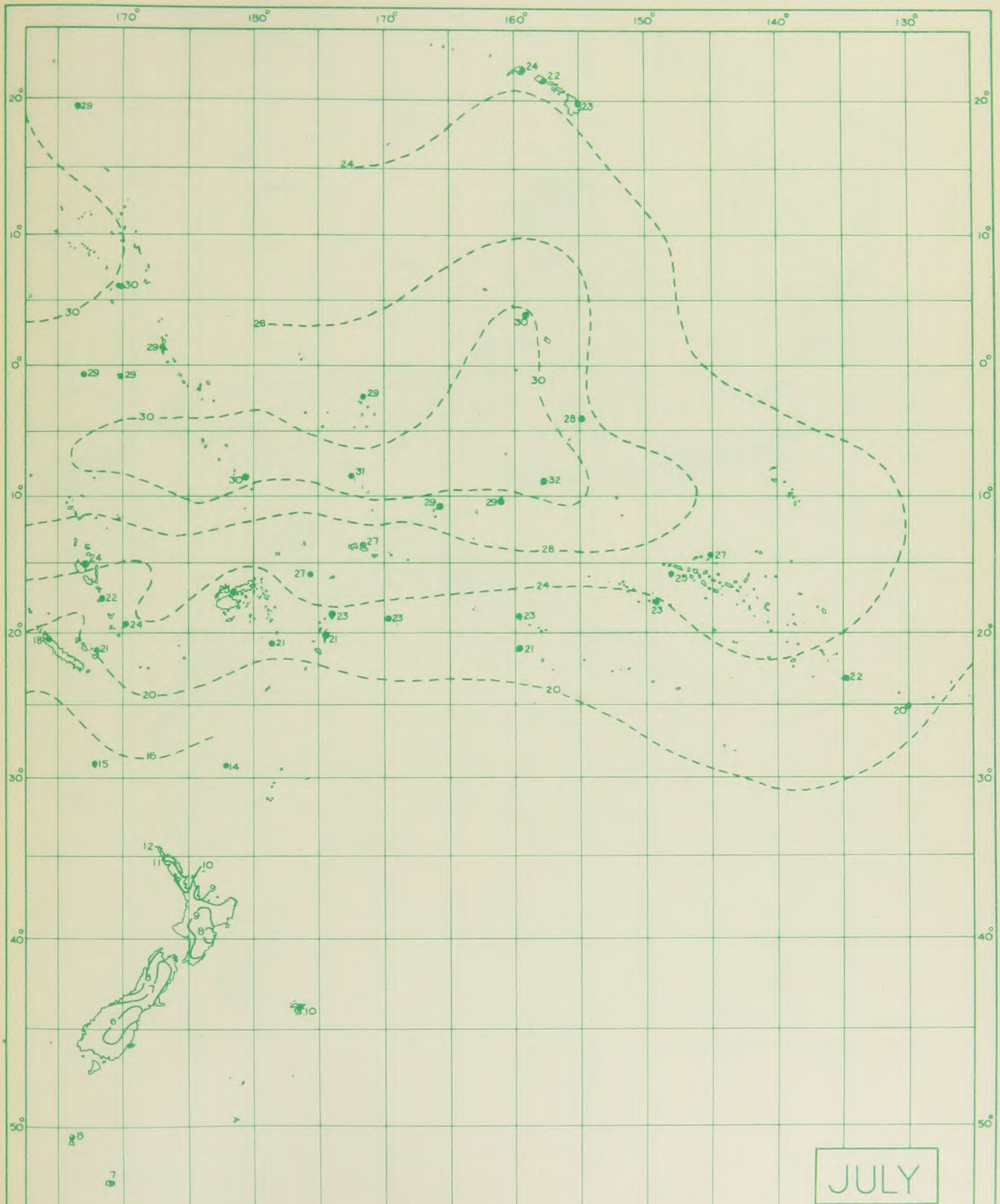
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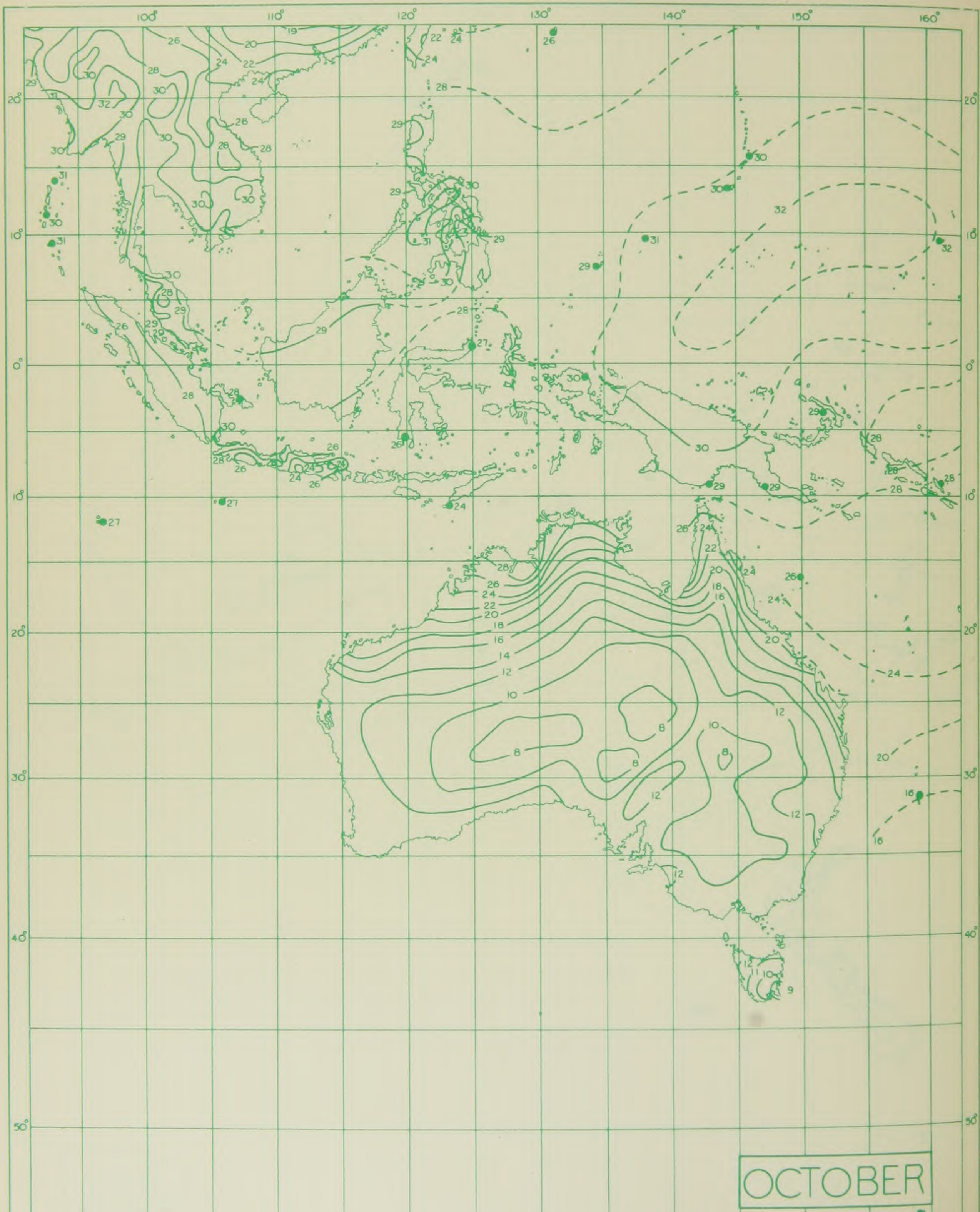
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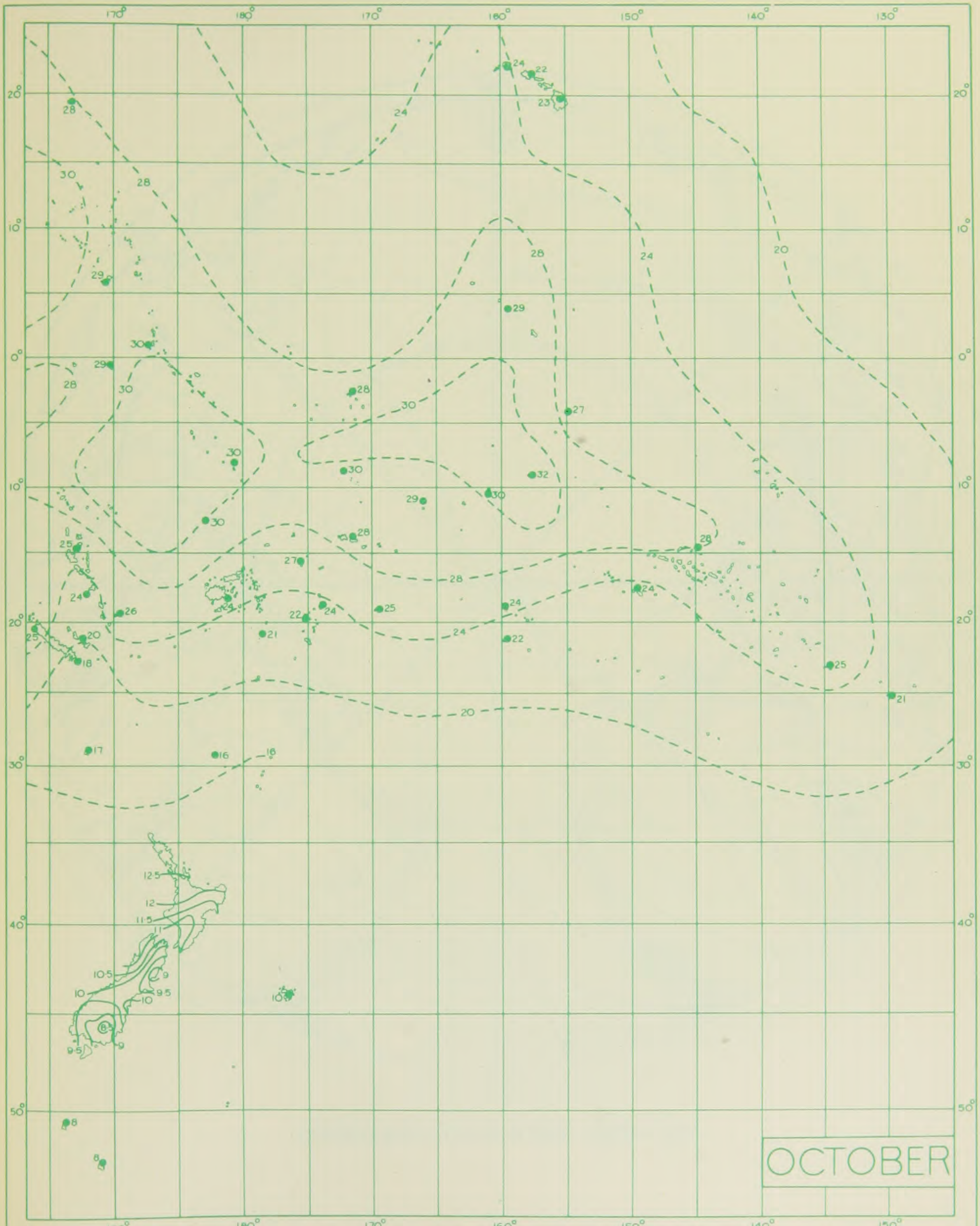
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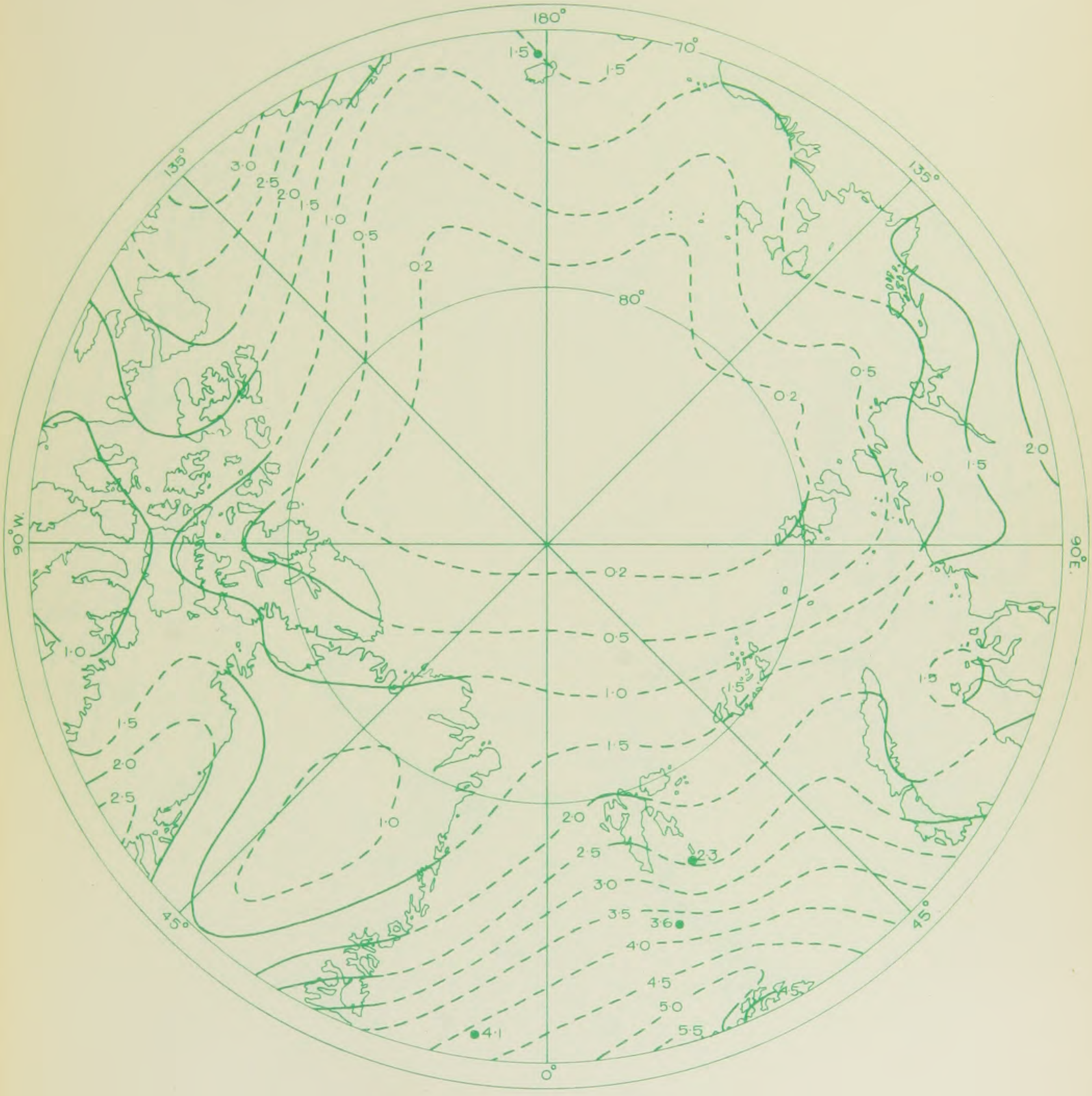

