MONTHLY WEATHER REVIEW

Editor, ALFRED J. HENRY

VOL. 58, No. 1
W. B. No. 1006

JANUARY, 1930

CLOSED MARCH 3, 1930
ISSUED APRIL 9, 1930

CYCLONES AND ANTICYCLONES OF THE NORTHERN HEMISPHERE, JANUARY TO APRIL, INCLUSIVE, 1925

By CHARLES L. MITCHELL

[Weather Bureau, Washington, December, 1929]

SYNOPSIS

INTRODUCTION

There has arisen during the past several years an insistent demand for daily synoptic weather maps of the entire Northern Hemisphere. It has been realized for a long time that a chain of meteorological stations along or near the Arctic Circle is essential to a proper study of pressure and temperature conditions over the entire hemisphere with the objective in view of forecasting weather and temperature for a week or more ahead with a satisfactory degree of accuracy. Furthermore, the additional knowledge of the behavior of the large masses of cold and of warm air will enable forecasters to increase the accuracy of their 36 to 48 hour forecasts.

The difficulties in the way, especially in regard to means of instantaneous communication, have prevented the consummation of such a plan up to the present time, but the amazing progress made during the last two or three years in perfecting high-frequency radio transmission with low-power transmitters encourages meteorologists to believe that the dream of a complete daily weather map of the Northern Hempishere will be realized within the next few years.

It is regrettable that, as pointed out by Henry,[1] the international polar stations of 1882 were established at a time when a very wide gap (1,200 miles or more) separated them from the northern border of the existing network of meteorological stations to the southward. It was not possible, of course, to utilize the results of the polar stations in the day-to-day forecasting of that time.

So far as the writer has been able to ascertain, no daily meteorological data have ever been published for the Siberian coast from the mouth of the Lena River to Bering Strait—a stretch of 1,356 miles embracing 60 degrees of longitude—nor for the 75-degree stretch from the mouth of the Mackenzie River eastward to the Greenland coast, about 1,675 statute miles. Data received either currently or by delayed mail from Point Barrow, Alaska, the lower Mackenzie Valley, Greenland, Jan Mayen, Spitsbergen, Nova Zembla, and the mouth of the Yenesei River have made it possible to construct charts showing fairly well for recent years the pressure distribution over the polar region. However, it has remained a disputed question as to the origin of the outbursts of polar air that frequently move southeastward over the British Northwest Territory and northern and eastern Alaska.[2]

AMUNDSEN EXPEDITION

Contribution by Sverdrup.—During the autumn of 1925, H. U. Sverdrup, meteorologist of the Amundsen expedition on the *Maud* during the years 1922–1925, lectured to the scientific staff of the Weather Bureau at Washington. He told of the meteorological work during the period that the *Maud* was frozen fast in the ice near Bear Islands off the Siberian coast at latitude 70° 40′ N., longitude 162° 25′ E. Upon learning that I had planned to make a study of outbursts of polar air over northeastern Siberia and northern North America, he kindly furnished complete twice-daily observations taken on the *Maud* during the period from January 1 to May 14, 1925. At that time (1925) the Weather Bureau was receiving daily data covering the rather limited area as shown on the map (isobars only) of December 31, 1924. (Fig. 1.) With the *Maud* data as a nucleus the great uncharted area of the Northern Hemisphere was gradually filled in with data secured from various sources until finally it was practicable to construct quite complete charts such as the one of February 28, 1925. (Fig. 2.)

OBSERVATIONAL MATERIAL AVAILABLE IN 1929 FOR CONSTRUCTING THE DAILY WEATHER MAP

At the present time (1929) reports are received at Washington each morning from more than 250 stations in North America, Greenland, and the West Indies, all of which, together with numerous reports from vessels in the Caribbean Sea, the Gulf of Mexico, the western Atlantic Ocean, and the eastern Pacific Ocean, are entered

[1] Henry, A. J., Whence Come Cold Waves, MONTHLY WEATHER REVIEW, 56: 143.

[2] Loc. cit. p. 144.

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on the forecast charts. On the weather maps of the various meteorological services of Europe, Asia, and northern Africa there are published a total of nearly 600 reports. About 275 of these are from stations in Europe, 57 from northern Africa, almost 150 from stations in India, and about 115 from stations situated elsewhere in Asia (including the Philippines and the Japanese Archipelago). Thus there are available (lacking only means of transferring them to some suitable center) daily meteorological reports from more than 850 land stations in the Northern Hemisphere, besides reports from at least 100 vessels. Of course it would be neither desirable nor practicable to collect and publish all of these available reports at any one collecting center. Reports would be needed at Washington from only a small percentage of the meteorological stations in Europe, India, and extreme northern Africa.

Data from Point Barrow for the first four months of 1925 were secured from reports received by mail; data from stations in the British Northwest Territory were copied from the Canadian Monthly Record of Meteorological Observations, and the European and Siberian data from Leningrad and Vladivostok maps. The maps of the Italian, Indian, Egyptian, and Algerian meteorological services were also of value in completing the charts for the more southerly latitudes, and the daily maps of the Kobe, Japan, and Zi-Ka-Wei, China, observatories furnished valuable data for the

