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National Oceanic and Atmospheric Administration
National Marine Fisheries Service

Surface Winds of the Southeastern Tropical Atlantic Ocean

JOHN M. STEIGNER and MERTON C. INGHAM

SEATTLE, WA.
October 1971

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Surface Winds of the Southeastern Tropical Atlantic Ocean[1]

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ABSTRACT

This publication presents mean monthly surface wind velocities by 5° rectangles (Marsden square quadrants) for the eastern tropical Atlantic Ocean from the African coastline at approximately lat 5° N to lat 20° S, and from long 15° E to long 20° W. The publication is intended to serve principally as an information resource for studies of air-sea interaction and related seasonal variation of the near-surface oceanic environment. It can also be used to outline potential areas and seasons of fishing operations.

INTRODUCTION

The southeastern tropical Atlantic Ocean has been the site of several recent oceanographic and fishery studies which have added to the knowledge of the oceanic environment and biota of this area. There have not been comparable meteorological investigations in the area. Adequate atlases of average meteorological conditions at the ocean surface exist for the North Atlantic Ocean (U.S. Navy, 1955; U.S. Naval Oceanographic Office, 1963), but those for the South Atlantic (Supplement "C" to H.O. No. 261, Naval Air Pilot West Central Africa—including Cape Verde, Ascension, and St. Helena Islands) are inadequate in geographical and temporal coverage. This publication was constructed to correct the inadequacy, at least for surface wind data, by presenting mean monthly wind velocities by 5° rectangles (Marsden square quadrants) for the eastern tropical Atlantic Ocean south of lat 5° N.

This publication is intended to serve principally as an information resource for studies of air-sea interaction and related seasonal variation of the near-surface oceanic environment. It is reasonable to hypothesize, for example, that the seasonal variation in the surface wind field is the cause of the variation of the position of an oceanic front which annually ranges between lat 1° and 17° S. This hypothesis can be tested by correlating the mean monthly surface wind data with mean monthly sea-surface temperature data for the tropical Atlantic Ocean as portrayed by Mazeika (1968). The relationship between the surface wind field and sea-surface temperature also is relevant to studies of the distribution of tuna and other pelagic fishes. Fishery scientists have tried to relate the distribution of tunas to the surface

[1] Contribution No. 204, National Marine Fisheries Service, Tropical Atlantic Biological Laboratory, Miami, Fla. 33149.

and near-surface temperature field with varying success. If the relationship between tuna distribution and sea-surface temperature and between sea-surface temperature and wind field can be determined, then synoptic wind data can be used as an aid to predict the distribution of tuna schools.

Average wind data, as portrayed in this atlas, also can be directly useful to commercial fishermen in the rapidly developing tuna fishery in the southeastern tropical Atlantic. Spotting tuna schools and carrying out purse-seine fishing operations are difficult at wind speeds above 15 knots, particularly in a fully arisen sea. Therefore, the publication can be used to generally outline potential areas and seasons of fishing operations.

DATA

The area covered by this atlas is shown in Figure 1; the wind data are from 458,129 surface weather observations made from 1854 to 1966. These observations are from the same sources and periods of years listed by Mazeika (1968), plus observations made through 1966. Observations were made by personnel of merchant and naval vessels of several nations.

Personnel of the National Weather Records Center, Asheville, N.C., transferred the observations to punch cards and programmed a computer print-out of data which included monthly means of:

1. Surface air temperature, 2° rectangles
2. Air-sea temperature difference, 2° rectangles
3. Clouds, 2° rectangles
4. Visibility, 2° rectangles
5. Ceiling and visibility, 2° rectangles
6. Precipitation types, 2° rectangles
7. Dew-point temperature, 2° rectangles
8. Wind speed versus air temperature, 2° rectangles
9. Surface wind rose, 5° rectangles

The above data are deposited at the National Marine Fisheries Service, Tropical Atlantic Biological Laboratory, Miami, Fla. The data for the surface winds are the basis for this publication.

The computer print-out of wind data showed for each month and for each 5° rectangle (Marsden square quadrant) the cumulative percentage distribution of wind direction and wind force. The direction is to eight points; force is by five Beaufort Force groups: 0-1 (0-3 knots); 2-3 (4-10 knots); 4 (11-16 knots); 5-6 (17-27 knots); 7-12 (28-71 knots).

GENERAL CHARACTERISTICS OF THE SURFACE WIND FIELD

The surface wind field of the southeastern tropical Atlantic Ocean is influenced by three surface pressure systems: the two subtropical high pressure cells over the North and South Atlantic Oceans and the low pressure cell over the continent of Africa.

The northeast portion of the subtropical high of the South Atlantic Ocean occupies most of the geographical area covered in this study. Between February and August this dominant pressure system of the South Atlantic Ocean strengthens and drifts about 5° northward. During this period surface pressure in the vicinity of Port Harcourt, Nigeria, changes little. As a result, the surface pressure gradient between Port Harcourt and the southwest corner of the wind field increases about 40%. As might be expected, the frequency of winds greater than 10 knots increases from 20 to 30% over the entire offshore field south of lat 7° S, and winds greater than 28 knots also increase significantly. At the same time, the frequency of onshore winds greater than 10 knots increases at least 20% over the 5° coastal squares from Cape Palmas to Accra, Grana. However, south of Cape Lopez, during this interval, the increase of winds greater than 10 knots is negligible (from 5 to 10%).

The subtropical high of the North Atlantic Ocean influences only the northernmost area of the wind field portrayed in these charts. The intertropical zone of convergence (ITC) is the southern boundary of the influence of this high pressure cell on the wind field. The position of the ITC ranges annually from lat 11° N in August to lat 1° N in February-March (Flohn, 1969, p. 111). It extends eastward to the zero meridian in January (Trewartha, 1968, p. 100, Fig. 336), and its center line, the thermal equator, is well to the north of this wind field 7 months of the year, April through October. From November through March the ITC affects

Marsden square quadrants 0012 and 0011 and the northern halves of Marsden square quadrants 3012, 3011, 3002, and 3001 or about 10% of the wind field's area during 40% of the year.

In contrast to the small seasonal movement of the oceanic high pressure cells, the strong thermal reaction of the African continent causes its low pressure cell to move from a Northern Summer latitude of lat 25° N to its Southern Summer latitude of 15° S. Throughout the year, this low pressure cell affects surface winds of the area just offshore from Cape Palmas to Luanda. Over these coastal waters this strong low pressure cell changes the flow of the South Atlantic High from southeasterly to predominantly southerly and southwesterly.

The west-east oriented area formed by Marsden square quadrants 3011, 3002, and 3001 has only a small seasonal change in wind speed. A comparison of the wind fields for February and August shows that this area has only a 0 to 5% change in frequency of wind speed greater than 10 knots; the area of zero change is about one-half Marsden square quadrant in size and is centered over Marsden square quadrant 3002. In contrast, a sharp gradient of seasonal change in wind frequency occurs to the north and south, and (more steeply) to the northeastward towards Port Harcourt. Also centered over Marsden square quadrant 3002 is an area of convergence (Trewartha, 1968, p. 100, Fig. 337), which is about the size of one Marsden square quadrant. This area of convergence persists months after the larger ITC, earlier described, has moved northward out of the wind field. Further study could possibly correlate other interface parameters with this coincident area of small change of convergence and frequency of wind speed.

INTERPRETING THE CHARTS

The wind data are portrayed in the first section by wind rose charts. Wind rose charts are interpreted as follows:

To determine the percentage of winds in a Marsden square quadrant *from* any one direction, measure the total length of the wind rose arm *pointing* in that direction and compare that length with the scale at the upper left of each chart. The percentage of winds of any force group *from* any one direction may be determined in the same manner. Thus in January in Marsden square quadrant 3011 the wind blew from the southeast 53% of the time; and 17% of the time this southeast wind was of Beaufort Force 4 (11-16 knots).

To determine the *total* frequency of winds falling within a certain force group, measure the length of that force group on the scale located in the Marsden square quadrant. Thus in January in Marsden square quadrant 3011 the wind was of Beaufort Force 2-3 (4-10 knots) 61% of the time.

The percentage frequency of wind speed is contoured in the second and third sections. The second section shows the percentage frequency of wind speeds of Beaufort Force 3 (10 knots) or less. The third section shows the percentage frequency of wind speeds of Beaufort Force 4 (16 knots) or less.

ACKNOWLEDGMENTS

Robert W. Wilder and Dennis C. Yazell, students of St. Petersburg Junior College, assisted in plotting wind roses from computer data.