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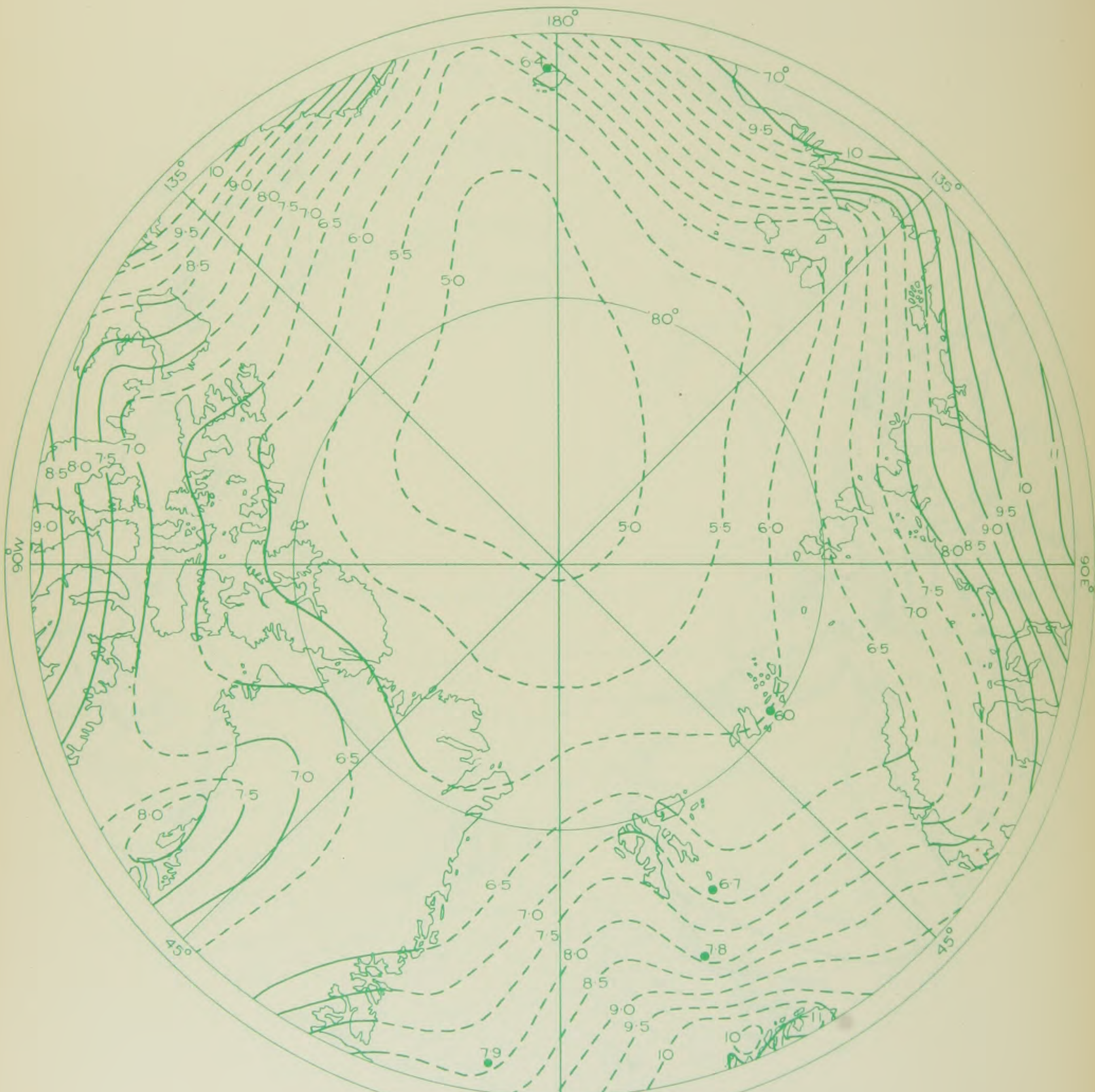