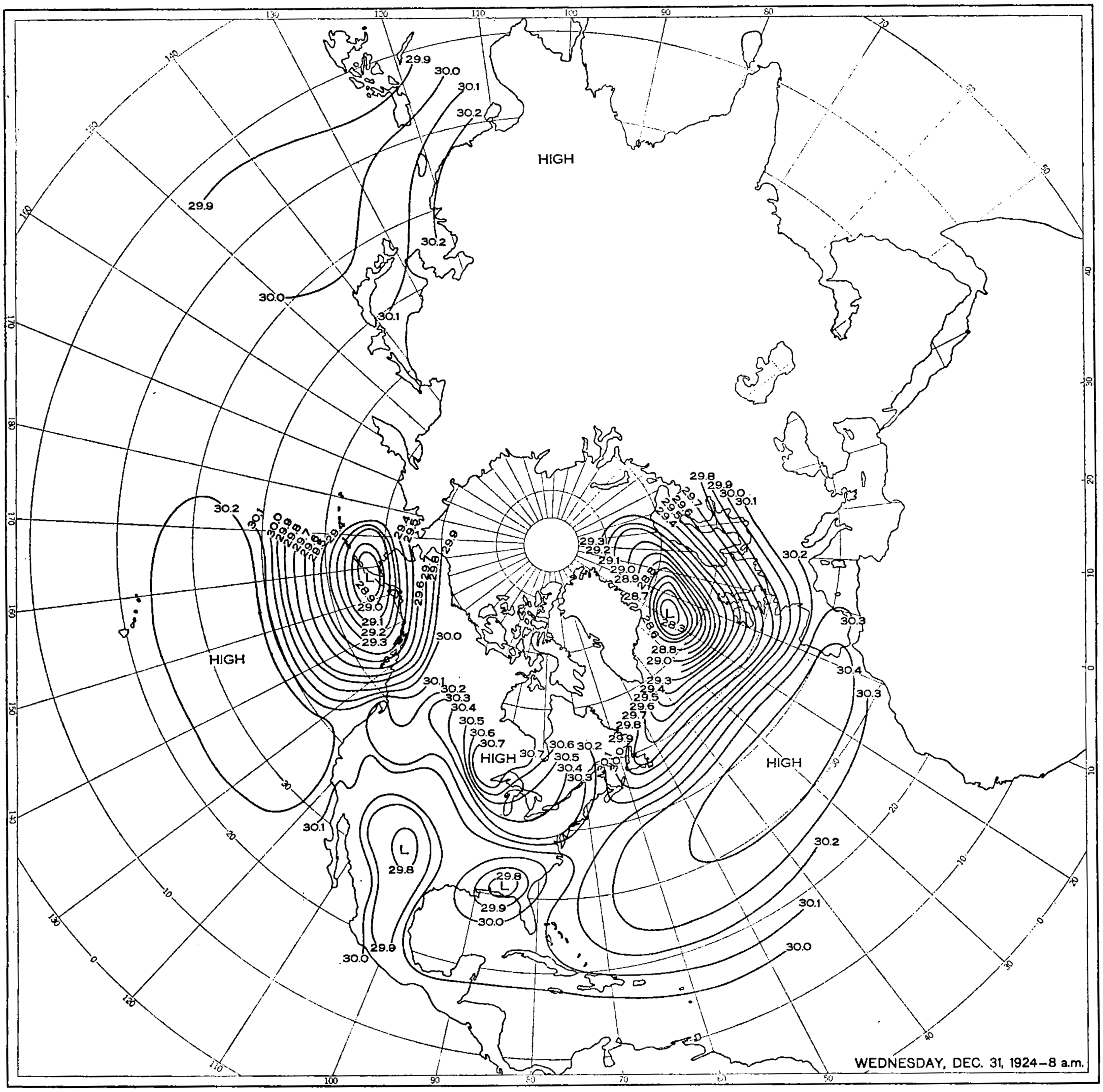

FIGURE 1.—Isobars, Northern Hemisphere, 8 a. m. seventy-fifth meridian time, December 31, 1924

western Pacific Ocean and the Asiatic coast south of the Sea of Okhotsk. Quite a gap still existed in northern regions, however, comprising the vast area from the Mackenzie Valley and Lake Winnipeg eastward over the remainder of British North America and all of Greenland. It was learned that the Danish Meteorological Institute maintained a number of regular observing stations in Greenland (reporting by mail at that time, but now by radio), and, upon request, the director of the Danish service furnished twice-daily reports from six places, the most northerly one being Upernivik at latitude 72° 47′ N., longitude 56° 7′ W.

During a visit to the central office of the Canadian Meteorological Service at Toronto the very gratifying information was obtained that regular reports were available from a few places in the Hudson Bay-Baffin Land region. Copies of twice-daily observations made at the following stations were obtained: Chesterfield Inlet and Port Harrison, both on Hudson Bay; Fort Chimo, near the eastern end of Hudson Strait; and Ponds Inlet, in Baffin Land at latitude 72° 43′ N., longitude 78° 30′ W.

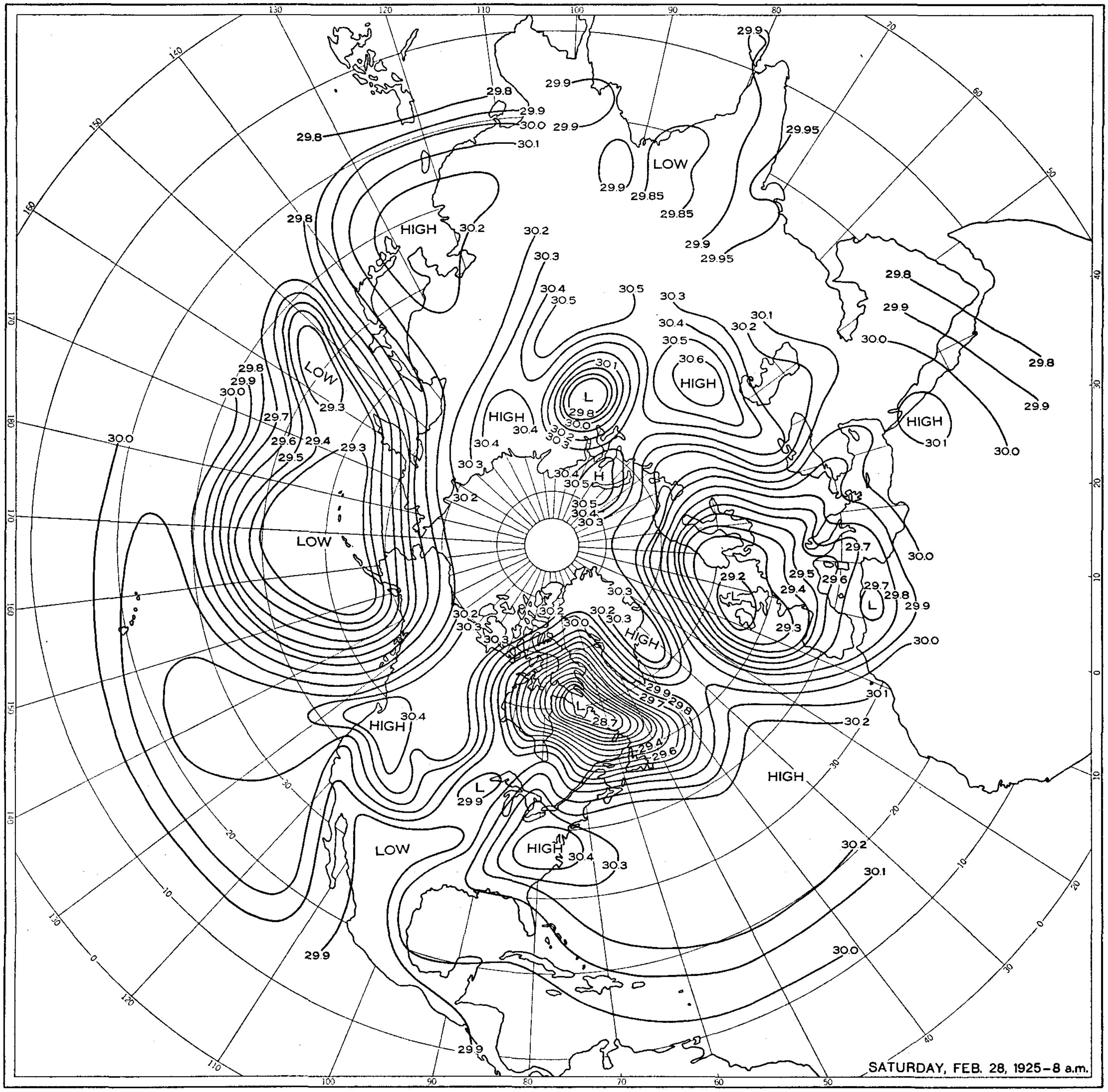

FIGURE 2.—Isobars, Northern Hemisphere, 8 a. m. seventy-fifth meridian time, February 28, 1925

CONSTRUCTION OF DAILY WEATHER MAPS OF NORTHERN HEMISPHERE, JANUARY–APRIL, 1925

After entering data from all stations near or above the Arctic Circle and from selected stations below that Circle on the daily a. m. Northern Hemisphere weather maps, the isobars were extended to include all cyclones and anticyclones of consequence of the entire hemisphere.

The paths of all cyclones and anticyclones and the location of the centers each 24 hours, as well as the approximate location of the place of dissipation or disintegration, were carefully plotted for the months of January, February, March, and April, 1925. (Figs. 3–6.) The complete tracks of all cyclones and anticyclones that were in existence during any particular month appear on the chart for that month, even though there is repetition in cases where the life histories began in the previous month or continued into the next month.