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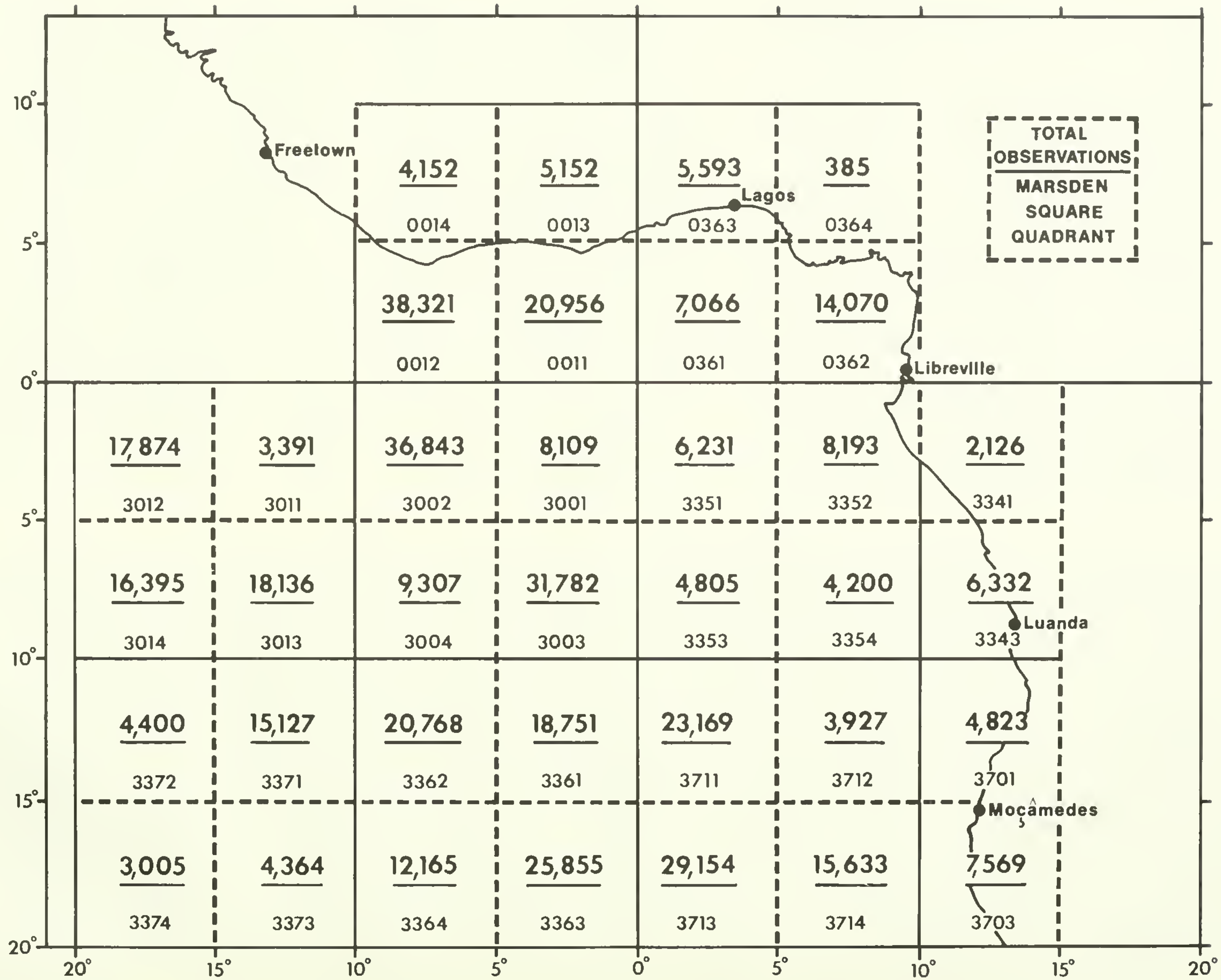


Figure 1.—Distribution of wind observations in the Gulf of Guinea. For each 5° quadrant, the number of observations is shown above the line and the Marsden square quadrant number is shown below the line.

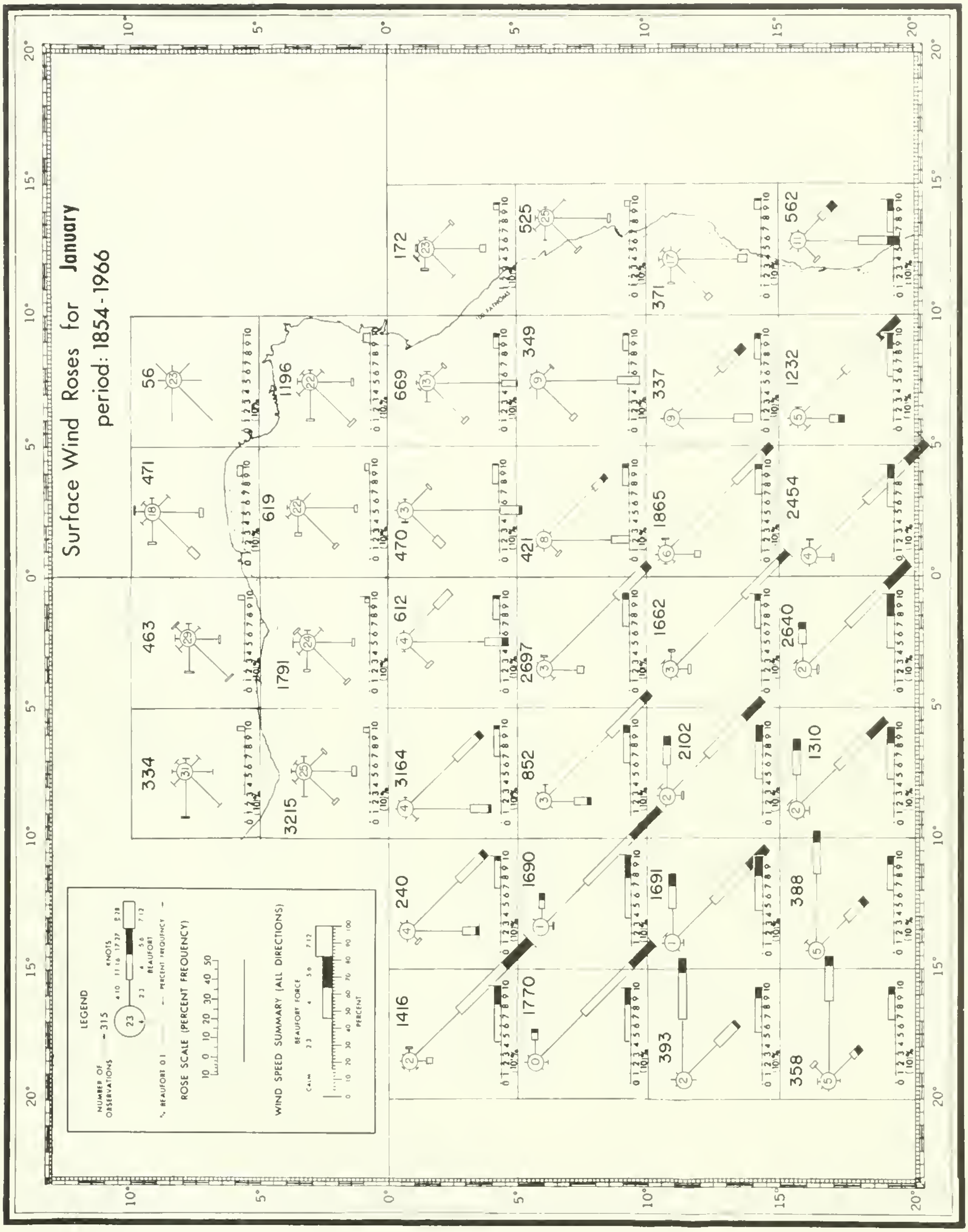
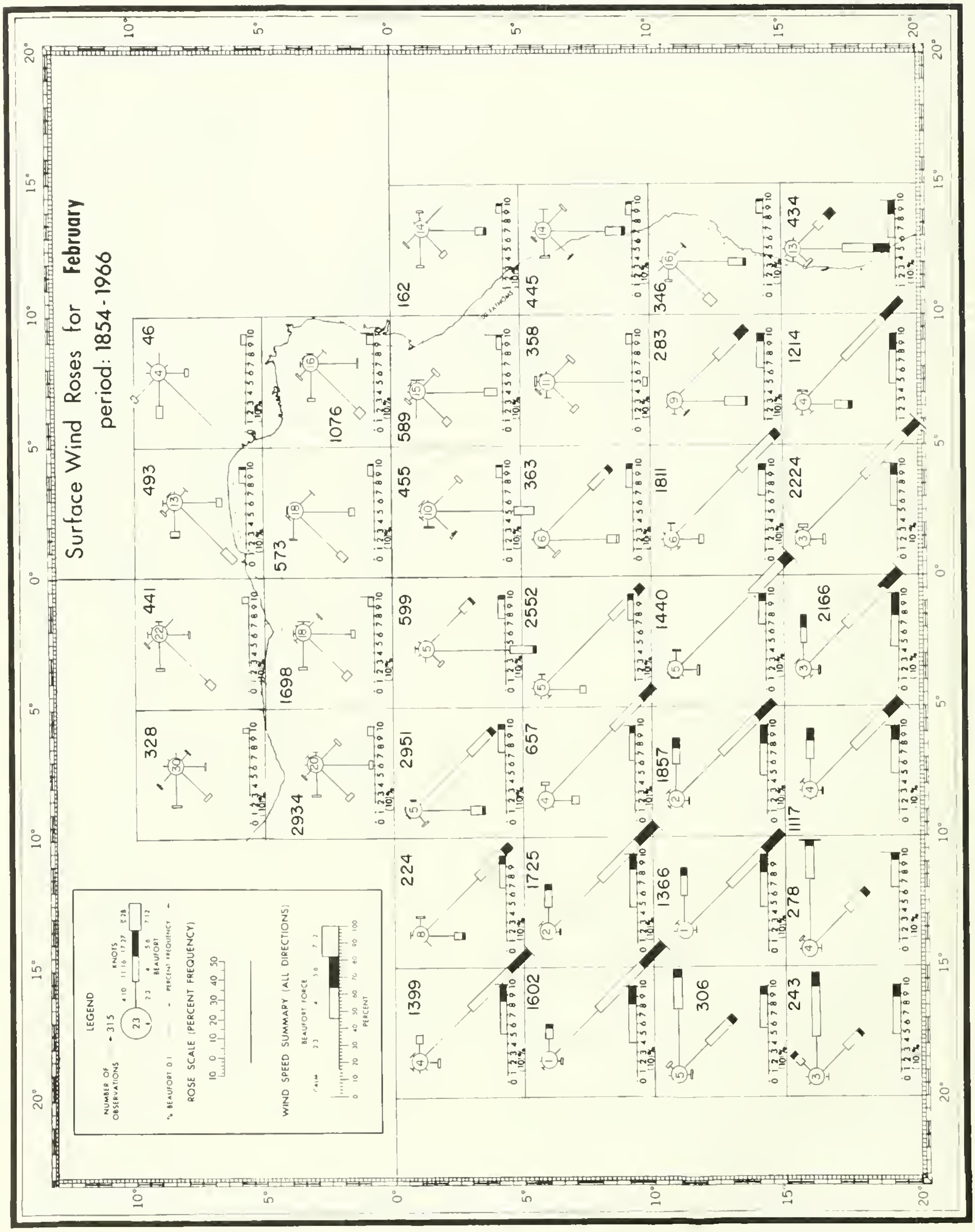