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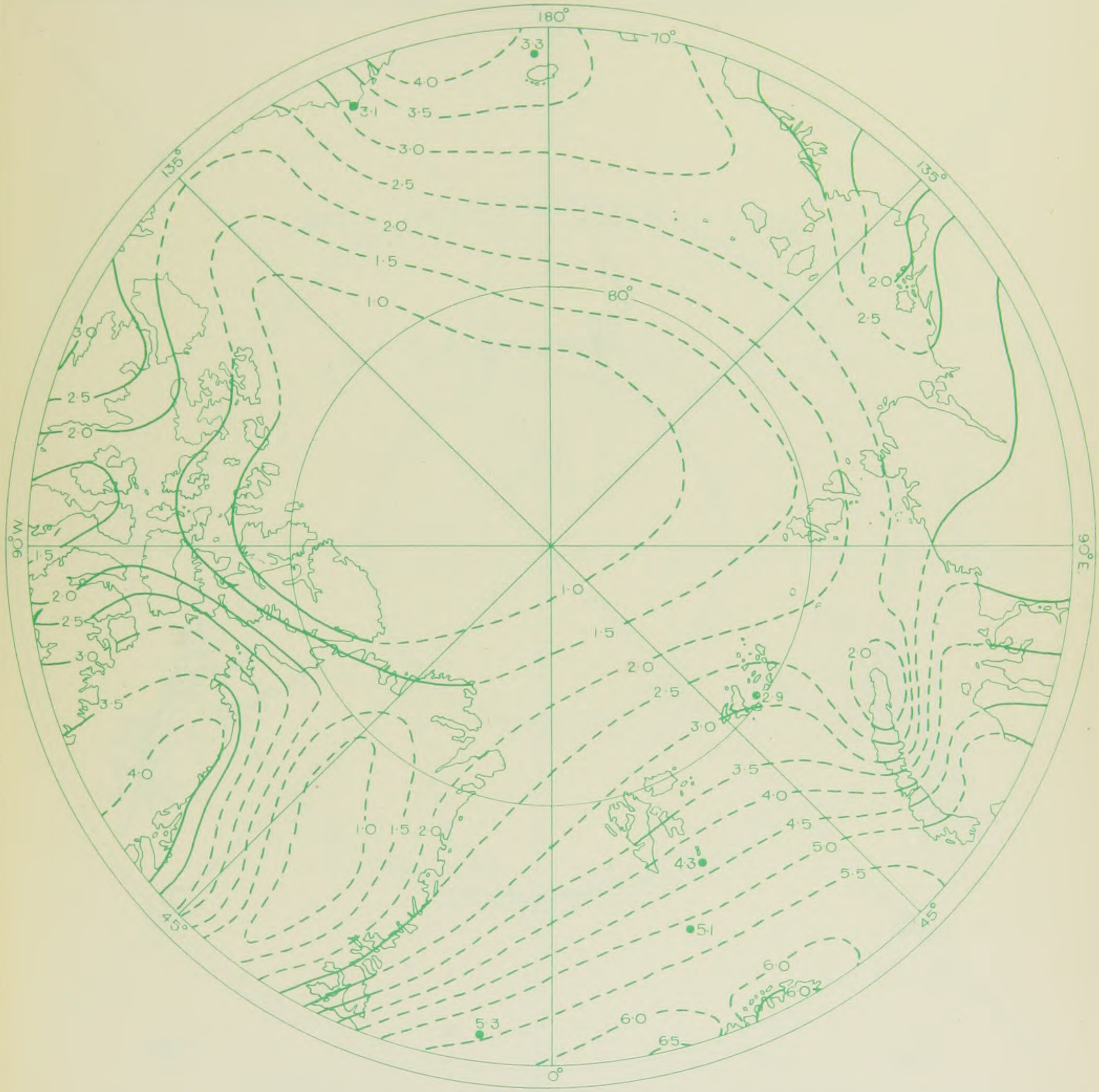
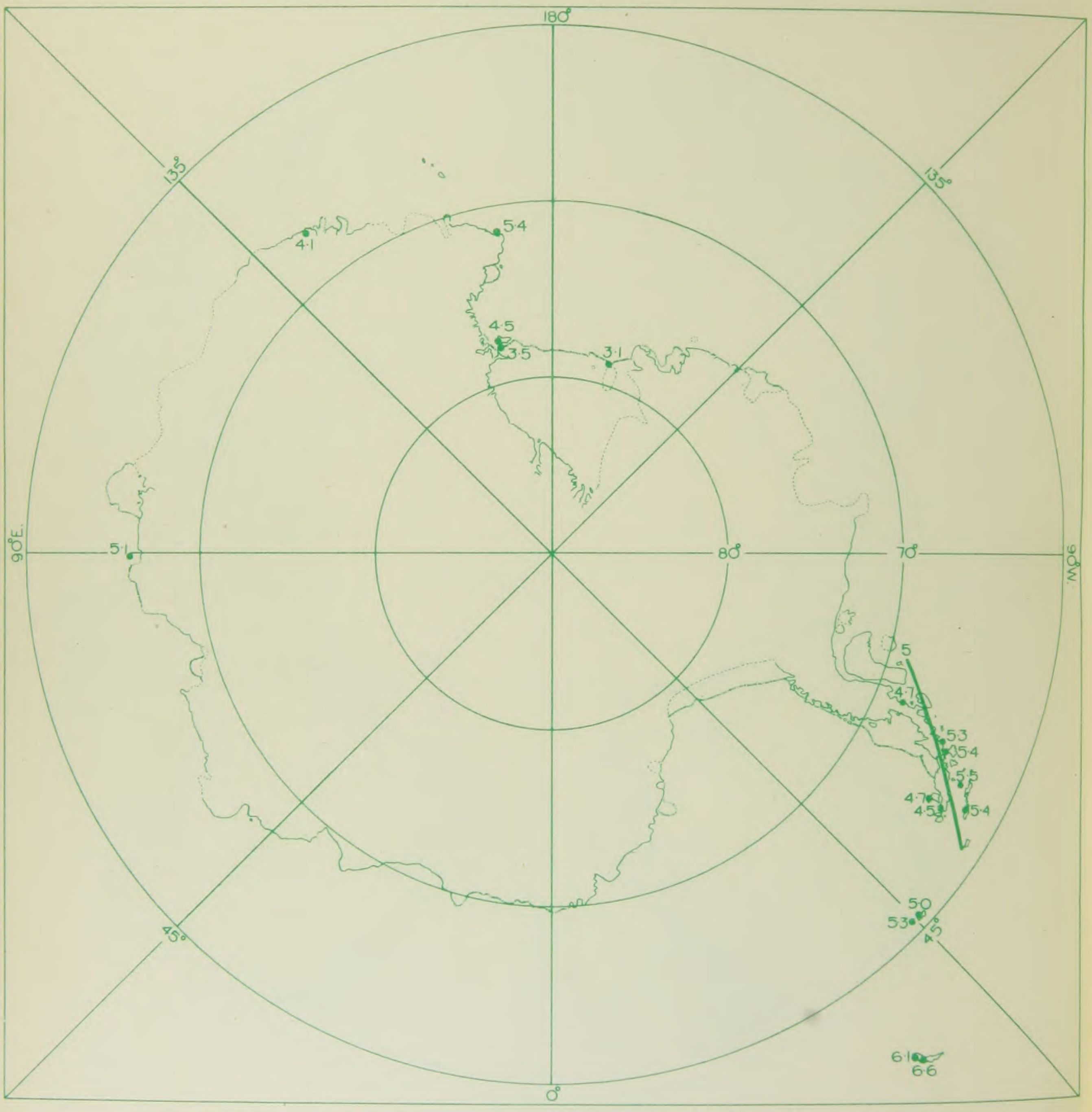


THE ARCTIC, NORTH OF 70°N., FOR OCTOBER



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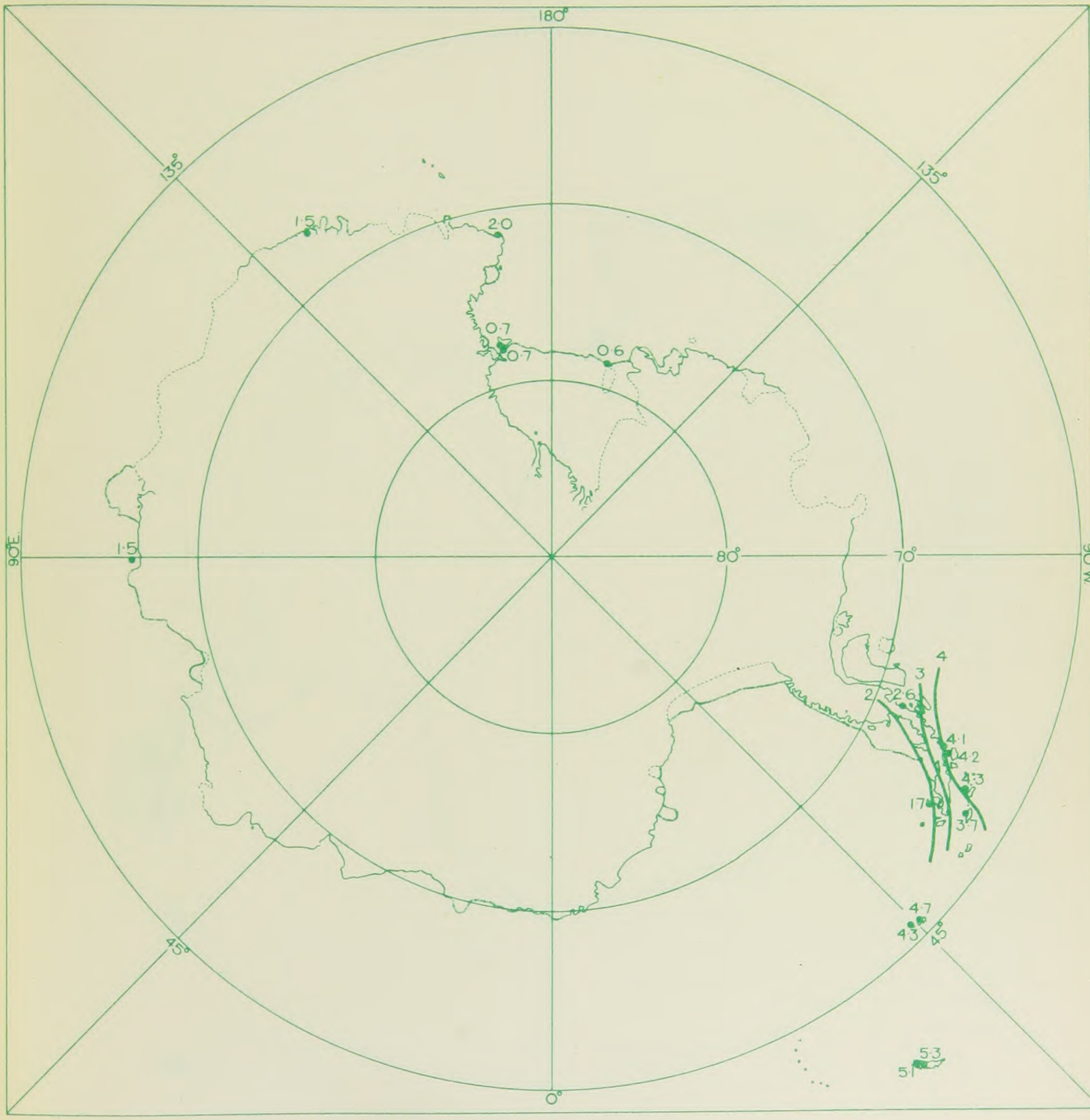