PATHS OF CYCLONES AND ANTICYCLONES BY MONTHS

January, 1925 (fig. 3).—The outstanding features during the month were the almost constant succession of cyclones from the North Pacific Ocean over British Columbia, and from the Newfoundland region northeastward over Iceland or southern Greenland and northern Scandinavia, and the equally large number of anticyclones that moved southeastward over the Mackenzie Basin and from the Pacific Ocean eastward over the southern half of the United States, the Bermuda and Azores regions and southern Europe. The centers of only two cyclones appeared over North America as far south as Utah and none over central or southern Europe, except two over the eastern Mediterranean.

As might have been expected from the number of anticyclones that moved southeastward from the Mackenzie Basin over Manitoba and the northern Lake region, there were frequent periods of low temperature during the month in the northeastern part of the United States, while in the Southern States the periods of temperature above normal were most pronounced.

February (fig. 4).—The cyclones from the north Pacific reached the coast farther south, on an average, than during January, thus permitting several of the anticyclones from the Mackenzie Basin to move southeastward over the Dakotas, while numerous cyclones moved eastward or northeastward over the Lake region. These changes in pressure distribution over North America resulted in more air of tropical origin reaching the eastern part of the United States, and, consequently, temperatures above normal greatly predominated. The cyclones from the North Atlantic also passed over northern Europe in more southerly latitudes and pressure over southern Europe averaged much lower than during the previous month, although few centers of cyclones appeared that far south.

March (fig. 5).—The pressure distribution over North America was quite similar to that during February, and, consequently, temperature conditions were much the same over the United States, the mild type predominating. However, over the remainder of the Northern Hemisphere conditions changed materially during March. Several cyclones appeared over southern Europe and extreme northern Africa, and few cyclones, but several anticyclones, passed over the British Isles. The majority of the North Pacific disturbances passed eastward with their centers north of the Aleutian Islands, instead of south of these islands as in January and February. A number of anticyclones moved southeastward or southward over central Siberia and eventually eastward over China and Japan, two of them crossing the Pacific Ocean.

April (fig. 6).—During the winter months the paths of the cyclones and the anticyclones were grouped within comparatively narrow limits. There was little tendency in April toward such grouping, especially over North America, the Atlantic Ocean and Europe. On the contrary the paths of the cyclones were fairly well distributed from Baffin Land, northern Greenland and Spitzbergen southward almost to the Tropics. This was due, no doubt, to the slowing up of the general circulation with the advent of spring and to the blocking effect of stationary or slow-moving anticyclones, especially those that, during the spring months, move southeastward from the Hudson Bay-Baffin Land region. The slowing up of the general circulation in the spring is due to the lessening of the temperature gradient from south to north as the sun advances northward.

The temperature during April averaged considerably above normal over practically the entire United States and southern Canada for the third successive month. This was undoubtedly due to the almost entire absence of cyclones over the extreme southern part of the United States. Unless cyclonic conditions exist over the far south, the cold polar air of the Canadian anticyclones does not travel southward either fast or far.

STATISTICS OF CYCLONES AND ANTICYCLONES

Statistics of the origin and movement of all cyclones and anticyclones of the Northern Hemisphere during the four months in question will be found in Table 1. Each primary cyclone or anticyclone is designated by a number, 1, 2, 3, etc., its secondaries, if any, by the same number and a single appropriate letter, *a*, *b*, *c*, etc., and other secondaries that develop, not in connection with the primary cyclone, but in close relation to a secondary, are designated by the number and letter of the originating secondary, together with an additional letter, and so on down the family line until the end. If, for example, the primary cyclone is No. 1, its secondaries are 1a, 1b, 1c, etc.; secondaries of 1a, 1b, 1c, etc., are 1aa, 1ba, 1ca, etc.; and further secondaries of 1aa, etc., are 1aaa, 1baa, 1caa, etc. In case 1aa gives rise to two or more secondaries, they are identified by 1aaa, 1aab, 1aac, etc. In an extreme case in the table one of the secondary anticyclones is No. 3aabaaaab, indicating an extremely long family line covering a great expanse of territory and several weeks of time. In the tabulation the cyclones and anticyclones are separated into principal areas of development, such as the western Pacific Ocean, North America, etc., and the primaries are tabulated by months, although the family line often extends well into the ensuing month. Each cyclone and anticyclone is given a number, arbitrarily designating the one originating nearest the eastern Asiatic coast as No. 1, irrespective of the date of development during the month. Then follows the longitude and latitude of origin, and ending in degrees of longitude and latitude covered during its life with respect to the place of origin, the length of life of each primary, followed by the same data for any secondaries that may develop, and, in addition, in the last column is given the location of the place of development of each secondary with respect to the place of dissipation of its primary cyclone or anticyclone (whether primary or secondary). If any similar attempt to tabulate data of the life histories of cyclones and anticyclones by families and to segregate them into principal areas of development has been made the author is not aware of it.