Figure 2.—Wind rose chart, January 1854-1966.



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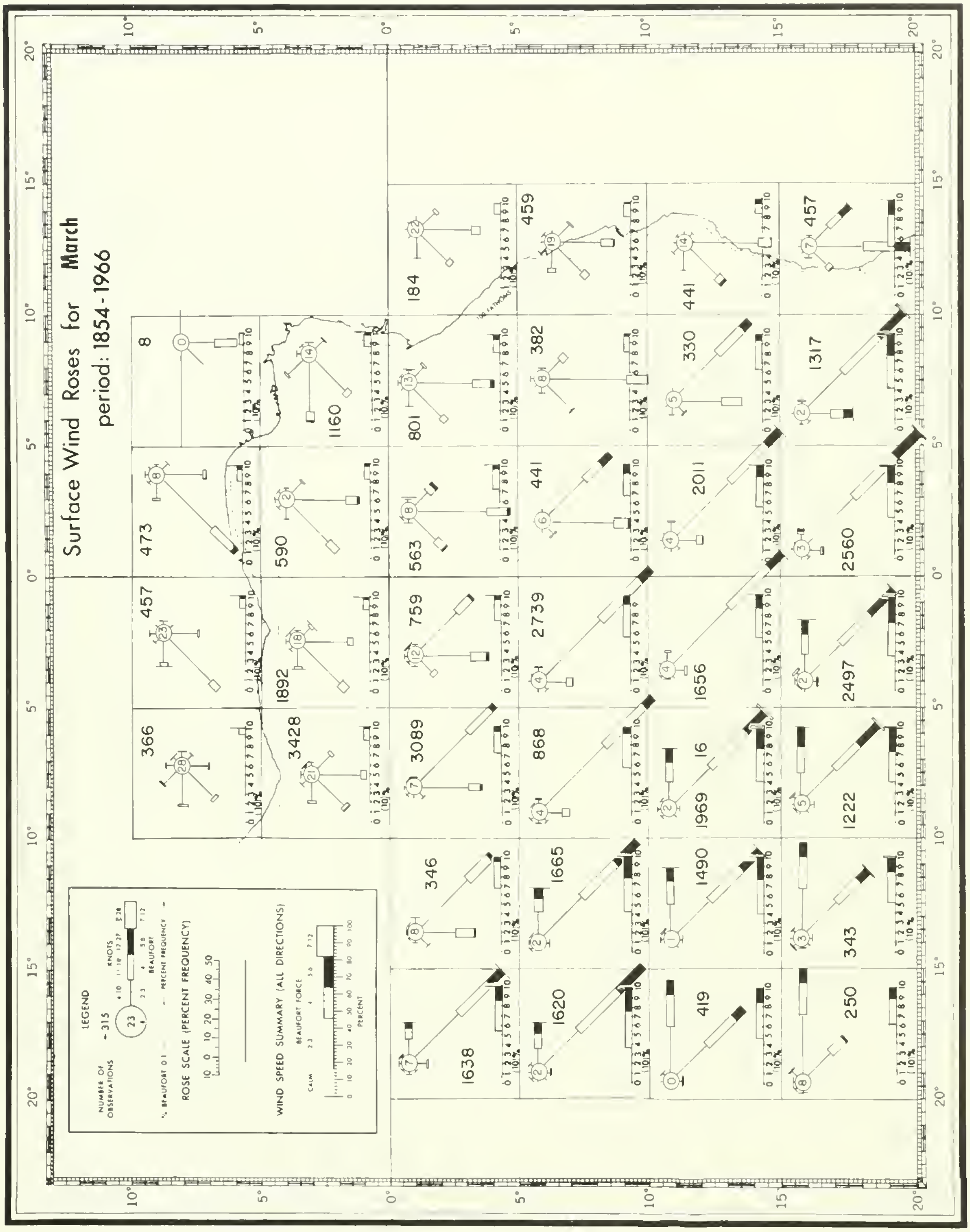


Figure 4.—Wind rose chart, March 1854-1966.

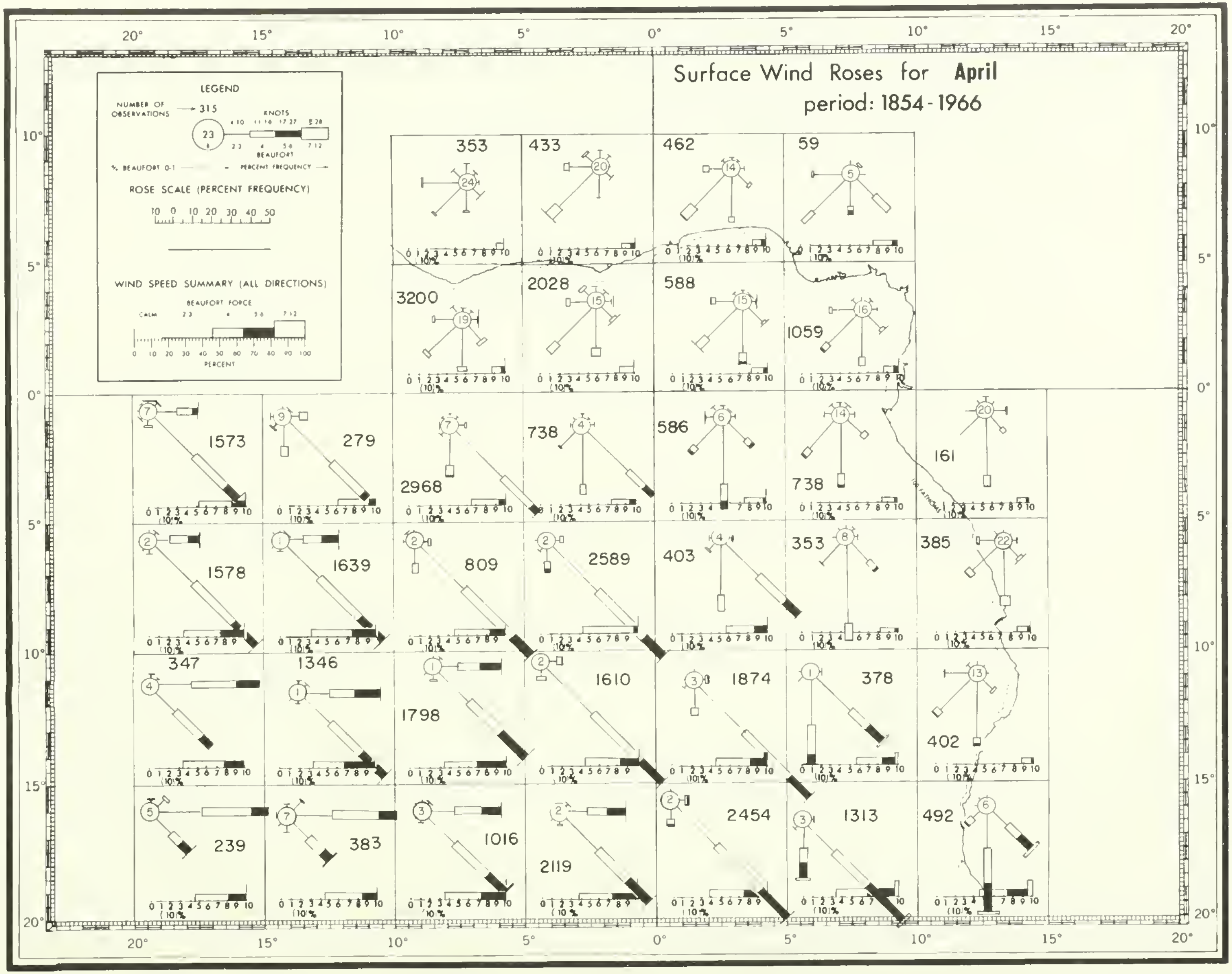


Figure 5.—Wind rose chart, April 1854-1966.