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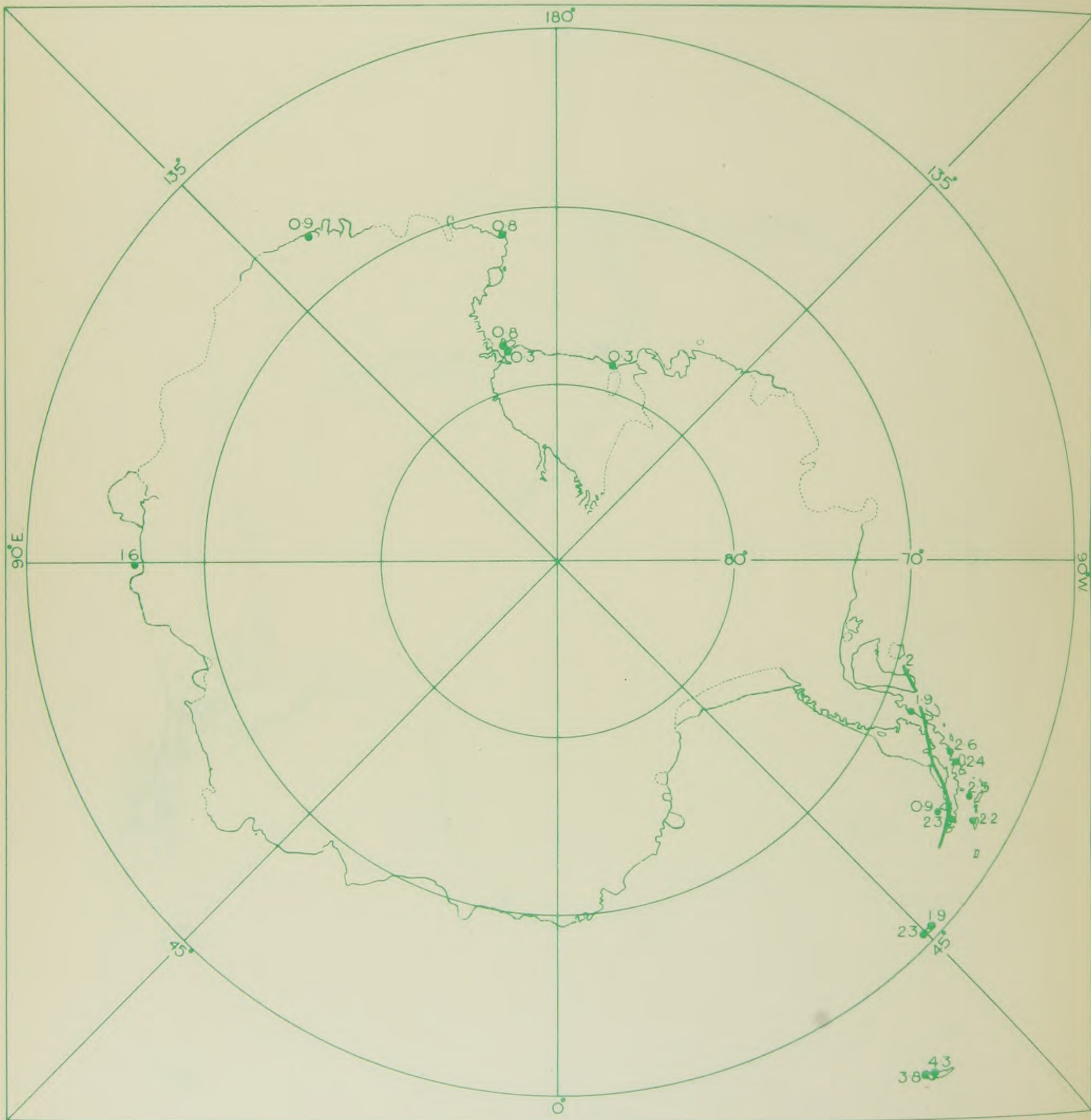

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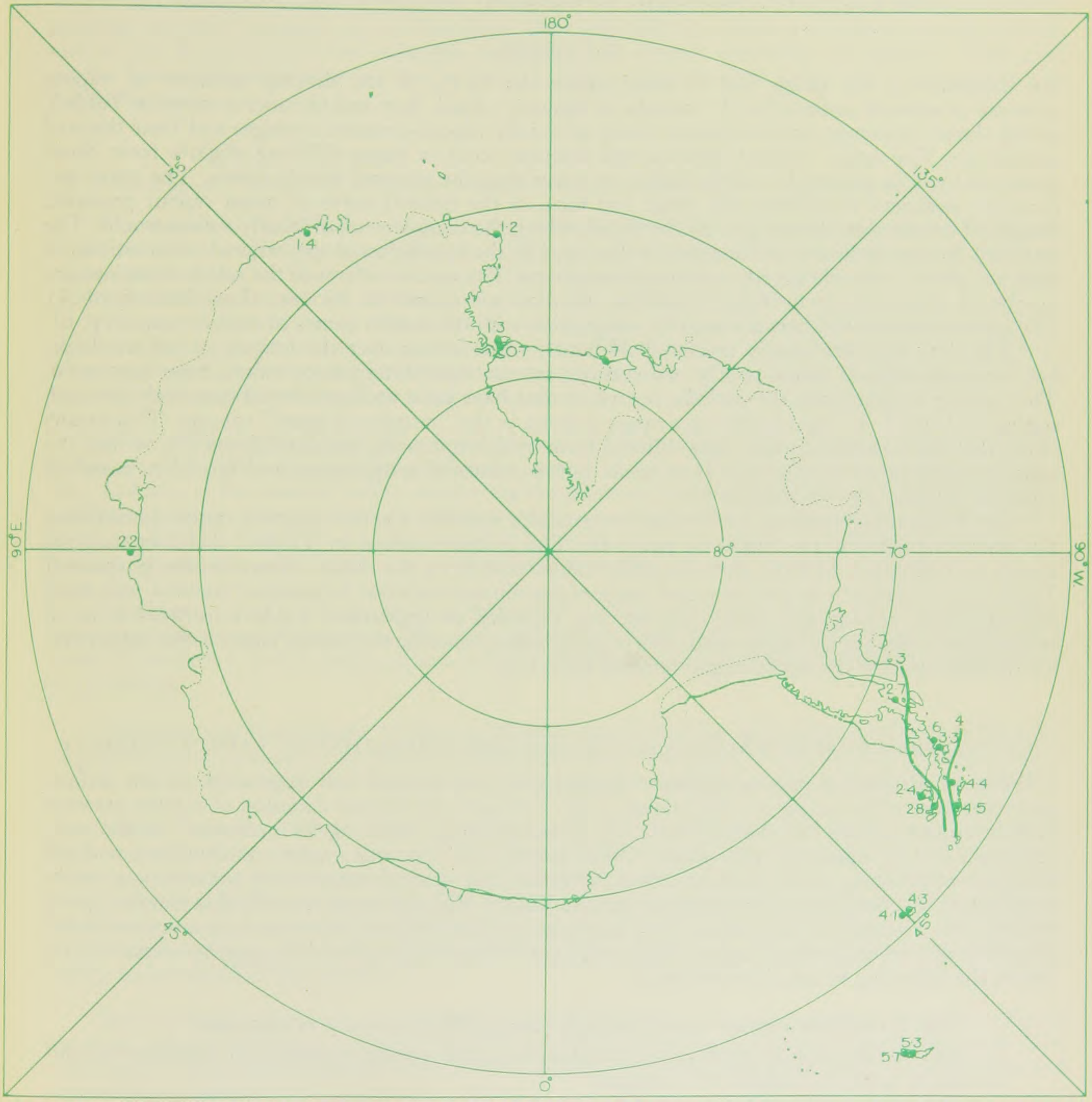

THE ANTARCTIC, SOUTH OF 60°S., FOR OCTOBER

PART II—THE DIURNAL VARIATION OF VAPOUR PRESSURE

§ 5—DATA

An indication of the range, and to some extent the form, of the diurnal variation of vapour pressure at selected stations for the months of January, April, July and October is given in Table I, which shows maximum and minimum values of hourly vapour-pressure averages and their times of occurrence. The actual diurnal maxima and minima occur at times differing slightly from those given, and will in general be a little higher or lower than the extreme hourly values. The latter are, however, sufficient to indicate the range and form of the diurnal curve of mean vapour pressure, though of course they do not give all the details which the complete set of hourly values would. The standard of time indicated in the table is that used in the tabulation of the original observations; it does not always coincide exactly with local mean time. For ease of reference the selected stations are numbered consecutively in Table I and the numbers are quoted in the text, thus, Gaasefjord (1). The same reference numbers are used in conjunction with the station names in the key map on p. 61.

The data used are mostly means of 24-hourly observations over the longest period available, but for some stations where hourly observations are not made interpolated values have been used. The number of years, and the periods, for which data have been used are shown separately for each station in Table I. In some instances a range is given in the "number of years" column. This means either that the number of years' data differed from month to month, e.g. Jan Mayen (2), or that the vapour pressures were computed from mean hourly values of temperature and humidity based on different periods, e.g. Trondheim (4).

For a number of stations hourly data are available only for a period which is much shorter than that used in preparing the charts on pp. 6-49. The extreme values in Table I therefore may not always be consistent with the mean monthly values read from the charts. However, the purpose of Table I is to indicate only the form and range of the diurnal variation for selected stations, and small inconsistencies arising on this account are not regarded as important. Table I includes a list of authorities for the hourly values used; this is partly taken from the very much larger list of authorities for the data used in the world maps, referred to in § 4.