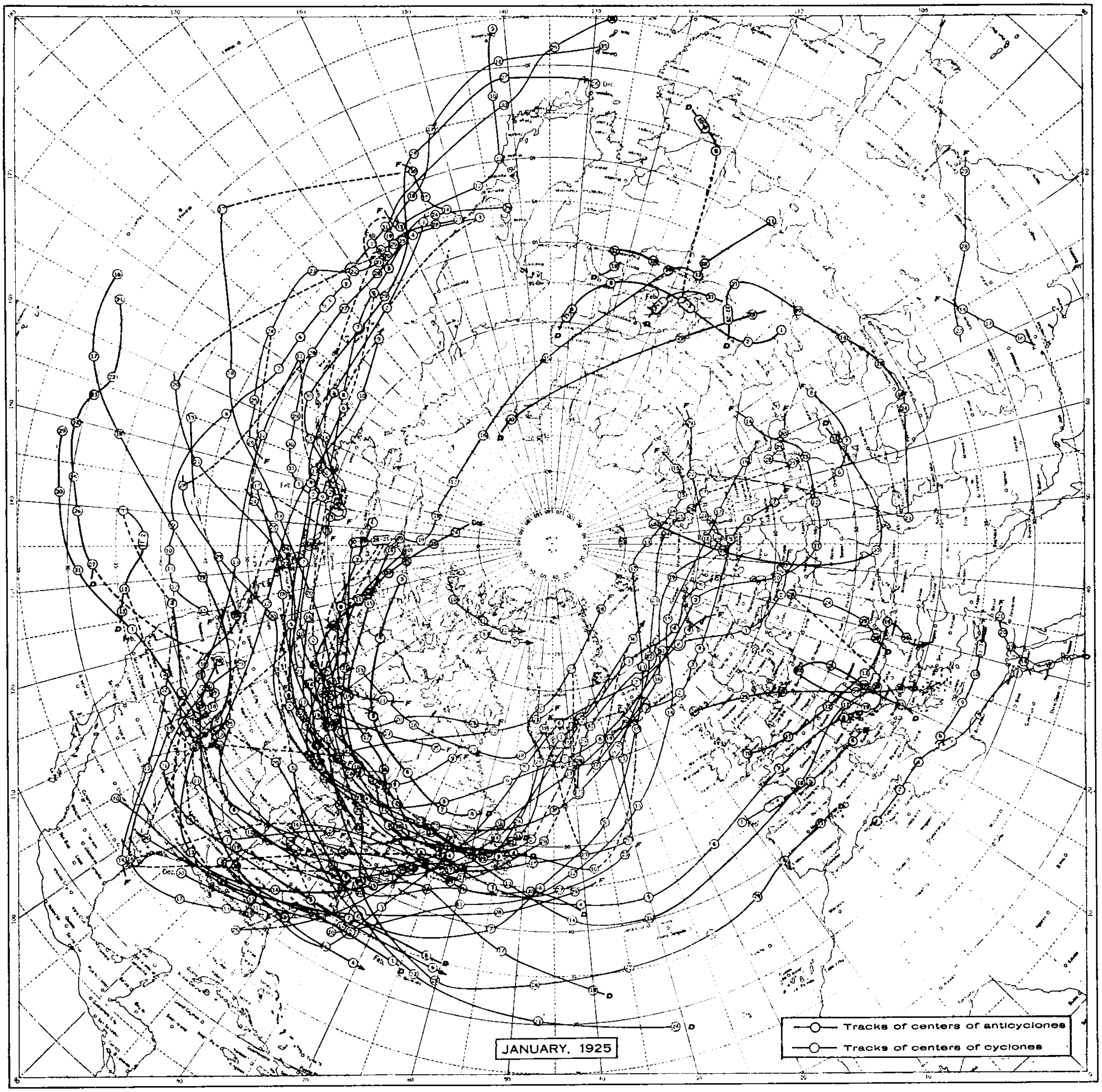

FIGURE 3.—Tracks of centers of cyclones in black and anticyclones in red, January, 1925

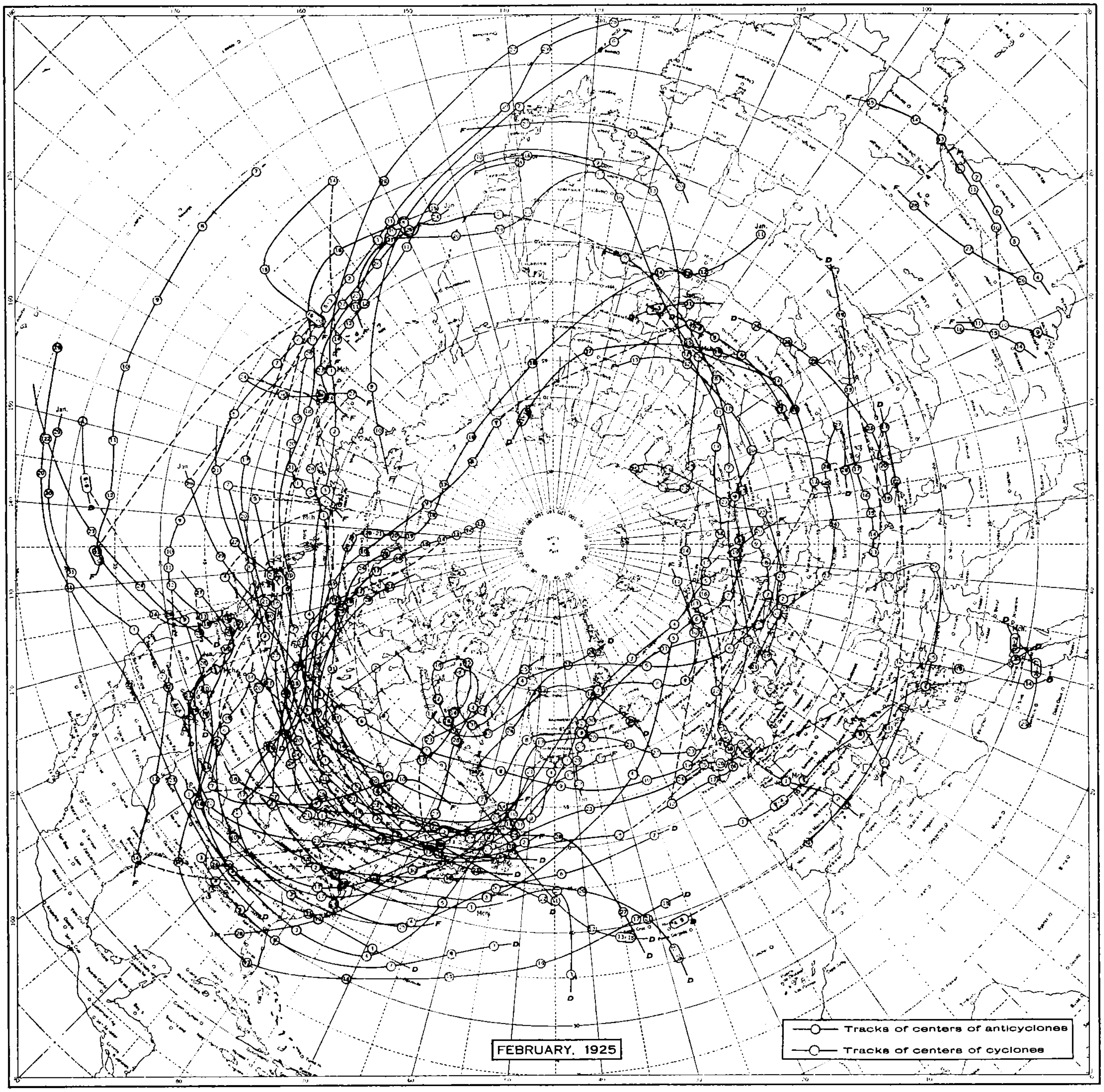

FIGURE 4.—Tracks of centers of cyclones in black and anticyclones in red, February 1925