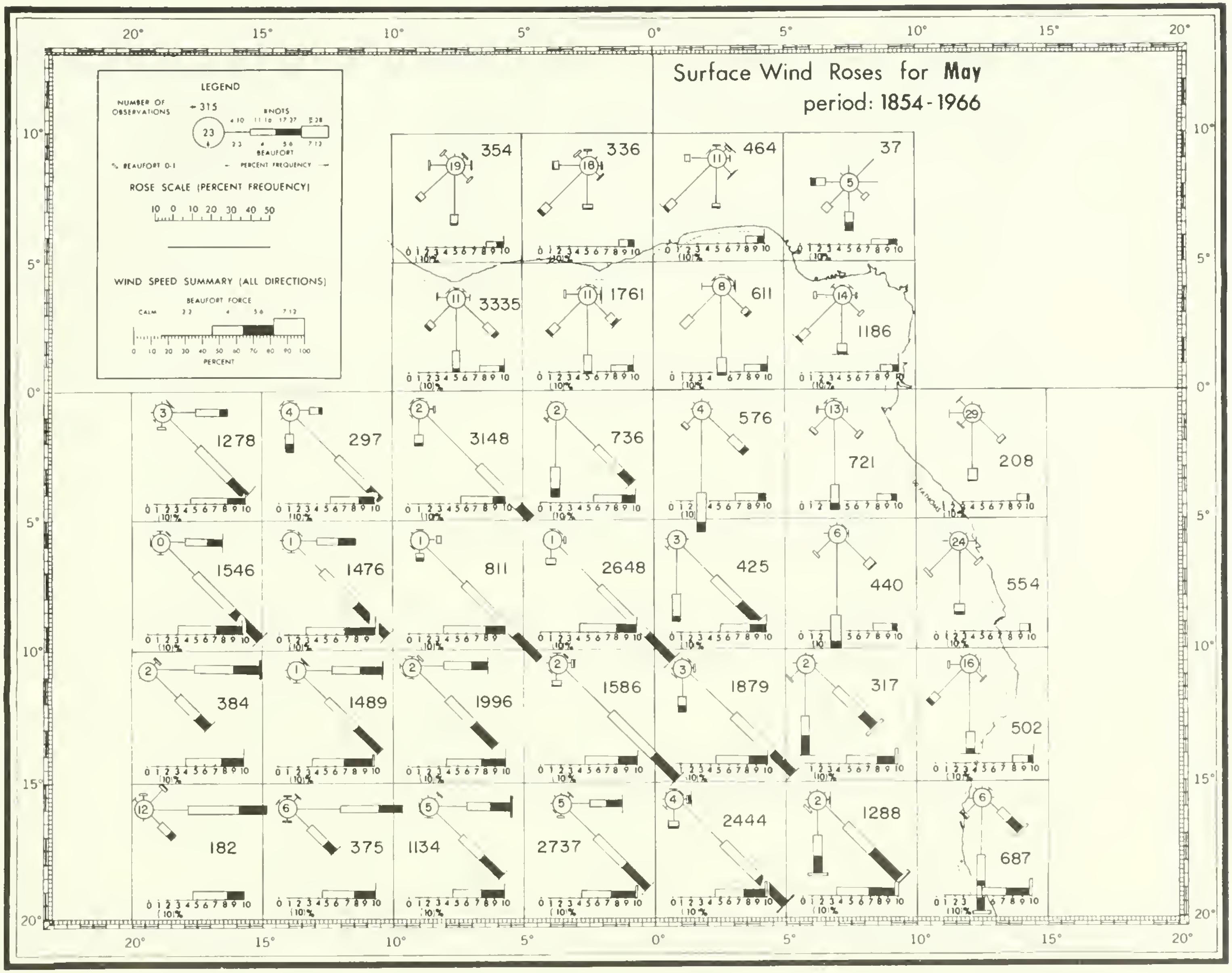


Figure 6.—Wind rose chart, May 1854-1966.

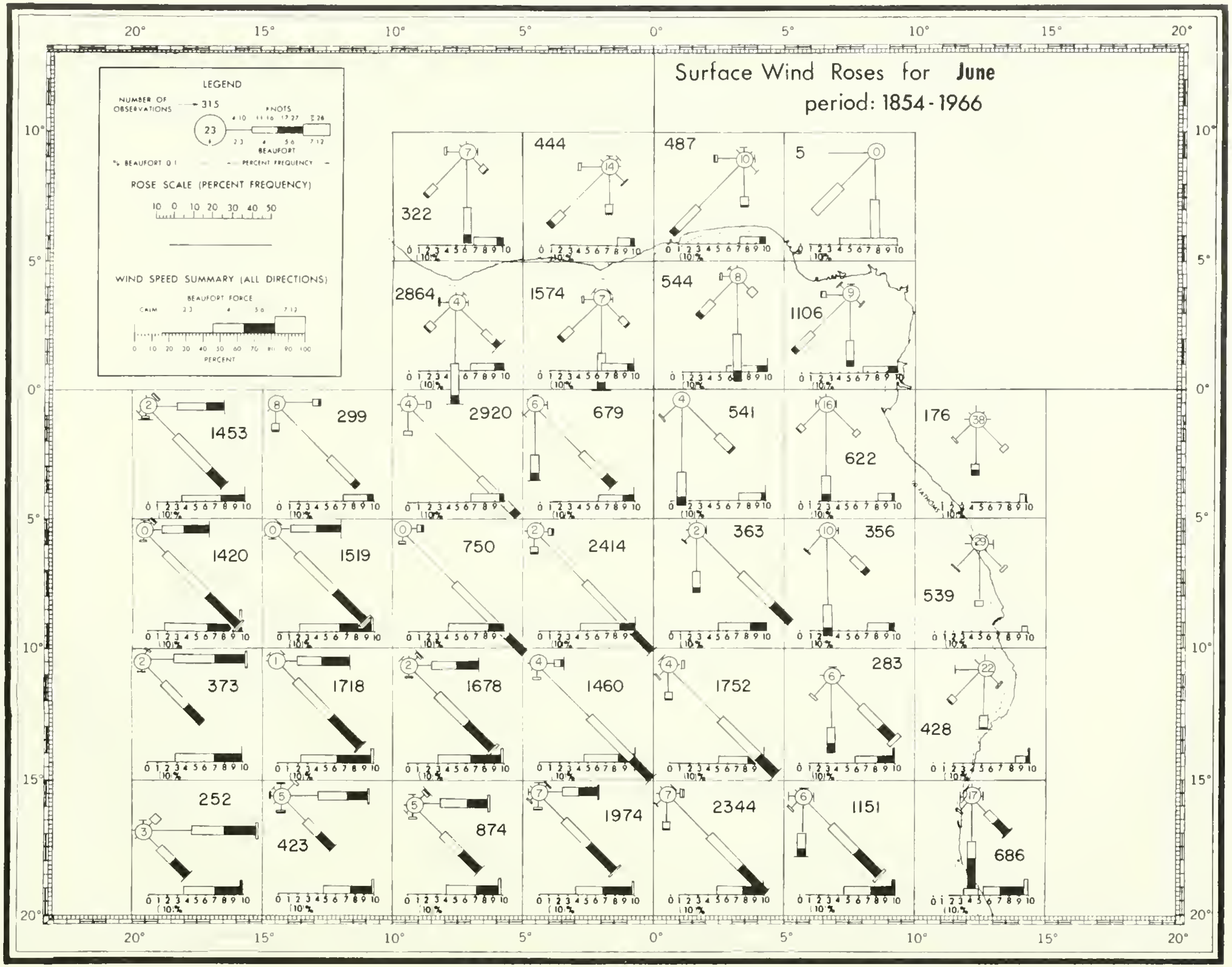


Figure 7.—Wind rose chart, June 1854-1966.