§ 6—GENERAL CHARACTERISTICS OF THE DIURNAL VARIATION OF VAPOUR PRESSURE

When an adequate supply of moisture is available from the soil and vegetation, or sea surface, and when convective transport of moisture is not excessive the diurnal variation of vapour pressure follows approximately the diurnal variation of temperature, attaining its maximum in the early afternoon and its minimum near dawn. Other factors, such as evaporation, condensation and soil transport of moisture at the earth's surface, advection, the vertical transport of water vapour in the atmosphere by convection and diffusion, and the history of the air mass, modify this simple type of variation to a greater or less degree. For example, at most stations where surface moisture is not abundant and where vertical transport processes are well developed, the daily vapour-pressure cycle shows the following broad characteristics:

(i) A rise after sunrise when dew and, later, soil moisture are evaporated.

(ii) A fall towards midday, due to either excessive vertical transport of moisture by convection or a fall in available soil moisture.

(iii) A rise towards sunset associated with the decrease of convection.

(iv) A slow decrease to dawn caused by the downward transport and deposition of moisture, associated with the nocturnal cooling of the lower layers of the atmosphere.

At most places, however, considerable variations from these simple types are produced, in the mean, by local advective factors such as sea-breezes and nocturnal winds. On individual days, of course, variations are caused by precipitation, cloud and sunshine, by air-mass changes associated with frontal passages, and by subsidence. There are, in Table I, several examples of characteristics peculiar to certain stations, e.g. at Hamilton, Bermuda (25) the evening maximum at all seasons, and at San Francisco (23) the midnight maximum and midday minimum in October. These and similar special characteristics are due to local or regional factors with which this brief summary is not concerned.

§ 7—DIURNAL VARIATION OF VAPOUR PRESSURE ASSOCIATED WITH CLIMATIC TYPES

The stations in Table I have been chosen as far as possible to represent the main climatic types of the well-known classification of Köppen. There are, however, not enough data to cover the more remote parts of the world and the corresponding climatic types are not represented. An attempt has been made to give reasonable coverage for continental, coastal and oceanic areas.

The broad characteristics of the diurnal variation of vapour pressure associated with the principal climatic types are briefly discussed below, and illustrated by selected stations from Table I. These examples, however, do include characteristics peculiar to the station in question; and it is not in general possible to associate a particular curve with a particular climatic type.

Arctic climate. (Gaasefjord (1) and Jan Mayen (2).) Gaasefjord, effectively a continental station, shows extremely low values of vapour pressure, except in July. The daily range is small in April and July, and zero at the onset of winter and during the polar night (October and January). At Jan Mayen, a maritime station, though absolute values are somewhat higher than at Gaasefjord the range is still quite small. The times of maximum and minimum, about midnight and 1800 respectively for January (during the polar night) are curiously different from those for the other months.

Continental (extra-tropical) climate. (Irkutsk (9).) The range is less than 1 mb., and the absolute values are low, except in summer. The early maxima in April, July and October reflect perhaps the onset of convection and depletion of soil moisture during the forenoon. The minima occur near dawn at all seasons.

Temperate maritime climate. (Valentia (10) and Kew (11).) The daily range is small at all seasons, its greatest value, in summer, being only a little more than 1 mb. Apart from the early evening maxima in July and October, at Kew the diurnal variation appears to follow closely that of the temperature.

Tropical maritime climate. (Hamilton (Bermuda) (25), St. Helena (47) and Mauritius (49).) The daily range is of the order 1 to 2 mb. Hamilton (Bermuda) and Mauritius show a marked annual variation, reflecting the seasonal changes in air trajectory and underlying sea temperatures associated with the trade winds in winter and spring, and the proximity of the doldrum belt to these stations in summer and early autumn. At St. Helena the vapour-pressure values at all seasons are characteristic of the trade winds, a reflection of the fact that in the Atlantic the intertropical convergence zone rarely moves south of the equator.

Desert climate. (Tamanrasset (30) and Alice Springs (51).) The diurnal range is small, except in summer, when it amounts to about 3 mb. The decrease from the early forenoon maximum at Alice Springs, except in July, probably reflects the depletion of surface moisture (dew) by evaporation and convective transport.

Monsoon climate. (Hong Kong (31) and Bombay (33).) The marked feature is the large annual variation; by comparison the daily variation is, on the whole, small and calls for no comment.

Equatorial continental climate. (Stanleyville (40).) The uniformly high values throughout the year and the comparatively large diurnal variation, reflect the intense solar heating of the ground, coupled with abundant surface moisture.

Equatorial maritime climate. (Djakarta (43).) The daily variation, smaller than at Stanleyville, is clearly associated with the smaller variation of temperature due to the greater cloudiness at an equatorial island as compared with an inland situation.

ACKNOWLEDGEMENT

Grateful acknowledgement is made to the many overseas meteorological services who have provided the basic data by exchange of publications or in response to special requests.

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TABLE I—ANALYSIS OF AVERAGES OF HOURLY OBSERVATIONS OF STATION LEVEL VAPOUR PRESSURE (MB.) FOR A SELECTION OF METEOROLOGICAL STATIONS DISTRIBUTED OVER THE WORLD

Station	Position: Latitude	Position: Longitude	Position: Height	Month	Highest: Value	Highest: Hour	Lowest: Value	Lowest: Hour	Standard of Time	Period of Years: No. of Years	Period of Years: Period	Authorities
	° ′	° ′	m.									
1. Gaasefjord*	76 40N.	88 38W.	5	January	0·2	0100–2400	0·2	0100–2400	L.M.T.	2	1900–1902	Mohn, H.; Report of the Second Norwegian Arctic Expedition in the *Fram*, 1898–1902. Kristiana, No. 4, 1907.
				April	0·9	1300–1500	0·6	0200–0500				
				July	6·6	1700–1900	6·3	0100–0300				
				October	1·2	0100–2400	1·2	0100–2400				
2. Jan Mayen	70 59N.	08 18W.	23	January	3·6	2300–0200	3·4	1700–1800	L.M.T.	4–9	1882–1883 1921–1933	Birkeland, B. J.; Mittel und Extreme der Feuchtigkeit in Norwegen, Geofysiske Publikasjoner av det Norske Videnskaps-Akademi. Oslo, 15, No. 1, 1944.
				April	3.9	1300–1600	3·7	0500–0900, 2100–0200				
				July	8·1	1600	7·4	0200–0300, 0600				
				October	5·2	1100–1300	4·9	0600–0800, 2000–0100				
3. Abisko	68 21N.	18 49E.	388	January	2·3	0100–2400	2·3	0100–2400	15°E.M.T.	4	1926–1929	Abisko, Naturveteuskapliga Station. *Obsns mét. Abisko,* 1926–29. Stockholm, 1928–30.
				April	3·7	1700	3·1	0200–0500				
				July	9·3	1500–1700, 2000–2100	8·9	0100–0300				
				October	4.4	1100–1300	4·1	1700–0800				
4. Trondheim*	63 26N.	10 25E.	58	January	3·7	1100–1900	3·6	2000–1000	L.M.T.	11–35	1896–1940	Birkeland, B. J.; Mittel und Extreme der Lufttemperatur, Geofyskiske Publikasjoner au det Norske Videnskaps-Akademi. Oslo, 14, No. 1, 1936. Birkeland, B. J.; Mittel und Extreme der Feuchtigkeit in Norwegen, Geofyskiske Publikasjoner av det Norske Videnskaps-Akademi. Oslo, 15, No. 1, 1944.
				April	6.1	1200–1400	4·9	0100–0500				
				July	12·9	1300	10.8	2400–0400				
				October	7·2	1100–1400	6·4	0600–0700				
5. Fort Rae	62 50N.	116 04W.	160	January	0·4	1200–1900	0·3	2000–1100	120°W.M.T.	1–2	1932–1933	London, British National Committee for the Polar Year. British Polar Expedition, Fort Rae, North-West Canada, 1932–33. London, Vols. 1 and 2, 1937.
				April	2·4	1600	1·5	0300–0500				
				July	12·9	2000	12·3	0200–0400				
				October	4·1	1000–1500, 1700	3.8	2200–2400				
6. Ilmala	60 12N.	24 56E.	2	January	3·8	1300	3·6	0700, 2100	L.M.T.‡	9–10	1915–1924	Helsinki, Meteorologischen Zentralanstalt. *Met. Jb., Helsingf.*, 15–24, 1923–28.
				April	5·9	1000	5·5	0400				
				July	14·3	0800	13·1	0300				
				October	8·2	1000	7·8	0700				
7. Moscow	55 50N.	37 33E.	167	January	3·2	1000–2200	3.1	2300–0900	30°E.M.T.	2–3	1935–1937	Moscow, Observatoire Actinométrique e Météorologique de Moscow. *Bull. Obs. actinomet. met., Moscow,* 1935–37
				April	6·7	2100–2400	6·3	1200, 1400				
				July	14·9	2200	14·0	1300, 1700				
				October	7·9	1000–1200, 1700–2000	6·7	0600–0700				
8. Potsdam	52 23N.	13 04E.	82	January	5·5	1400	5·2	0500–0600	L.M.T.	5	1934–1937, 1946	Berlin, Reichsamt für Wetterdienst. *Dtsch. met. Jb.*, 1934–37, 46. Berlin, Teil IV, Heft I, 1936–39, 48.
				April	8·6	0900	8.0	1600				
				July	15.3	0800	13·9	1700				
				October	9·8	1000	9·1	0600				