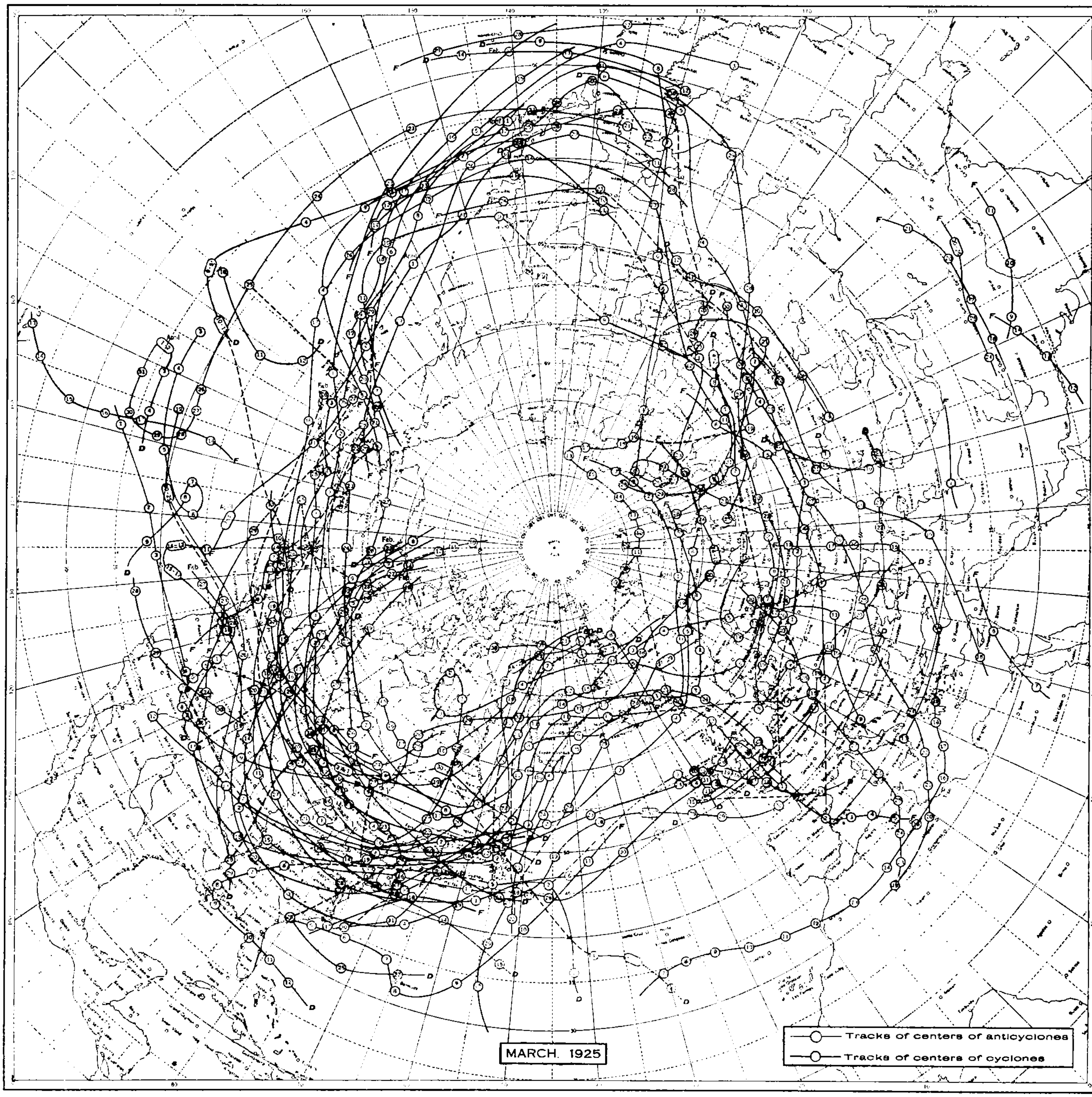

FIGURE 5.—Tracks of centers of cyclones in black and anticyclones in red, March, 1925

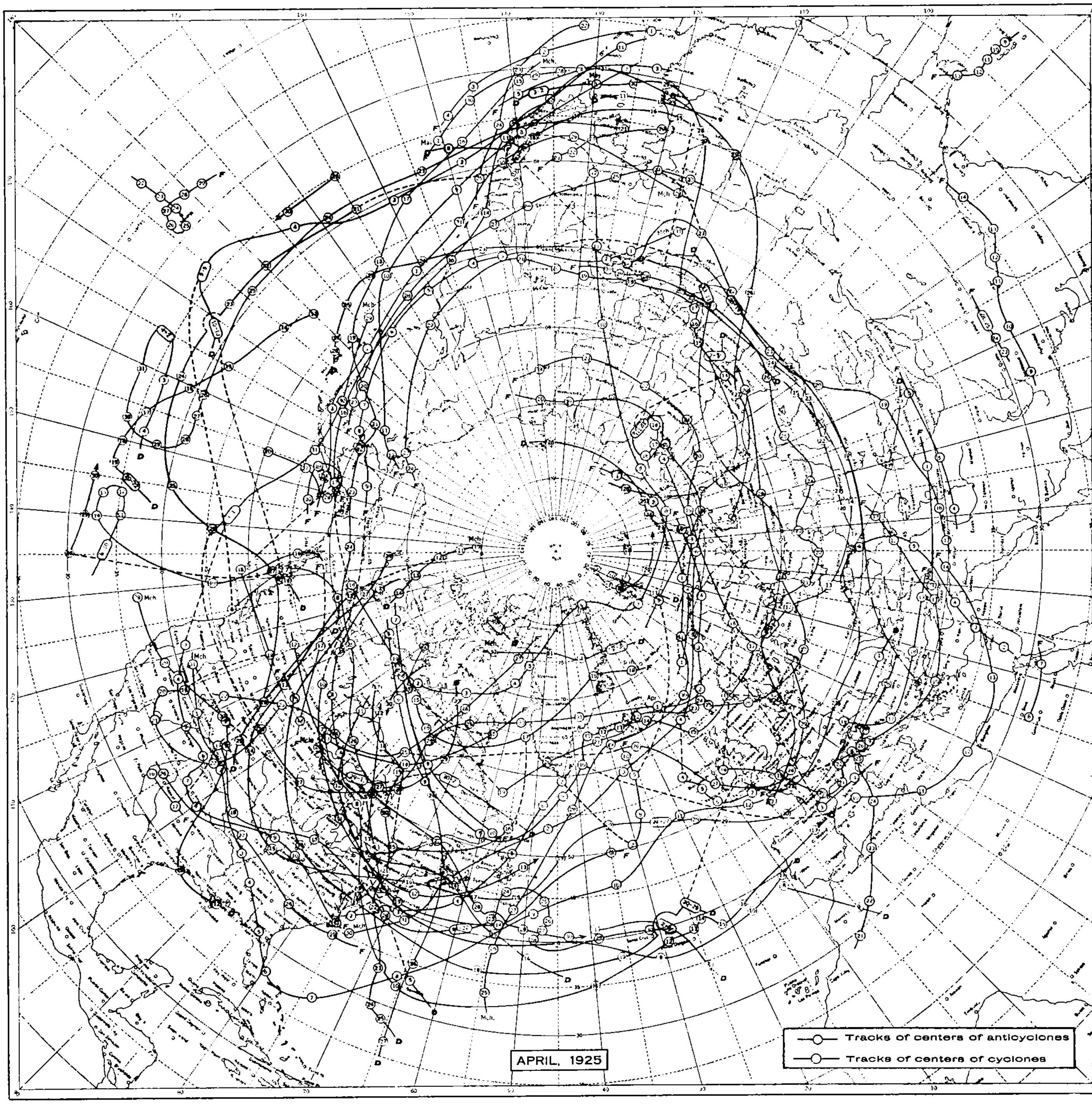

FIGURE 6.—Tracks of centers of cyclones in black and anticyclones in red, April, 1925