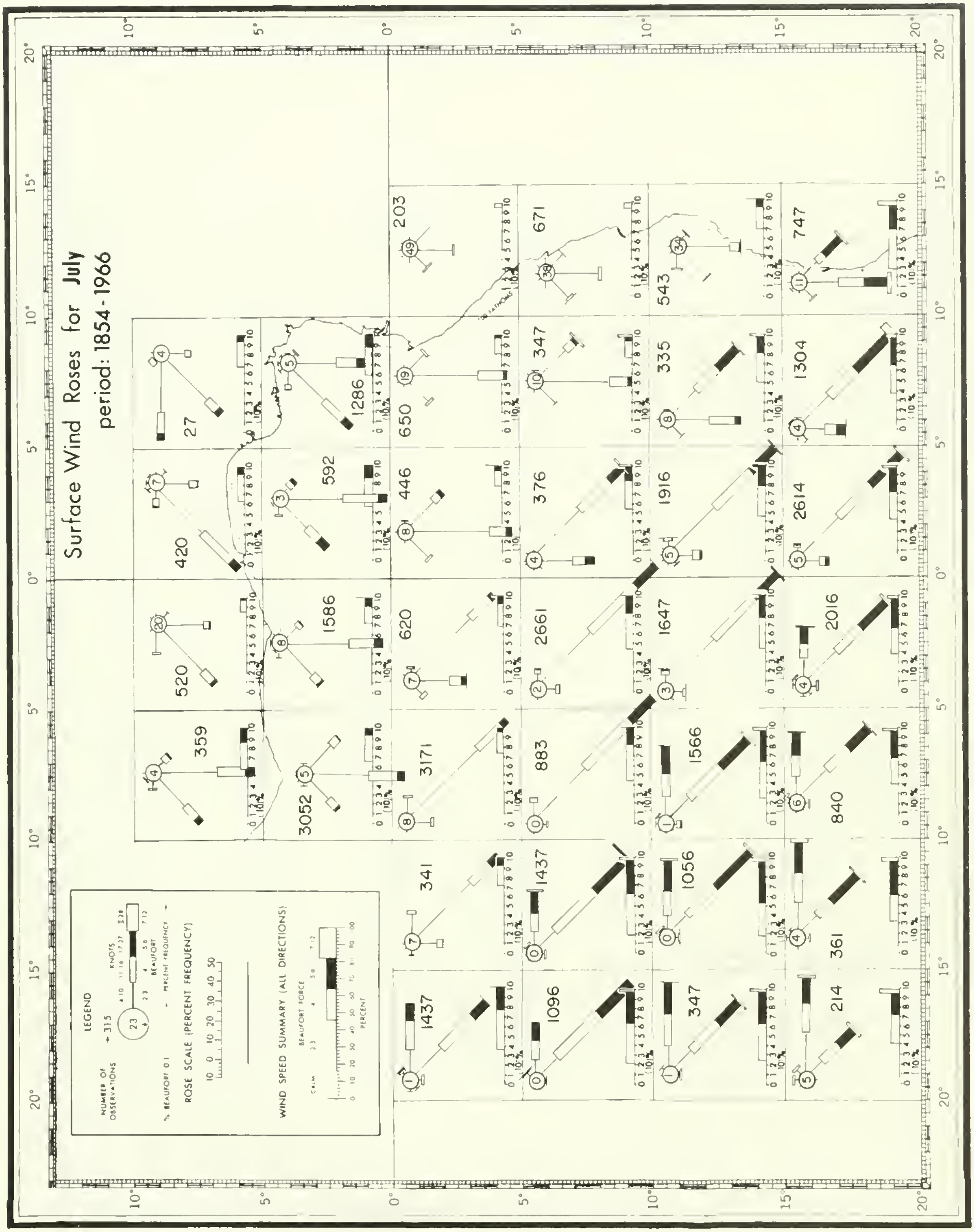
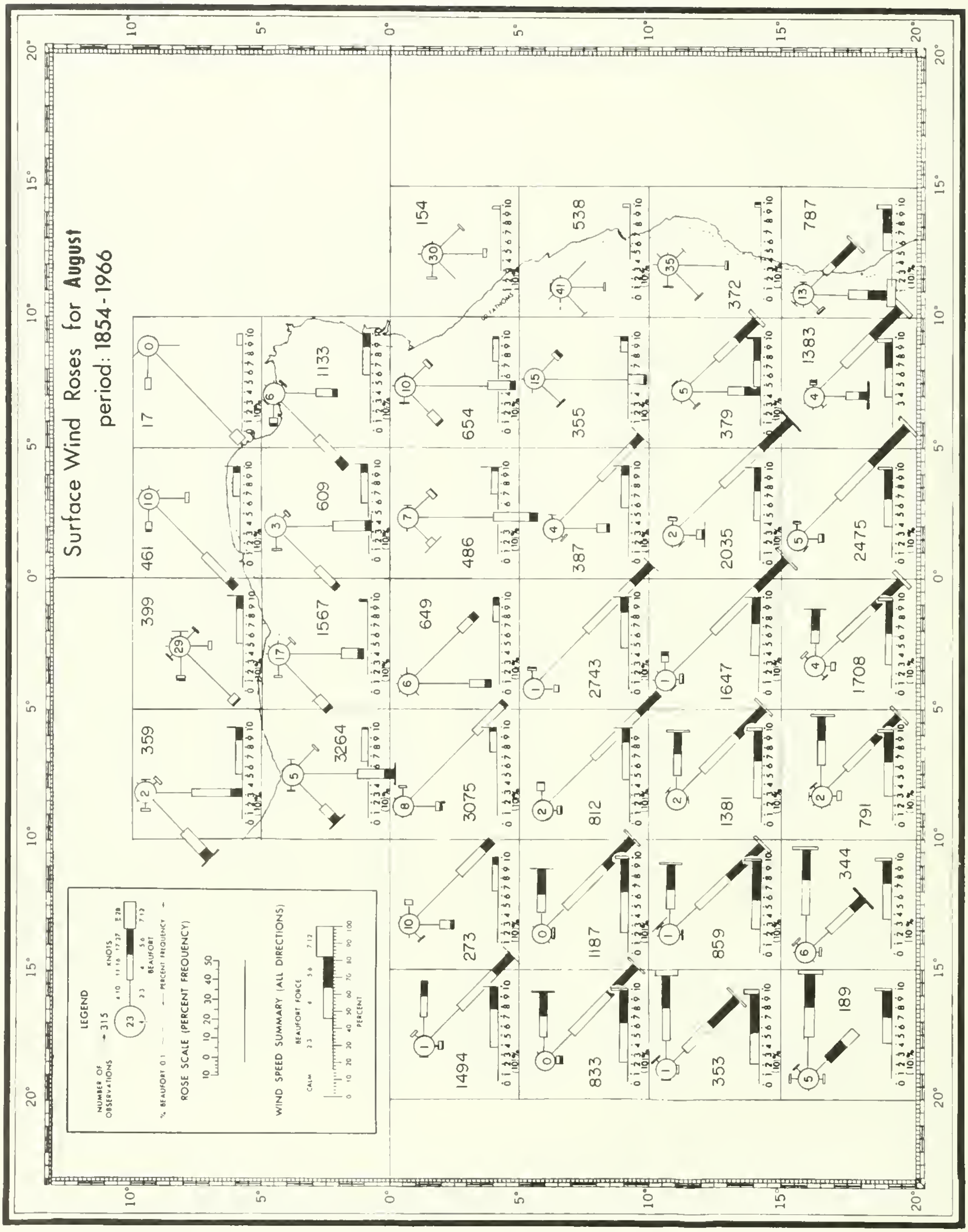


Figure 8.—Wind rose chart, July 1854-1966.



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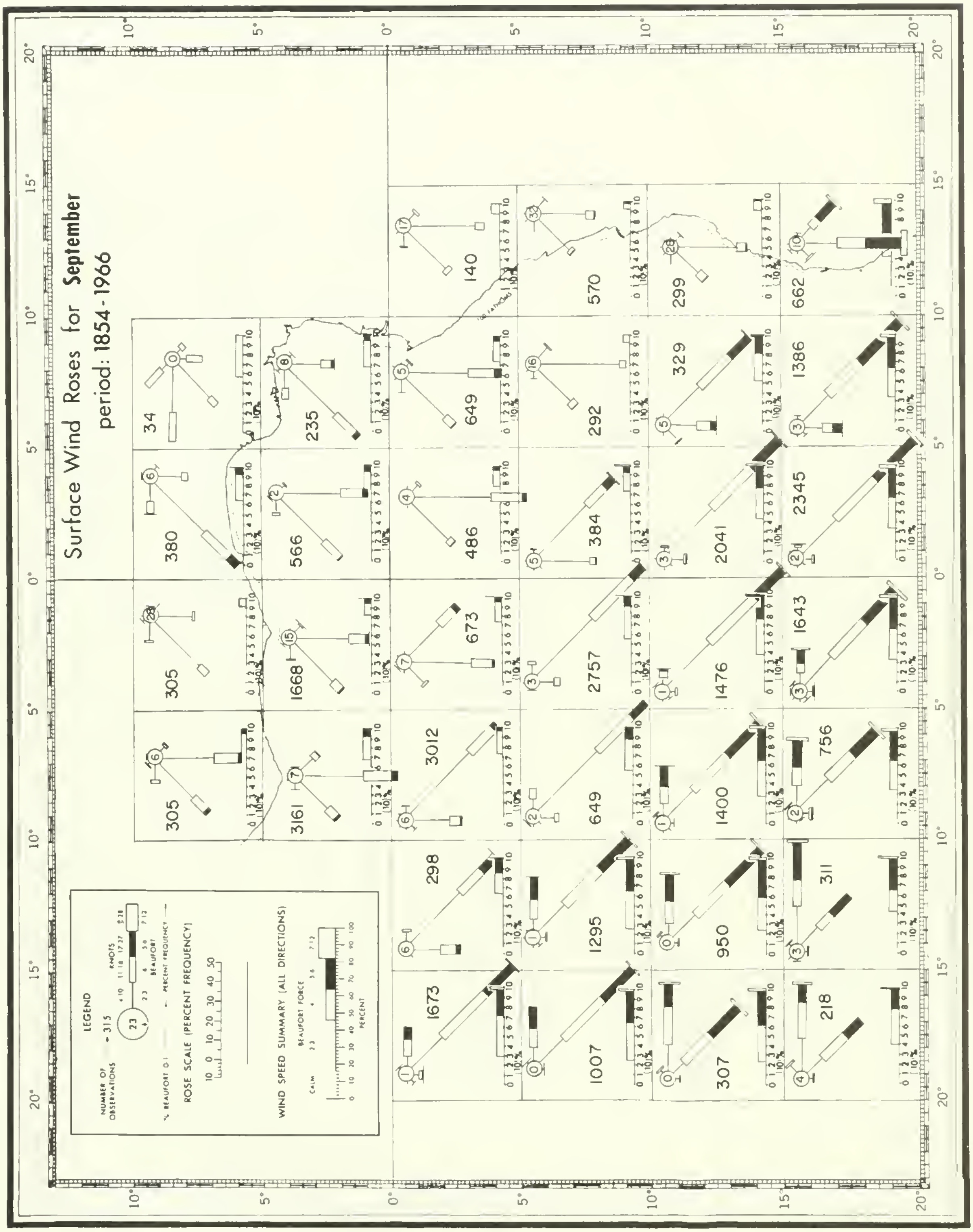