TABLE I—*cont.*

Station	Position: Latitude	Position: Longitude	Height	Month	Highest: Value	Highest: Hour	Lowest: Value	Lowest: Hour	Standard of Time	Period of Years: No. of Years	Period of Years: Period	Authorities
	° ′	° ′	m.									
9. Irkutsk	52 16N.	104 19E.	467	January	1·4	1400	0·9	0700	105°E.M.T.	30	1887–1916	Schostakovitch, W. B.; The Climate of Irkutsk, Results of Observations at the Irkutsk Magnetic and Meteorological Observatory 1887–1916. Irkutsk, 1920.
				April	3·9	0900	3·5	0500				
				July	14·7	1100	12·3	0300				
				October	5·0	1100	4·2	0600				
10. Valentia	51 56N.	10 15W.	9	January	9·1	1500	8.6	0800	G.M.T.	30	1901–1930	MS.
				April	11·6	1500, 1700	10.5	0500				
				July	14·9	1300	13·7	0400				
				October	12·4	1000–1100	11·8	0600, 0800				
11. Kew	51 28N.	00 19W.	5	January	7 1	1300–1600	6·6	0300–0800	G.M.T.	30	1886–1915	London, Meteorological Office. Averages of Humidity for the British Isles. London, 1938.
				April	8·4	1300, 1500	7·7	0300–0600				
				July	14·2	1900	13 1	0200, 0400				
				October	10·5	{1100–1300, 1500–1800}	9·6	0500–0700				
12. Burlington*	44 29N.	73 13W.	123	January	3·2	1600–2000	3·0	0200–1000	75°W.M.T.	5	1911–1916	Day, P. C.; Relative humidities and vapour pressures over the U.S., including a discussion of data from recording hair hygrometers. *Mon. Weath. Rev.*, *Washington*, Supplement No. 6, 1917.
				April	6·5	{0900–1200, 1600–1900}	6·0	0500–0600				
				July	16·1	{0900–1000, 1800–1900, 2200}	14·9	0400–0500				
				October	9·6	1200–1600	8·8	0200–0600				
13. Sapporo	43 04N.	141 21E.	17	January	3·4	1400–1500	3·0	0500	135°E.M.T.	10	1909–1918	Tokyo, Central Meteorological Observatory. *Bull. cent. met. Obs.*, *Tokyo*, **4**, Pt. 3, 1931.
				April	6·6	1300	5·7	0500				
				July	19·2	1300	16·8	0400				
				October	10·5	1600–1700	8·8	0600				
14. Yûki*	42 20N.	130 21E.	64	January	1·9	1400–1900	1·5	0500–0900	135°E.M.T.	10	1926–1935	Zinsen, Weather Bureau of Tyosen. Results of Meteorological Observations in Tyosen for the Lustrum 1926–35. Zinsen, 1931, 36.
				April	5·3	1200–1600	4·8	0400–0500				
				July	19·7	1200–1300	18.3	0400–0600				
				October	8·4	1700–1900	7·1	0400–0600				
15. Chicago*	41 53N.	87 37W.	251	January	4·3	1600–1900	3·8	0200–0400	90°W.M.T.	5	1911–1916	Day, P. C.; Relative humidities and vapour pressures over the U.S., including a discussion of data from recording hair hygrometers. *Mon. Weath. Rev.*, *Washington*, Supplement No. 6, 1917.
				April	8·6	1500–1900	7·9	0500–0600				
				July	19·4	1900–2000	17·9	0600				
				October	11.5	1700–1900	10·4	0500–0600				
16. Gaia	41 08N.	08 36W.	100	January	10·1	1700–1800	8·9	0700	G.M.T.	10	1935–1944	Gaia, Observatorio da Serra do Pilar. Boletins Mensais e Resumo Anual 1935–44. Gaia, 1936–45.
				April	12·1	2100–2200	10·2	0600				
				July	17·5	1200	15·2	0600				
				October	14·0	{1500–1600, 1800}	11·9	0700				
17. Tyûkôtin*	41 47N.	126 53E.	312	January	1·5	1300–1500	0·8	0300–0400	135°E.M.T.	10	1926–1935	Zinsen, Weather Bureau of Tyosen. Results of Meteorological Observations in Tyosen for the Lustrum 1926–35. Zinsen, 1931, 36.
				April	5·7	2100–2300	5·4	1600				
				July	22·8	1700–1900	20·6	0500				
				October	7·5	1800–1900	6·4	0600				

TABLE I—*cont.*

Station	Position: Latitude	Position: Longitude	Position: Height	Month	Highest: Value	Highest: Hour	Lowest: Value	Lowest: Hour	Standard of Time	Period of Years: No. of Years	Period of Years: Period	Authorities
	° ′	° ′	m.									
18. New York City	40 47N.	73 58W.	43	January	4·2	1300–1500	3·8	0200–0800, 2400	75°W.M.T.	19–20	1921–1940	New York, U.S. Weather Bureau. Report of the New York Meteorological Observatory of the Department of Parks. 1921–40, New York, *s.a.*
				April	7·7	1400–1600	6·7	0400–0500				
				July	20·8	1500	18·8	0500				
				October	10·4	1100	9·6	0500–0600				
19. Madrid*	40 24N.	03 41W.	655	January	7·5	1300	6·1	0500–0700	G.M.T.	10	1910–1919	Madrid, Direction General del Instituto Geografico y Estidistico. Annuario del Observatorio de Madrid. Madrid, 1912–21.
				April	9·2	1300–1400	7·4	0500				
				July	13·3	0900–1000	10·8	2300–2400				
				October	10·9	1200–1400	9·1	0600				
20. St. Louis*	38 45N.	90 23W.	171	January	5·5	1500–1700	4·7	0400–0800	90°W.M.T.	3–4	1911–1914	Day, P. C.; Relative humidities and vapour pressures over the U.S., including a discussion of data from recording hair hygrometers. *Mon. Weath. Rev.*, *Washington*, Supplement No. 6, 1917.
				April	10·9	1500–1600	9·4	0500–0600				
				July	21·7	1400	20·0	0500				
				October	12 7	1400–1500	11 3	0500				
21. Washington	38 54N.	77 03W.	41	January	4·6	1300–1400, 1700–1800, 2000	4·2	0500–0700, 0900	75°W.M.T.	31–53	1890–1945	Washington, U.S. Weather Bureau. The climatic handbook for Washington D.C. *Tech. Pap. U.S. Weath. Bur.*, *Washington*, No. 8, 1949.
				April	8·6	1900–2000	7·6	0700				
				July	22·2	2200	20·6	0500, 0700				
				October	11·3	2000	10·0	0700				
22. Athens	37 58N.	23 43E.	105	January	8·5	1000–1100, 1800–1900, 2100	8·2	0300–0800	30°E.M.T.	10	1921–1930	MS.
				April	10·4	1900, 2100	9·5	1400				
				July	15·4	2100–2200	13·4	1400				
				October	14·4	1900	13 2	1400–1500				
23. San Francisco*	37 47N.	122 26W.	47	January	9·7	1800–2100	9·1	0900–1000	120°W.M.T.	5	1911–1916	Day P. C.; Relative humidities and vapour pressures over the U.S., including a discussion of data from recording hair hygrometers. *Mon. Weath. Rev.*, *Washington*, Supplement No. 6, 1917.
				April	10 5	1700–1900	10·0	1000–1100				
				July	13·3	1400–1500, 1700–1800	12·4	0500				
				October	12·2	2400	11·3	1200–1400				
24. Tokyo	35 41N.	139 46E.	6	January	5·4	1700	4·4	0700	135°E.M.T.	10	1909–1918	Tokyo, Central Meteorological Observatory. ***Bull. cent. met. Obs.***, ***Tokyo***, **4**, Pt. 3, 1931.
				April	11·2	1900	9·7	0600				
				July	25·3	1400	24 2	0400–0500				
				October	15·3	1800	13.9	0600				
25. Hamilton	32 18N.	64 47W.	40	January	14·9	2100	14·4	0400–0600	60°W.M.T.	3	1949–1951	Bermuda, Meteorological Office. Summary of Observations 1949–51. Bermuda, 1950–52.
				April	16·4	2200	15·7	1100				
				July	27·1	2200	26·5	0900–1200, 1400–1600, 1800				
				October	22·9	2000, 2200	22 4	0400–0600				

TABLE I—*cont.*

Station	Position: Latitude	Position: Longitude	Height	Month	Highest: Value	Highest: Hour	Lowest: Value	Lowest: Hour	Standard of Time	Period of Years: No. of Years	Period of Years: Period	Authorities
	° ′	° ′	m.									
26. Tel Aviv	32 05N.	34 47E.	20	January	14·2	1200–1300	11.2	0700	30°E.M.T.‡	6	1936–1941	Ashbel, D.; Temperature and air humidity in Palestine and adjacent countries. Jerusalem, *s.a.*
				April	19.1	1200	14·5	0500				
				July	29·6	1000	23·3	0500				
				October	25·7	1400	17·6	0500				
27. Nanking	32 03N.	118 47E.	68	January	5·1	0800–1000, 1900–0500	4·8	1100–1200, 1400	120°E.M.T.	2	1934–1935	Nanking, National Research Institute of Meteorology. *Mon. met. Bull., Nanking*, **7, 8.** 1934, 35.
				April	12·2	1200, 1500–1600	11·3	0500–0600				
				July	30·5	0800	29·2	1900				
				October	15·7	0900	14·3	0500				
28. Helwan	29 52N.	31 20E.	116	January	9·1	1000	7·9	0700	30°E.M.T.	14	1906–1919	Sutton, L. J.; The Climate of Helwan. *Phys. Dep. Pap.*, Cairo, No. 20, 1926.
				April	10·8	0800	7·6	1600				
				July	19·6	0700	11·7	1600				
				October	16·6	0800	12.3	1500–1600				
29. Sibsagar	26 59N.	94 40E.	101	January	15·9	1200, 1700–1800	12·5	0500–0700	L.M.T.	13	1873–1885	Calcutta, Department of Meteorology. *Indian met. Mem., Calcutta*, **5**, 1892–95.
				April	24·7	1800	21·7	0500–0600				
				July	33·9	1900	31·2	0500–0600				
				October	28·1	1800–1900	24.7	0500–0600				
30. Tamanrasset	22 47N.	05 31E.	1350	January	5·0	1300	3.2	2300	L.M.T.‡	N/A	N/A	MS.
				April	6·9	1100, 1300, 1600	4·1	2400–0100				
				July	10·3	1300–1400	7·0	0300				
				October	8·7	1000	5.7	0400–0500, 2300–0200				
31. Hong Kong	22 18N.	114 09E.	33	January	14·2	1300–1600	13·4	0600–0800	120°E.M.T.	5	1935–1939	Hong Kong, Royal Observatory. *Met. Results* 1935–39, Hong Kong, 1936–40.
				April	22·3	1400	21·2	0500–0600				
				July	31·9	1200	31·0	0300–0600				
				October	23·9	1400–1500	22·6	0600				
32. Mexico City	19 26N.	99 08W.	2280	January	7·6	1000–1100, 2200	6·3	1600	L.M.T.	11	1902–1912	Mexico, Observatorio meteorológico-magnético Central. *Bol. Obs. met.-magn. Méx.* Anõs Met. 1902–12, Mexico, *s.a.*
				April	9·5	2000–2400	7·3	1300				
				July	13·3	2000–2200	11·6	1300–1400				
				October	11·6	2000–2100	10·1	1500				
33. Bombay	18 38N.	72 52E.	7	January	21·0	1700–1900	17·8	0700	L.M.T.	N/A	N/A	MS.
				April	27·8	1200–1400	26·3	0500–0600				
				July	31·0	1200–1400	29·6	0500				
				October	29·0	1500–1600	27·1	0500–0600				
34. Sao Vicente	16 53N.	25 00W.	15	January	19·3	2300	18·1	1400	30°W.M.T.	1	1941	Praia, Servicos de Estatistica da Colonia de Caba Verde Meteorologia e Climatologia. Resumo das observações efectuadas nos postos oficiais da Colónia no ano de 1941. Praia, 1942.
				April	18·8	1700–1800	17·3	0800				
				July	22·5	1500	21·0	0600–0700				
				October	25·3	1400–1500	23·7	0600				