TABLE 1.—*Life history of cyclones and anticyclones*

Primary: No.	Primary: Origin, Longitude	Primary: Origin, Latitude	Primary: Distance traveled with reference to place of origin		Primary: Life	Secondary: No.	Secondary: Origin, Longitude	Secondary: Origin, Latitude	Secondary: Distance traveled with reference to place of origin		Secondary: Life	Secondary: Beginning, with reference to place of ending of primary or previous secondary	
JANUARY, 1925													
CYCLONES NOS. 1-20													
WESTERN PACIFIC OCEAN													
	°	°	°	°	*Days*		°	°	°	°	*Days*	°	°
1	128 E	25 N	110 E	15 N	17	1a	114 W	38 N	20 E	10 S	3	10 E	5 S
						1aa	78 W	38 N	50 E	20 N	4	15 E	10 N
2	128 E	29 N	80 E	20 N	12	2a	158 W	37 N	80 E	20 N	·6	5 W	10 S
						2b	141 W	51 N	10 E	5 N	3	10 E	0
						2bb	99 W	50 N	15 E	0	2	40 E	0
						2bba	103 W	40 N	20 E	0	2	15 W	5 S
						2ba	105 W	42 N	135 E	20 N	9	25 E	10 S
						2baa	99 W	27 N	60 E	15 N	4	5 E	15 S
						2baaa	84 W	27 N	120 E	35 N	9	45 W	15 S
3	142 E	26 N	20 E	15 N	5	3a	160 W	57 N	25 E	0	4	35 E	15 N
						3aa	118 W	55 N	40 E	10 S	3	40 E	0
						3ab	147 W	51 N	80 E	10 N	5	15 E	5 S
4	143 E	47 N	75 E	15 N	16	4a	145 W	41 N	180 E	25 N	9	5 W	20 S
						4aa	101 W	32 N	120 E	40 N	11	135 W	30 S
						4aaa	81 W	35 N	195 E	30 N	12	100 W	40 S
5	148 E	47 N	120 E	15 N	8	5a	170 W	58 N	65 E	5 S	3	80 W	0
						5b	174 E	54 N	85 E	15 S	5	95 W	5 S
						5c	170 W	50 N	85 E	20 S	9	80 W	10 S
						5ca	87 W	40 N	150 E	30 N	12	5 W	10 N
						5caa	62 E	57 N	10 E	0	4	0	10 S
						5cb	91 W	34 N	60 E	10 N	5	10 W	5 N
						5d	102 W	36 N	90 E	35 N	6	10 W	25 S
						5da	44 W	52 N	135 E	15 N	7	35 W	20 S
						5daa	47 E	42 N	15 E	0	2	40 W	20 S
6	152 E	47 N	15 E	0	4								
7	152 E	44 N	5 E	5 S	3	7a	179 E	32 N	140 E	35 N	7	20 E	10 S
						7aa	70 W	48 N	60 E	25 N	7	30 W	20 S
						7aaa	42 W	55 N	70 E	5 N	7	30 W	25 S
8	157 E	44 N	135 E	10 N	9	8a	94 W	45 N	175 E	25 N	12	25 W	10 S
						8b	69 W	44 N	160 E	20 N	9	0	10 S
NORTH AMERICA													
9	115 W	74 N	45 E	5 N	3								
10	112 W	47 N	30 E	5 S	4								
11	108 W	56 N	165 E	5 N	14	11a	57 E	52 N	20 E	5 S	3	0	5 S
12	102 W	58 N	55 E	5 N	5								
13 [1]						13a	103 W	48 N	185 E	15 N	13	45 E	10 S
14	106 W	27 N	35 E	5 N	3								
14½ [1]						14½a	93 W	29 N	110 E	35 N	6	10 E	5 S
15	85 W	73 N	20 E	0	2								
16	76 W	33 N	145 E	30 N	9								
SOUTHERN EUROPE AND NORTHERN AFRICA													
17	18 E	35 N	15 E	0	7								
18	31 E	30 N	5 E	0	4								
INDIA													
19	67 E	23 N	10 E	10 N	3								
20	72 E	30 N	15 E	5 S	3								
ANTICYCLONES NOS. 1-22													
EASTERN PACIFIC OCEAN													
1	168 W	26 N	65 E	15 N	9	1a	95 W	43 N	65 E	15 S	5	10 E	0
2	165 W	29 N	35 E	5 N	7	2a	115 W	43 N	55 E	15 S	5	15 E	10 N
3	155 W	40 N	45 E	0	6								
4	148 W	28 N	40 E	5 N	7								
5	140 W	35 N	15 E	0	13	5a	127 W	41 N	20 E	5 S	8	15 E	5 N
						5aa	99 W	33 N	45 E	5 S	3	5 E	5 S
						5ab	89 W	31 N	30 E	5 N	3	15 E	5 S
						5ac	95 W	37 N	35 E	5 N	3	10 E	0
						5b	108 W	35 N	70 E	5 S	7	15 E	0
NORTH AMERICA AND ARCTIC REGIONS TO NORTH													
6	150 W	75 N	165 E	30 S	16	6a	92 W	33 N	20 E	0	3	105 W	15 S
7	142 W	66 N	160 E	30 S	18	7a	29 W	58 N	10 W	10 S	4	10 E	25 N
8	135 W	72 N	95 E	40 S	9								
9	133 W	67 N	85 E	20 S	8								
10	122 W	69 N	60 E	20 S	6								
11	110 W	51 N	25 E	5 S	2								

[1] December storm.

TABLE 1.—*Life history of cyclones and anticyclones*—Continued

Primary						Secondary							
No.	Origin: Longitude	Origin: Latitude	Distance traveled with reference to place of origin		Life	No.	Origin: Longitude	Origin: Latitude	Distance traveled with reference to place of origin		Life	Beginning, with reference to place of ending of primary or previous secondary	

JANUARY, 1925—Continued

ANTICYCLONES NOS. 1-22—Continued

EUROPE AND NORTHERN AFRICA

	°	°	°	°	*Days*		°	°	°	°	*Days*	°	°
12	2 W	51 N	35 E	10 S	7								
13	2 W	61 N	25 E	20 S	6								
14	5 E	43 N	10 E	5 S	2								
15	5 E	35 N	25 E	10 S	13								
16	29 E	25 N	5 E	10 S	4								

NOVA ZEMBLA REGION

17	58 E	76 N	40 E	20 S	4								

SIBERIA

18	70 E	42 N	0	10 N	9								
19	90 E	51 N	45 E	10 N	11	19a	113 E	35 N	5 E	5 S	3	20 W	25 S
20	95 E	51 N	80 E	25 N	3								
21	102 E	41 N	220 E	10 N	25	21a	105 W	54 N	110 E	15 S	10	65 W	5 N
						21aa	8 W	45 N	10 E	0	5	15 W	5 N
						21b	110 W	53 N	70 E	15 S	6	70 W	5 N
						21c	95 W	32 N	45 E	5 N	7	55 W	20 S
22	115 E	50 N	10 E	5 N	3								

FEBRUARY, 1925

CYCLONES NOS. 1-13

WESTERN PACIFIC OCEAN AND ASIATIC COAST

1	127 E	24 N	205 E	40 N	12	1a	116 W	43 N	120 E	30 N	12	85 W	20 S
						1aa	96 W	37 N	75 E	30 N	6	100 W	40 S
						1aaa	7 E	53 N	10 E	5 S	2	25 E	10 S
2	127 E	28 N	75 E	40 N	5								
3	115 E	40 N	30 E	5 S	3								
4	130 E	42 N	50 E	10 N	6	4a	166 E	36 N	20 E	10 N	7	15 W	15 S
						4aa	151 W	48 N	30 E	0	3	25 E	0
						4aaa	113 W	39 N	115 E	0	12	5 E	10 S
						4aaaa	76 W	37 N	15 E	0	2	80 W	5 S
						4ab	148 W	44 N	20 E	10 N	3	25 E	5 S
						4aba [3]	104 W	48 N	405 E	0	29	25 E	5 S
						4abaa	70 E	64 N	60 E	5 S	3	230 W	15 N
						4abaaa	145 E	47 N	35 E	10 N	3	15 E	15 S
						4abaaaa	126 E	42 N	40 E	5 N	3	50 W	15 S
						4abab	6 E	55 N	35 E	10 N	8	295 W	10 N
						4ac	134 W	33 N	5 E	0	3	45 E	10 S
						4ad	122 W	53 N	125 E	15 S	13	55 E	20 N
						4ada	28 E	34 N	10 E	15 N	3	25 E	5 S
						4adb	20 E	52 N	75 E	10 N	5	15 W	5 N
						4adc	29 E	56 N	50 E	5 N	4	20 E	15 N
5	140 E	42 N	5 E	0	1								
6 [2]						6a [4]							
						6b	130 W	47 N	180 E	30 N	11	10 E	15 S
						6ba	20 W	53 N	70 E	5 N	8	70 W	20 S
						6baa	24 E	68 N	45 E	5 S	4	25 W	10 N
						6bab	15 E	56 N	85 E	0	10	35 W	5 S
						6baba	8 E	39 N	10 E	0	2	80 W	15 S
						6babb	126 E	45 N	70 E	20 N	6	25 E	10 S
						6babba	132 W	52 N	10 E	10 S	3	35 E	10 S
						6bb	60 E	55 N	135 E	5 N	12	10 E	20 S
						6bba	164 W	44 N	10 W	15 N	4	0	15 S
						6bbaa	152 W	56 N	70 E	10 S	5	20 E	5 S
						6bbab	110 W	51 N	60 E	10 N	6	65 E	10 S
						6c	102 W	53 N	30 E	5 S	2	40 E	10 S
						6d	145 W	50 N	30 E	50 N	3	5 W	10 S
						6da	102 W	41 N	35 E	10 N	5	15 E	15 S
						6e	145 W	47 N	30 E	0	3	0	15 S
						6ea	105 W	39 N	50 E	15 N	6	10 E	10 S
						6eaa	76 W	56 N	5 E	5 N	6	20 W	0