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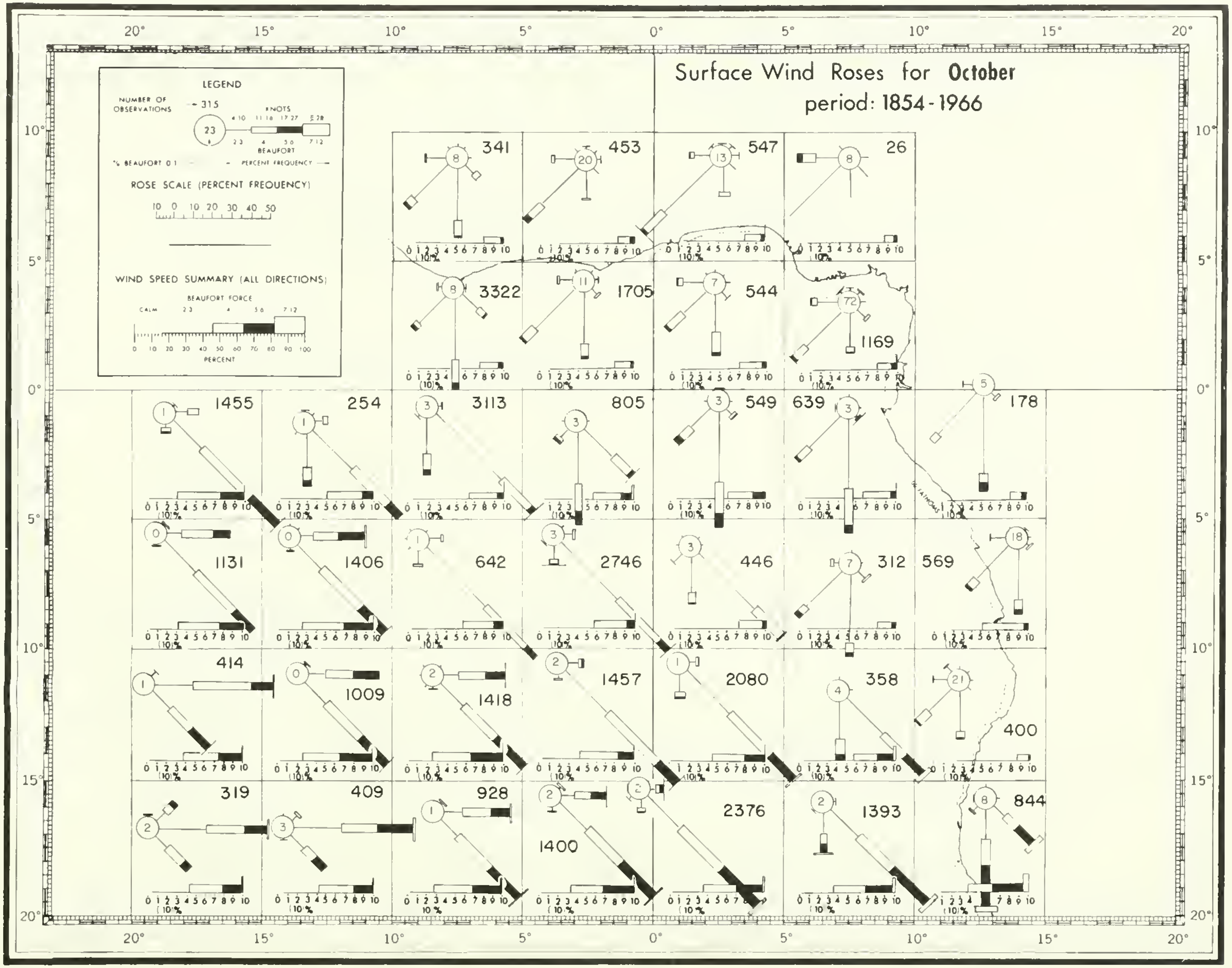

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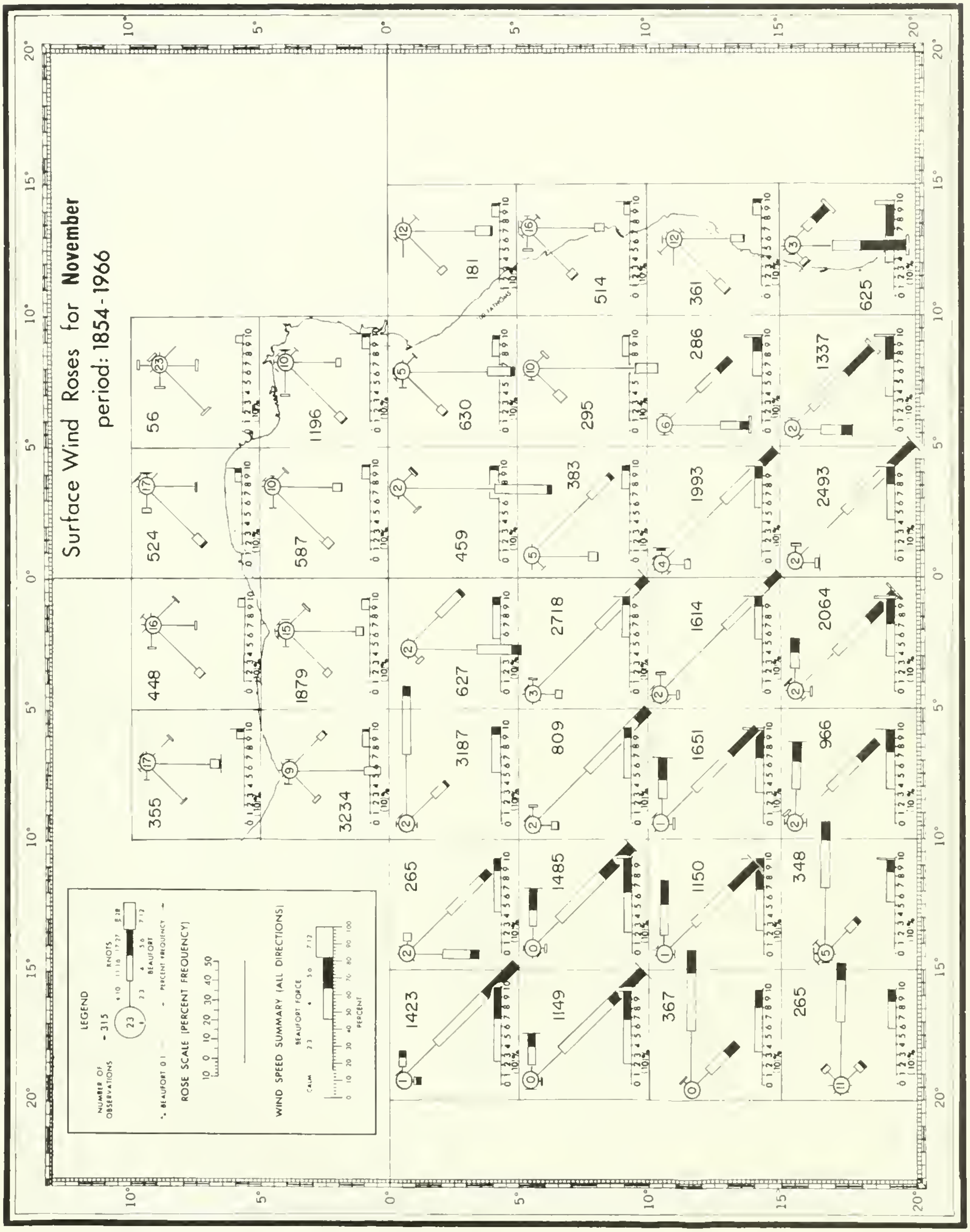