TABLE I—*cont.*

Station	Position: Latitude	Position: Longitude	Height	Month	Highest: Value	Highest: Hour	Lowest: Value	Lowest: Hour	Standard of Time	Period of Years: No. of Years	Period of Years: Period	Authorities
	° ′	° ′	m.									
35. Kano	12 02N.	08 32E.	467	January	6·7	2100	4·3	1000	G.M.T.	3	1947–1949	MS.
				April	16.4	0700	9.6	1600				
				July	25·5	2100	22·9	1500				
				October	17·4	0700	11.8	1500				
36. Bangalore	12 58N.	77 35E.	921	January	15·8	0200–0400	12·7	1400–1600	L.M.T.	N/A	N/A	MS.
				April	21·7	0800	14·9	1600				
				July	21·5	0800	20·8	1400				
				October	21·2	0700–0800	19·6	1400, 1600				
37. Djibouti	11 36N.	43 09E.	3	January	26·2	1500	23·2	0600–0800	45°E.M.T.	4	1944–1947	Paris, Ministère de Travaux Publiques des Transports et de Tourisme. Bulletin Annuel 1944–47. Paris, 1946–49.
				April	32·6	1700	29·2	0700				
				July	31.6	1700	25.4	0300				
				October	30·2	1400	26·1	0600				
38. Ikeja	06 35N.	03 20E.	39	January	28·8	1700	25·2	0400	G.M.T.	3	1947–1949	MS.
				April	32·1	0900	28·6	0500–0600				
				July	28·2	0900, 1200	25·9	0500				
				October	29·6	1000, 1300–1400	26·2	0500				
39. Mogadishu	02 01N.	45 20E.	12	January	28·9	1300–1400	25·9	0500–0600	45°E.M.T.	3–4	1944–1947	MS.
				April	30·5	1300–1400	27·1	0500				
				July	27·9	1300–1400	25·6	0400–0500				
				October	30·2	1300–1400	27·5	0400–0500				
40. Stanleyville*	00 31N.	25 11E.	430	January	27·9	1600	22.8	0400	G.M.T.	3†	1946–1948	MS.
				April	27·9	1700	22·7	0300				
				July	27·6	1600–1700	23·5	0400				
				October	28·0	1600	23·1	0300				
41. Brazzaville*	04 15S.	15 17E.	341	January	27·5	2000–2100	25·3	0600–0700	15°E.M.T.	5–6†	1935–1937, 1950–1952	Brazzaville, Service Météorologique de l'Afrique Equatoriale Française. *Résumé Temps A.E.F.*, 1935–37, 1950–52. Brazzaville, *s.a.*
				April	27·9	1900	25·8	1100				
				July	21·3	1900	19·2	0600				
				October	25·6	0900–1000	23·7	1400				
42. Dar-es-Salaam	06 50S.	39 18E.	14	January	30·1	1500–1700	28·5	0600	45°E.M.T.	8	1901–1904, 1948–1951	Hamburg, Kaiserliche Marine Deutsche Seewarte. *Dtsch. übers. met. Beob.*, *Hamburg*, Heft 13–14, 1905–07. MS.
				April	29·7	0900, 1300	26·1	0600				
				July	24·7	1000	21·3	0200				
				October	26·6	0900	22·9	0600				
43. Djakarta	06 11S.	106 50E.	8	January	28·9	1800	27·3	0600	L.M.T.	70	1866–1935	Batavia, Royal Magnetical and Meteorological Observatory. ***Results met. Obsns, Batavia***, 1886–1935. **58C**, 1938.
				April	29·7	1900	27·7	0600				
				July	28·0	1900	25·6	0600–0700				
				October	28·2	2000	26·2	0600				
44. Lima*	12 05S.	77 03W.	111	January	22·7	1000, 1400–1500	20.4	0600	75°W.M.T.‡	9–10	1929–1938	Lima, Instituto Nacional de Meteorologico. *Bol. met. Lima*, 1929–38. Lima, Anos 1–10, Nos. 1–21, 1930–39.
				April	21·0	1000	18·5	0600				
				July	16·1	1300–1400	15·2	0400–0600				
				October	17 0	1200–1300	16·0	0400–0600				

TABLE I—*cont.*

Station	Position: Latitude	Position: Longitude	Height	Month	Highest: Value	Highest: Hour	Lowest: Value	Lowest: Hour	Standard of time	Period of Years: No. of Years	Period of Years: Period	Authorities
	° ′	° ′	m.									
45. Caeteté*	14 02S.	42 39W.	900	January	20·9	0800–0900	20·0	1300–1400, 1600	45°W.M.T.‡	11†	1909, 1914–1923	Hann, J.; Taglicher Gang der meteorologischen elemente zu Caeteté, Brasilien, Staat Bahia. *Met. Z.*, *Braunschweig*, **28**, 1911.
				April	20·9	0600	20·0	1300–1400				
				July	16·4	0200–0400, 2400	15·3	1500, 1700				
				October	19·1	0800–0900	17.6	1600–1700				Rio de Janeiro, Directoria de Meteorologia. *Bol. met.*, *Rio de J.*, Anõs 1914–23. 1922—*s.a.*
46. Broken Hill	14 24S.	28 24E.	1195	January	20·7	1900	18.9	0500–0600	30°E.M.T.	6	1932–1937	British East African Meteorological Service. *Met. Rep. N. Rhod.* 1932–37. Nairobi, 9–15, 1932–38.
				April	17·3	0800	15·5	0600				
				July	11·5	1000	10·2	0600				
				October	14.6	0900	12.3	1700				
47. St. Helena*	15 57S.	05 40W.	620†	January	18·4	1300–1600	17·8	0500–0700	G.M.T.	41	1911–1924, 1925–1952	MS.
				April	19·6	1300–1400	18·5	0500–0700				
				July	15·4	1300–1400	14·5	0300–0700				
				October	15·7	1400	14·5	0400–0700				
48. Broome*	17 57S.	122 13E.	19	January	33·4	2200	30·3	1200	120°E.M.T.	3–7	N/A	MS.
				April	26.2	2000	21.0	1300				
				July	16.5	1730	12.8	0400–0600				
				October	25·3	1800–2200	21·1	1100–1200				
49. Mauritius	20 06S.	57 33E.	55	January	27·0	0800–0900	25·6	0500–0600	60°E.M.T.	45	1891–1935	Port Louis, Royal Alfred Observatory. *Results magn. met. Obsns, Mauritius*, 1891–1935. Port Louis, **1–21**, 1915–36.
				April	25·3	1000	23·4	0600–0700				
				July	18.6	1000	17.3	0600–0800				
				October	20·1	0800	18·7	0600				
50. Windhoek	22 34S.	17 06E.	1727	January	13·2	1700	12·2	1300–1400	30°E.M.T.	7	1944–1950	Pretoria, Weather Bureau. Annual Reports for South West Africa, 1944–50. Pretoria, 1945–51.
				April	10·9	0900, 1400	10·0	0500–0700				
				July	5·7	1000	4·6	2300				
				October	6·7	1300	5·9	0500–0600				
51. Alice Springs*	23 28S.	133 53E.	547	January	12.9	0600	9·7	1700–1800	142½°E.M.T.	3–7	N/A	MS.
				April	8·9	0800–1000	7·4	1730–2100				
				July	6·5	2130–2200	5·4	0400				
				October	8·1	0800–0930	6·6	1800–1900				
52. Brisbane	27 28S.	153 02E.	42	January	23·7	2000	22.3	0700, 1100	L.M.T.	5	N/A	Foley, J. C.; A study of average hourly values of temperature, relative humidity and saturation deficit in the Australian Region from records of capital city bureaux. *Bull. Bur. Met. Aust., Melbourne*, **35**, 1945.
				April	18·4	1800, 2000	16·4	0600				
				July	11·9	1800–1900	10·2	0700				
				October	18·1	2000	15·7	1100				
53. Kimberley	28 48S.	24 46E.	1197	January	15·6	0900	13·1	2000	30°E.M.T.	11	1939–1949	Pretoria, Weather Bureau. Reports for the years 1939–49. Pretoria, 1940–51.
				April	12·2	1100	10·6	0400				
				July	7·1	1200–1300	5·5	0600–0700				
				October	11·0	1000	8·7	0200				