[2] Around-the-world storm. [3] January cyclone No. 4. [4] January secondary No. 4a.

NORTH AMERICA

7	121 W	62 N	35 E	10 S	3	7a	111 W	47 N	105 E	10 N	10	25 W	5 S
8	98 W	39 N	95 E	15 N	6								
9	77 W	58 N	20 E	15 N	3								

INDIA

10	68 E	28 N	5 E	10 N	3								
11	68 E	23 N	5 E	5 N	3	11a	82 E	25 N	20 E	0	6	10 E	5 S
12	75 E	26 N	15 E	5 N	3								
13	75 E	22 N	10 E	5 N	4								

TABLE 1.—*Life history of cyclones and anticyclones*—Continued

FEBRUARY, 1925—Continued

ANTICYCLONES NOS. 1-15

PACIFIC OCEAN

Primary: No.	Primary: Origin, Longitude	Primary: Origin, Latitude	Primary: Distance traveled with reference to place of origin		Primary: Life	Secondary: No.	Secondary: Origin, Longitude	Secondary: Origin, Latitude	Secondary: Distance traveled with reference to place of origin		Secondary: Life	Secondary: Beginning, with reference to place of ending of primary or previous secondary	
	°	°	°	°	*Days*		°	°	°	°	*Days*	°	°
1	163 E	30 N	90 E	10 N	13								
2	158 E	25 N	75 E	5 N	6								
3	151 W	30 N	10 E	5 N	3	3a	123 W	42 N	100 E	0	10	20 E	5 N
4	147 W	26 N	30 E	15 N	4	4a	128 W	45 N	25 E	10 S	4	10 W	0

NORTH AMERICA AND ARCTIC REGIONS TO NORTH

Primary: No.	Primary: Origin, Longitude	Primary: Origin, Latitude	Primary: Distance traveled with reference to place of origin		Primary: Life	Secondary: No.	Secondary: Origin, Longitude	Secondary: Origin, Latitude	Secondary: Distance traveled with reference to place of origin		Secondary: Life	Secondary: Beginning, with reference to place of ending of primary or previous secondary	
5	155 W	80 N	110 E	35 S	12	5a	121 W	60 N	95 E	30 S	15	75 W	15 N
6	132 W	67 N	90 E	30 S	9	6a	76 W	50 N	40 E	15 S	4	35 W	15 N
						6aa	65 W	58 N	45 E	15 N	4	30 W	25 N
						6b	15 W	55 N	10 E	5 S	3	25 E	20 N
7	123 W	68 N	100 E	20 S	9	7a	55 W	61 N	40 E	10 S	6	30 W	10 N
						7aa	12 E	78 N	90 E	5 S	11	25 E	30 N
						7aaa	5 W	65 N	10 E	25 S	4	105 W	10 S
						7aaaa	20 W	52 N	20 E	0	5	25 W	10 N
						7aaaaa	13 E	50 N	50 E	0	9	15 E	5 S
						7aab	75 E	60 N	25 E	10 S	7	25 W	15 S
						7aaba	120 E	34 N	25 E	5 N	3	20 E	15 S
						7b	85 W	37 N	15 E	10 S	7	60 W	15 S
8	100 W	62 N	65 E	25 S	9								
9	97 W	54 N	45 E	10 S	3								
10	80 W	62 N	65 E	0	5								

EASTERN ATLANTIC OCEAN

Primary: No.	Primary: Origin, Longitude	Primary: Origin, Latitude	Primary: Distance traveled with reference to place of origin		Primary: Life	Secondary: No.	Secondary: Origin, Longitude	Secondary: Origin, Latitude	Secondary: Distance traveled with reference to place of origin		Secondary: Life	Secondary: Beginning, with reference to place of ending of primary or previous secondary	
11	28 W	38 N	5 E	0	6	11a	5 W	40 N	30 E	10 S	5	15 E	5 N
						11aa	52 E	42 N	10 E	0	2	25 E	15 N
						11aaa	43 E	47 N	50 E	5 S	7	20 W	5 N
						11aaaa	52 E	46 N	40 E	5 N	6	40 W	5 N

EUROPE

Primary: No.	Primary: Origin, Longitude	Primary: Origin, Latitude	Primary: Distance traveled with reference to place of origin		Primary: Life	Secondary: No.	Secondary: Origin, Longitude	Secondary: Origin, Latitude	Secondary: Distance traveled with reference to place of origin		Secondary: Life	Secondary: Beginning, with reference to place of ending of primary or previous secondary	
12	13 E	59 N	40 E	10 S	8								
13	22 E	28 N	10 E	5 N	6								

LIBERIA

Primary: No.	Primary: Origin, Longitude	Primary: Origin, Latitude	Primary: Distance traveled with reference to place of origin		Primary: Life	Secondary: No.	Secondary: Origin, Longitude	Secondary: Origin, Latitude	Secondary: Distance traveled with reference to place of origin		Secondary: Life	Secondary: Beginning, with reference to place of ending of primary or previous secondary	
14	73 E	51 N	70 E	25 N	7								
15	105 E	52 N	10 E	5 N	3	15a	75 E	53 N	30 E	0	9	40 W	0
						15aa	158 E	72 N	110 E	25 S	7	50 E	15 N