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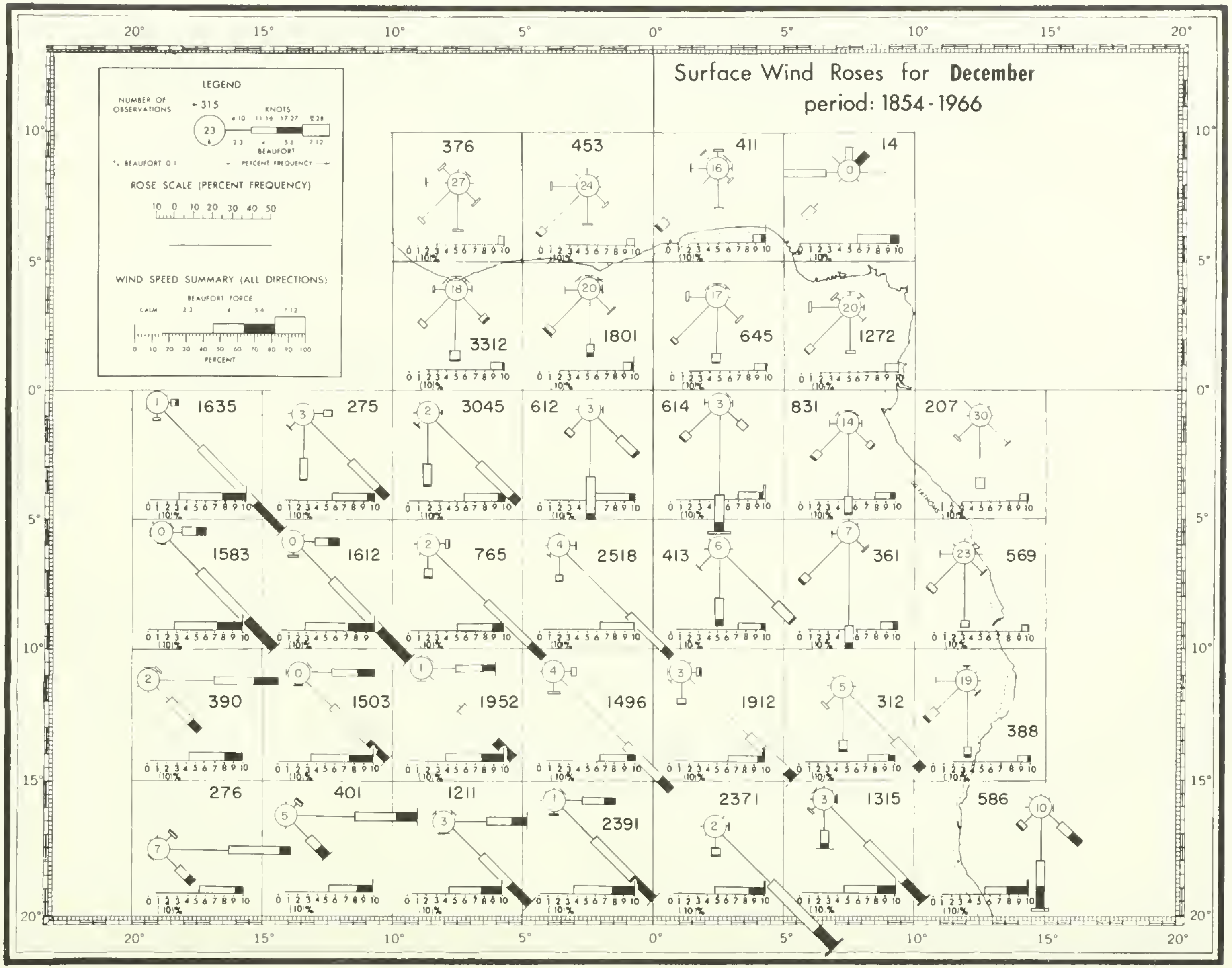

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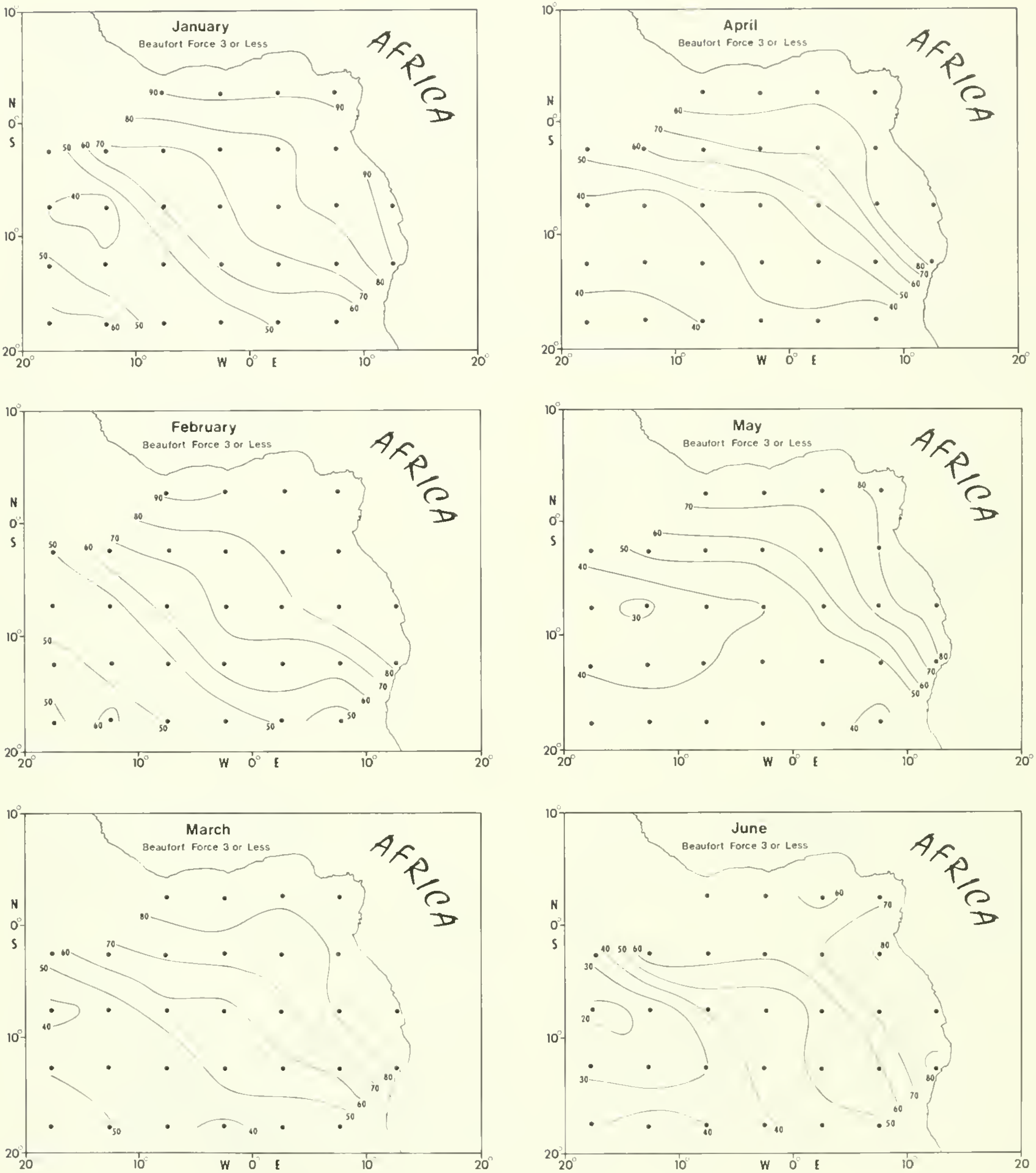
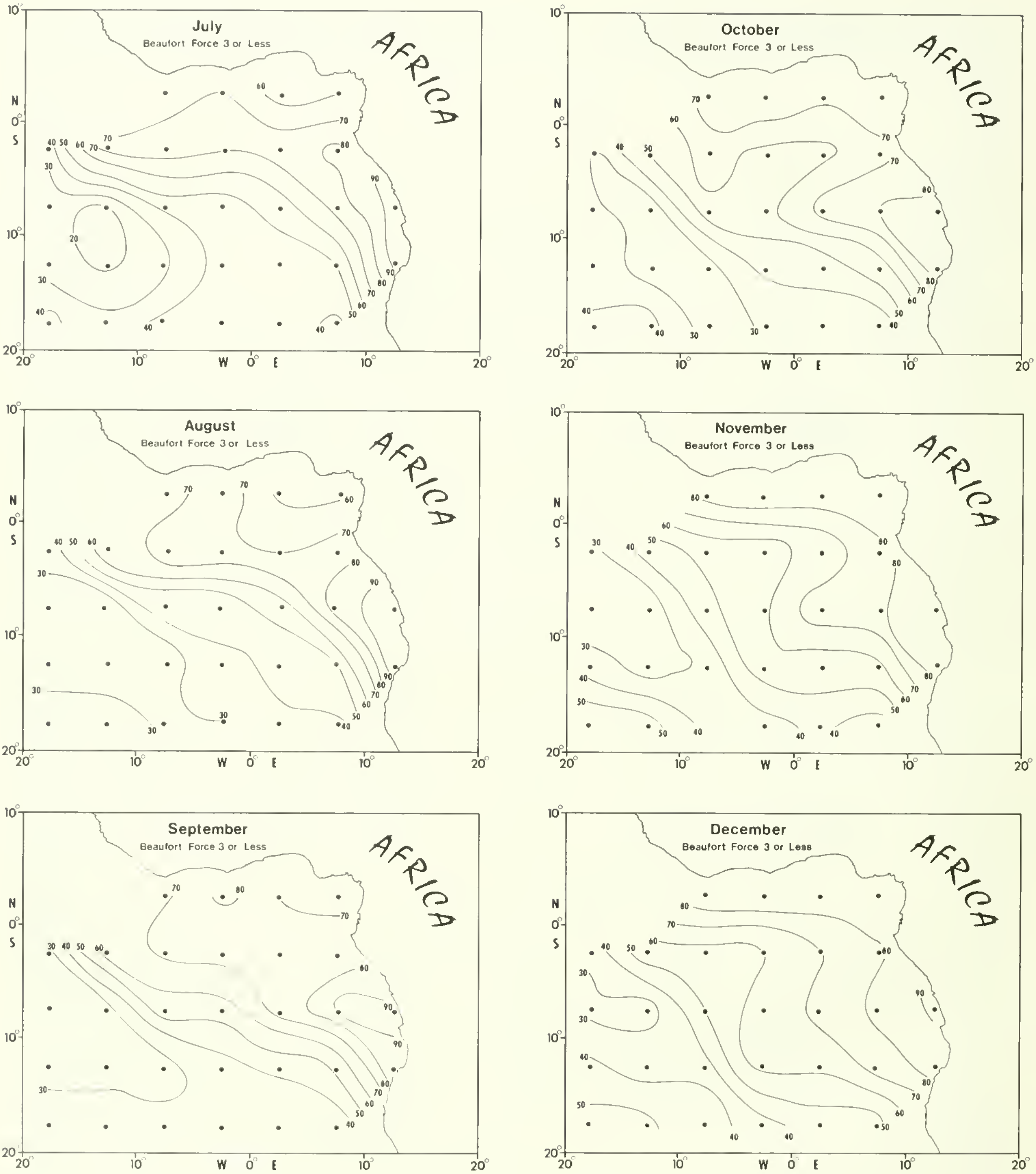


Figure 14.—Percentage frequency of occurrence of winds of speeds of Beaufort Force 3 or less, January-June.