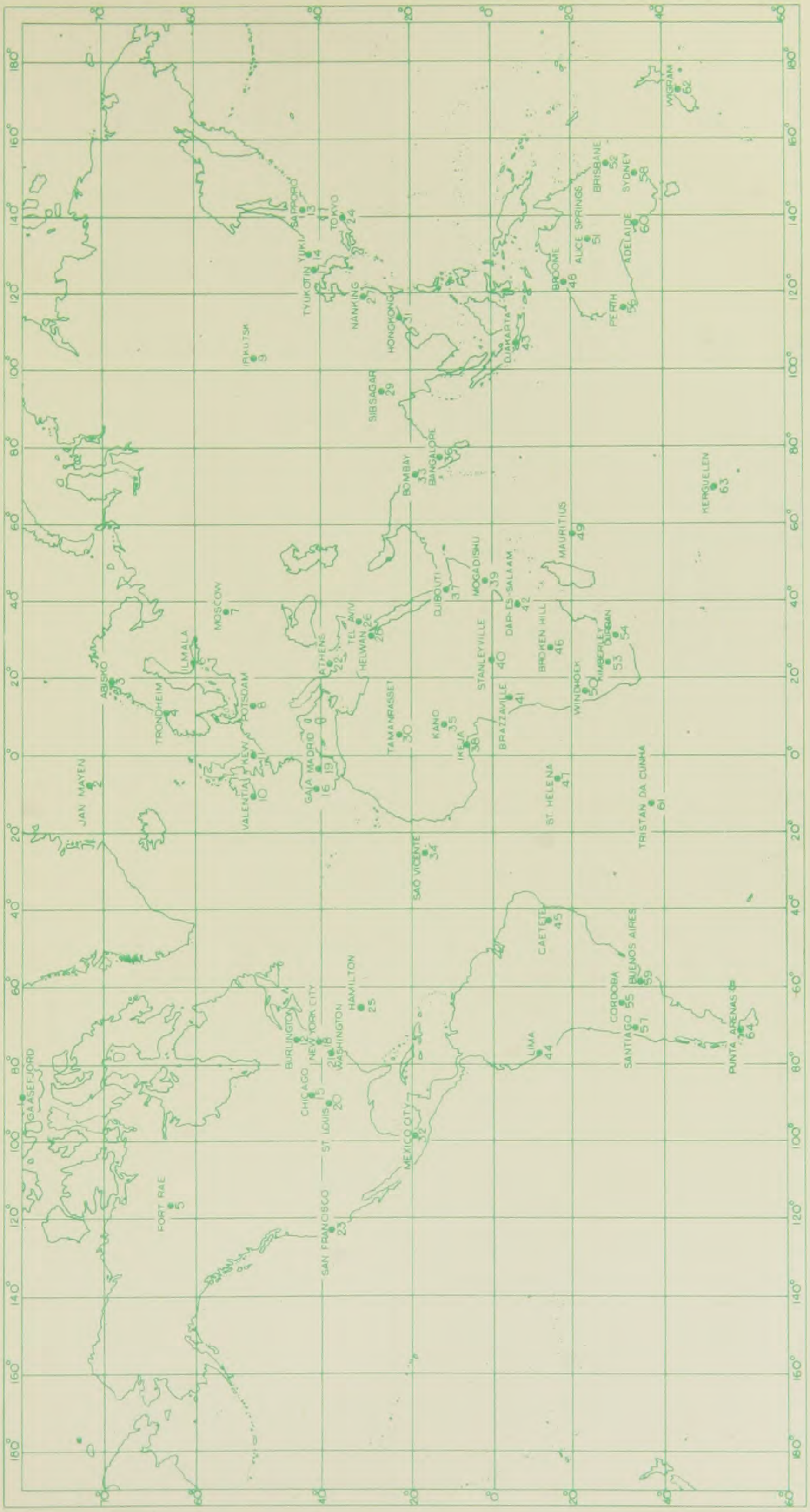
TABLE I—*cont.*

Station	Latitude	Longitude	Height	Month	Highest Value	Highest Hour	Lowest Value	Lowest Hour	Standard of Time	No. of Years	Period	Authorities
	° ′	° ′	m.									
54. Durban	29 51S.	31 03E.	13	January	25·1	1500	21·9	0500	30°E.M.T.	11	1939–1949	Pretoria, Weather Bureau. Reports for the years 1939–49. Pretoria, 1940–51.
				April	22·8	1600	18·7	0600				
				July	16·5	1600	11·3	0700				
				October	20·2	1300	17·6	0400, 0600				
55. Cordoba §	31 25S.	64 12W.	423	January	18·0	0800–0900, 1100–1200, 2000–2100	16·1	0500	60°W.M.T.‡	10	1898–1907	Davis, W. G.; Climate of the Argentine Republic. Buenos Aires, 1910.
				April	14·9	1100–1200	12·7	0600				
				July	8·8	1000–1200	7·6	0600–0700				
				October	12.3	0900–1100	10·8	0500				
56. Perth	31 57S.	115 51E.	60	January	16·3	2000	12·5	1000, 1200	L.M.T.	2–5	N/A	Foley, J. C.; A study of average hourly values of temperature, relative humidity and saturation deficit in the Australian Region from records of capital city bureaux. *Bull. Bur. Met. Aust., Melbourne*, **35**, 1945.
				April	15·3	1900	12·4	0500–0600				
				July	12·0	1800	9·6	0600–0700				
				October	12·6	2000–2100	11·0	1200				
57. Santiago*	33 27S.	70 42W.	519	January	13·9	1100	12·1	0400–0500	75°W.M.T.	10†	1911–1921	Santiago, Instituto Central Meteorologico y Geofisico de Chile. Valores horarias de los elementos meteorologicos en Santiago, 1911–14. Santiago, Pubs. 5, 7, 11, 17, 1913–15. Santiago, Instituto Central Meteorologico y Geofisico de Chile. Annuario meteorologica de Chile 1911–17, 19–21. Santiago, Pubs. 3, 6, 13, 25, 19, 26, 27, 31–35, 1912–23.
				April	11·7	1100	9·9	0600				
				July	9·2	1600	7·6	0600–0700				
				October	11·7	1500–1600	9·3	0400–0500				
58. Sydney	33 51S.	151 13E.	42	January	19·8	0100, 2000	18·7	0800	L.M.T.	7	N/A	Foley, J. C.; A study of average hourly values of temperature, relative humidity and saturation deficit in the Australian Region from records of capital city bureaux. *Bull. Bur. Met. Aust., Melbourne*, **35**, 1945.
				April	15·5	1700, 2000	14·2	0600				
				July	10·2	1800	9·0	0600–0700				
				October	14·0	2100	12·8	0500				
59. Buenos Aires§	34 36S.	58 22W.	25	January	21·1	2000–2100	19·1	0400–0500	60°W.M.T.	10	1898–1907	Davis, W. G.; Climate of the Argentine Republic. Buenos Aires, 1910.
				April	17·2	1800–1900	15·3	0600				
				July	11·9	1600–1800	10·5	0600–0700				
				October	14·7	1900–2000	13·3	0400–0600				
60. Adelaide	34 56S.	138 35E.	43	January	13·5	1100	12·4	0500–0600	L.M.T.	5–20	N/A	Foley, J. C.; A study of average hourly values of temperature, relative humidity and saturation deficit in the Australian Region from records of capital city bureaux. *Bull. Bur. Met. Aust., Melbourne*, **35**, 1945.
				April	12·8	1400	11·1	0600				
				July	10·3	1200–1400	9·1	0600–0700				
				October	10.6	2000	9.7	0500, 0700				

TABLE I—*cont.*

Section	Position: Latitude	Position: Longitude	Position: Height	Month	Highest: Value	Highest: Hour	Lowest: Value	Lowest: Hour	Standard of time	Period of Years: No. of Years	Period of Years: Period	Authorities
	° ′	° ′	m.									
61. Tristan da Cunha	37 03S.	12 19W.	23	January	16·6	1200–1600	15·4	0400–0500	15°W.M.T.	4–5	1943–1947	Pretoria, Weather Bureau. Meteorological observations at Tristan da Cunha 1943-47. Pretoria, 1949.
				April	15·2	1200	14·2	0600–0700, 2000, 2200–2400				
				July	12·1	1200	11·4	1900–0500				
				October	12·3	1100	11·4	0500				
62. Wigram, Christchurch	43 33S.	172 33E.	23	January	13·7	2000	12·9	0500, 1000	172½° E.M.T.	4	1940–1944	Wellington, New Zealand Meteorological Office. *Met. Obsns Wellington, N.Z.*, 1940–44. Wellington, 1945–48.
				April	11·0	2000	9·7	0600				
				July	8·4	1600	7·1	0600–0800				
				October	9·6	0800, 1200	8·7	0500				
63. Kerguelen	49 25S.	69 53E.	16	January	7·6	1300	6·8	2100	L.M.T.	1	1902–1903	Berlin. Deutsche Südpolar Expedition 1901–03. Meteorologie, Band 4, Tabellen, Band 2, Berlin, 1913.
				April	6·3	1200, 1400	5·8	0500, 0700				
				July	5·3	2100	4·9	0700				
				October	• 5·2	0600	4·7	1900				
64. Punta Arenas*	53 10S.	70 54W.	4	January	8·7	0600–0900, 1200–1300, 1800	8·1	1600, 1900–2000, 2400	75°W.M.T.‡	10†	1912–1923	Santiago, Instituto Central Meteorologico y Geofisico de Chile. Valores horarias de los elementos meteorologicos en Punta Arenas, 1912. Santiago, Pub. 12, 1914. Santiago, Instituto Central Meteorologico y Geofisico de Chile. Annuario meteorologico de Chile 1912–13, 15–17, 19–23. Santiago, Pubs. 6, 13, 19, 26, 27, 31–35, 1914–25.
				April	7·9	1500	7·1	0800, 2200, 2400				
				July	5·9	0100–0300, 0500–0600, 1000–1800, 2200–2300	5·7	0400, 0700–0900, 1900–2100, 2400				
				October	6·9	0700, 1300–1400	6·4	0400, 0600				
65. Little America	78 34S.	163 56W.	14	January	3·6	1200–1700	3·0	0200	180°M.T.	2	1929–1935	Grimminger, G., and Haines, W. C.; Meteorological results of the Byrd Antarctic Expeditions 1928–30, 33–35. Tables, *Mon. Weath. Rev., Washington*, Supplement No. 41, 1939.
				April	0·5	1200–1600	0·4	2200–2300				
				July	0·2	1700–2200	0·1	1000–1200				
				October	0·7	1300–1400	0·5	0100–0200				

Symbols: N/A Not available
* Interpolated values.
† Corrected to.
‡ Probably.
§ Mean value for seasons summer, autumn, winter, spring for respectively January, April, July, October.



KEY MAP TO SELECTED STATIONS OF TABLE 1