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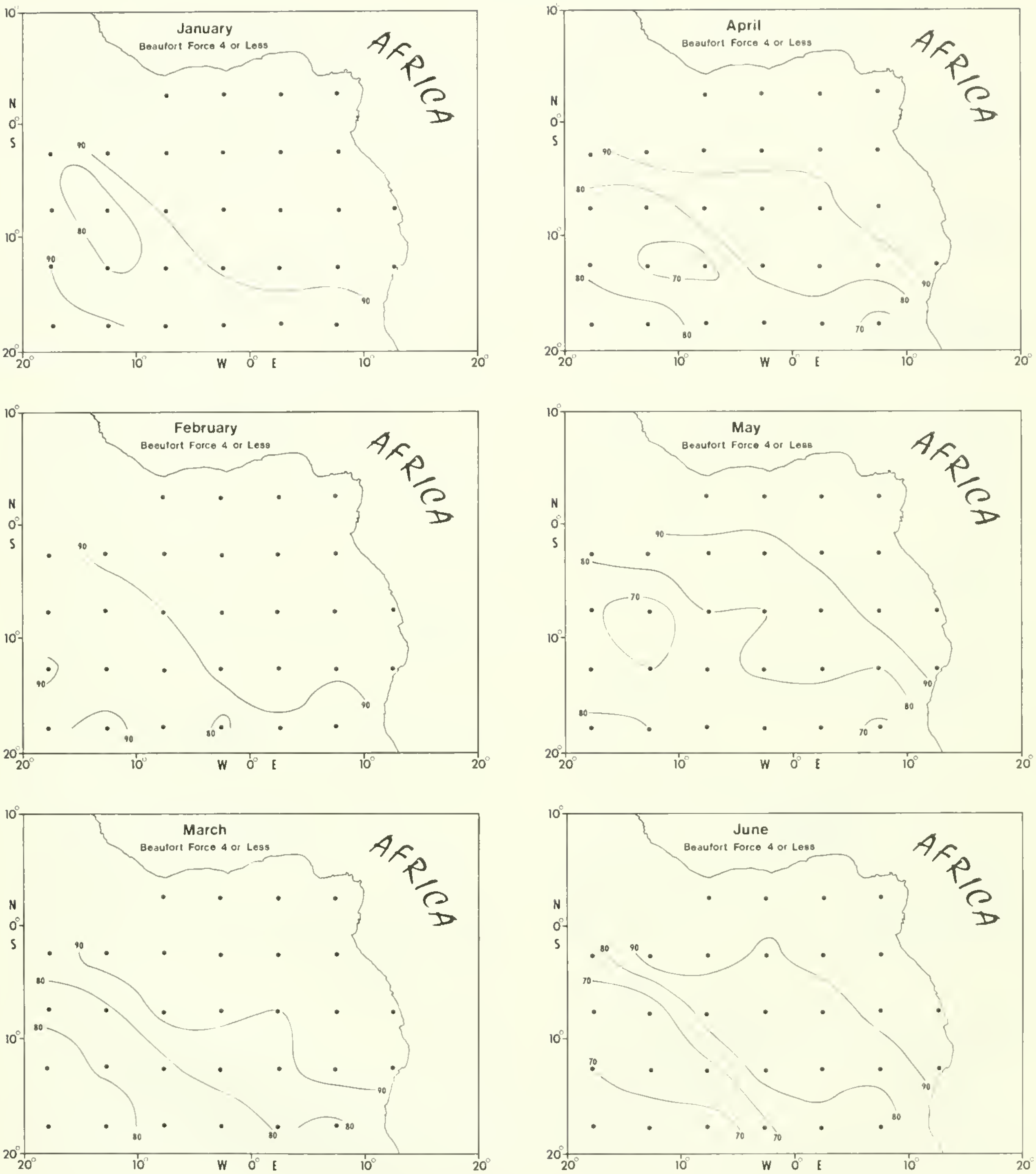

Figure 16.—Percentage frequency of occurrence of winds of speeds of Beaufort Force 4 or less, January-June.

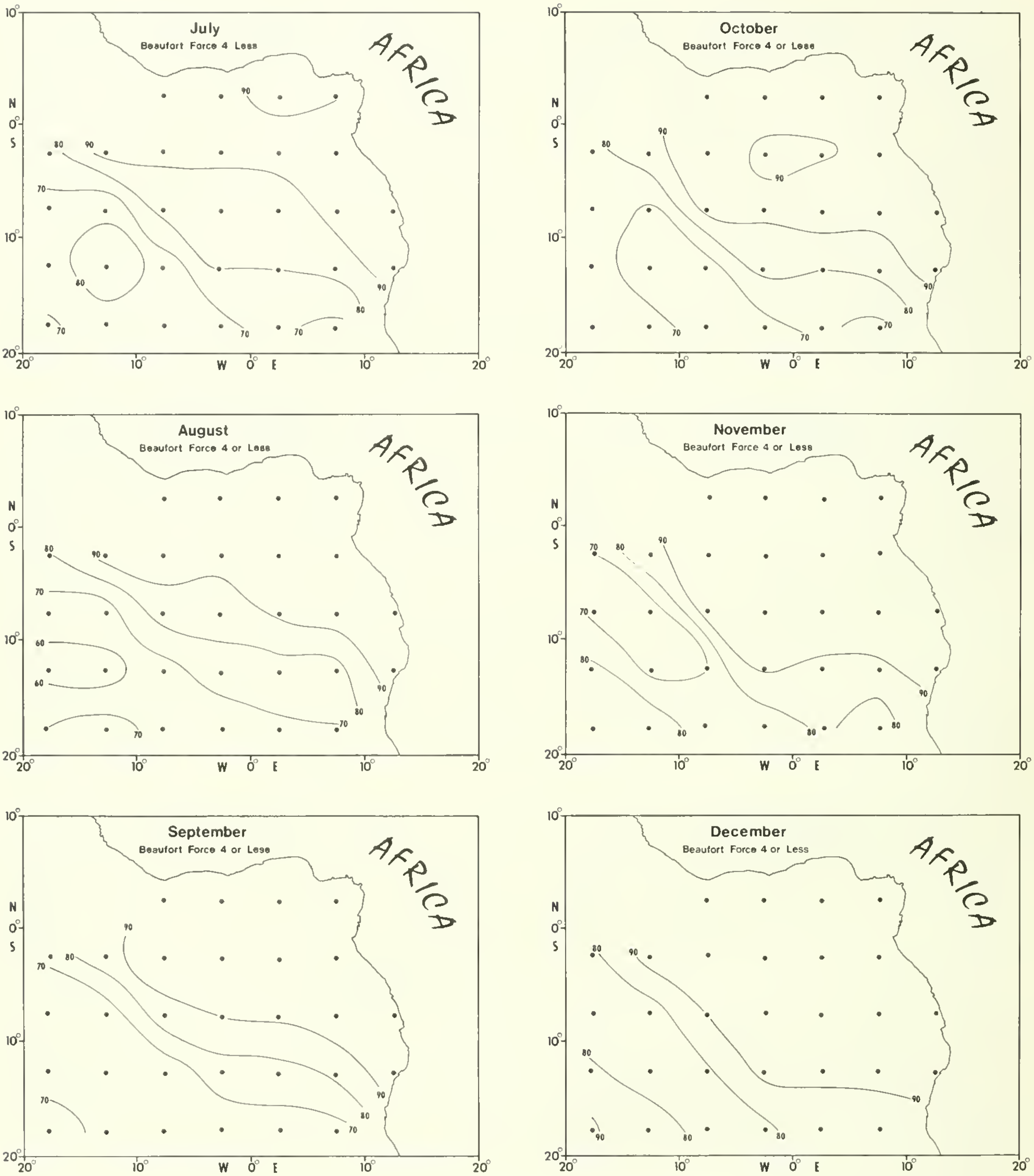

Figure 17.—Percentage frequency of occurrence of winds of speeds of Beaufort Force 4 or less, July-December.

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