MARCH, 1925

CYCLONES NOS. 1-29

WESTERN PACIFIC OCEAN AND ASIATIC COAST

Primary: No.	Primary: Origin, Longitude	Primary: Origin, Latitude	Primary: Distance traveled with reference to place of origin		Primary: Life	Secondary: No.	Secondary: Origin, Longitude	Secondary: Origin, Latitude	Secondary: Distance traveled with reference to place of origin		Secondary: Life	Secondary: Beginning, with reference to place of ending of primary or previous secondary	
1	115 E	26 N	75 E	40 N	5								
2	117 E	42 N	115 E	15 N	8								
3	121 E	39 N	50 E	5 N	4								
4	124 E	37 N	80 E	30 N	8	4a	173 E	51 N	45 E	5 S	6	30 W	10 S
						4aa	122 W	41 N	50 E	5 S	9	20 E	5 S
						4b	138 W	51 N	20 E	10 S	3	15 E	10 S
5	126 E	25 N	25 E	0	3								
6	138 E	32 N	280 E	45 N	22	6a	118 W	52 N	40 E	5 N	4	170 W	25 S
						6b	146 W	56 N	35 E	10 S	4	200 W	20 S
						6c	75 W	42 N	10 E	0	3	135 W	35 S
						6ca	73 W	35 N	125 E	35 N	8	5 W	10 S
						6caa	76 W	37 N	30 E	25 N	6	125 W	35 S
						6 cab	17 W	56 N	15 E	10 S	4	65 W	15 S
						6caba	9 E	45 N	40 E	0	6	0 E	5 S
						6 caaa	29 W	50 N	5 E	10 N	4	15 E	10 S
						6 caaaa	15 E	75 N	135 E	5 S	12	35 E	15 N
						6 caaaaa	90 E	59 N	110 E	10 N	11	60 W	10 S
						6d	3 E	44 N	5 E	0	2	55 W	35 S

HAWAIIAN ISLANDS

Primary: No.	Primary: Origin, Longitude	Primary: Origin, Latitude	Primary: Distance traveled with reference to place of origin		Primary: Life	Secondary: No.	Secondary: Origin, Longitude	Secondary: Origin, Latitude	Secondary: Distance traveled with reference to place of origin		Secondary: Life	Secondary: Beginning, with reference to place of ending of primary or previous secondary	
7	143 E	36 N	40 E	20 N	3								
8	159 W	21 N	10 E	25 N	4								

TABLE 1.—*Life history of cyclones and anticyclones*—Continued

Primary					Secondary					
No.	Origin: Longitude	Origin: Latitude	Distance traveled with reference to place of origin	Life	No.	Origin: Longitude	Origin: Latitude	Distance traveled with reference to place of origin	Life	Beginning, with reference to place of ending of primary or previous secondary
MARCH, 1925—Continued										
CYCLONES NOS. 1-29—Continued										
NORTH AMERICA										
	°	°	° °	*Days*		°	°	° °	*Days*	° °
9	143 W	53 N	60 E 0	5	9a	107 W	36 N	105 E 15 N	9	20 W 15 S
					9aa	52 W	41 N	55 E 25 N	8	50 W 10 S
10	130 W	37 N	25 E 5 N	3	10a	118 W	40 N	115 E 5 N	13	15 W 0
11	111 W	53 N	25 E 5 S	2						
12	112 W	35 N	200 E 35 N	14						
13	94 W	60 N	65 E 15 N	5						
14	78 W	33 N	45 E 20 N	7						
15	75 W	34 N	15 E 10 N	3						
ATLANTIC OCEAN										
16	55 W	33 N	55 E 20 N	7	16a	42 W	55 N	160 E 20 N	7	40 W 0
					16aa	1 W	66 N	80 E 5 N	4	120 W 10 S
17	32 W	34 N	60 E 5 N	13						
SOUTHERN EUROPE AND NORTHERN AFRICA										
18	6 W	73 N	30 E 10 S	3						
19	0	32 N	100 E 20 N	12						
20	3 E	33 N	30 E 30 N	8						
21	17 E	38 N	30 E 20 N	6						
22	16 E	45 N	30 E 20 N	7						
23	33 E	28 N	10 E 5 N	2						
24	36 E	35 N	45 E 20 N	6	24a	127 E	43 N	30 E 0	2	40 E 5 S
CASPIAN SEA REGION										
25	54 E	39 N	10 E 0	1						
INDIA										
26	62 E	22 N	10 E 10 N	3						
27	68 E	31 N	15 E 0 N	7						
28	71 E	28 N	20 E 5 N	4						
29	74 E	25 N	15 E 0	3						
ANTICYCLONES NOS. 1-20										
EASTERN PACIFIC OCEAN										
1	175 h	35 N	5 E 15 N	3						
2	168 W	38 N	35 E 0	7						
3	155 W	39 N	65 E 5 S	11	3a	126 W	45 N	20 E 5 S	3	35 W 15 N
					3aa	95 W	48 N	10 E 0	4	10 E 10 N
					3aaa	70 W	57 N	15 E 0	4	15 E 10 N
					3aab	40 W	41 N	15 E 5 S	4	45 E 10 S
					3aaba	12 W	50 N	90 E 5 N	13	10 E 15 N
					3aabaa	50 W	60 N	65 E 5 S	6	25 W 5 N
					3aabaaa	117 E	35 N	25 E 5 N	8	0 15 S
					3aabaaaa	165 E	39 N	95 E 0	9	25 E 5 S
					3aabaaaaa	104 W	45 N	30 E 20 N	5	5 W 5 N
					3aabaaaab	135 W	30 N	10 W 0	3	35 W 10 S
4	152 W	33 N	35 E 5 N	4						
NORTH AMERICA AND ARCTIC REGIONS TO NORTH										
5	138 W	71 N	85 E 35 S	8	5a	137 W	53 N	125 E 25 N	25	85 W 20 N
6	130 W	68 N	80 E 20 S	4	6a	97 W	53 N	45 E 10 S	4	50 W 5 N
7	135 W	80 N	20 E 20 S	5	7a	122 W	62 N	155 E 15 S	20	5 W 0
8	120 W	70 N	75 E 30 S	8	8a	80 W	33 N	20 E 0	3	35 W 20 S
9	113 W	56 N	90 E 20 N	5						
10	75 W	74 N	65 E 0	5						
NORTHERN EUROPE										
11	28 E	63 N	15 E 20 S	4						
NOVA ZEMBLA REGION										
12	53 E	66 N	135 E 25 S	20	12a	132 W	54 N	20 E 5 N	2	35 E 10 N
					12b	126 W	48 N	5 E 5 N	1	40 E 5 N
13	60 E	73 N	70 E 45 S	7						
14	85 E	76 N	10 E 20 S	12	14a	141 E	38 N	10 E 0	2	45 E 15 S
15	84 E	73 N	55 E 45 S	7						

TABLE 1.—*Life history of cyclones and anticyclones*—Continued

Primary: No.	Primary: Origin, Longitude	Primary: Origin, Latitude	Primary: Distance traveled with reference to place of origin	Primary: Life	Secondary: No.	Secondary: Origin, Longitude	Secondary: Origin, Latitude	Secondary: Distance traveled with reference to place of origin	Secondary: Life	Secondary: Beginning, with reference to place of ending of primary or previous secondary
MARCH, 1925—Continued										
ANTICYCLONES NOS. 1-20—Continued										
SIBERIA										
	°	°	° °	*Days*		°	°	° °	*Days*	° °
16	59 E	47 N	10 E 10 N	3						
17	63 E	52 N	5 E 0	1						
18	70 E	50 N	45 E 0	5						
COAST OF CHINA										
19	118 E	32 N	30 E 0	3						
20	125 E	37 N	85 E 0	15	20a	175 W	60 N	45 E 5 N	3	25 W 25 N
APRIL, 1925										
CYCLONES NOS. 1-27										
WESTERN PACIFIC OCEAN AND ASIATIC COAST										
1	124 E	26 N	25 E 5 N	4						
2	123 E	29 N	20 E 5 N	3						
3	127 E	29 N	85 E 30 N	7	3a	117 W	62 N	15 E 0	2	35 E 5 N
					3aa	59 W	57 N	150 E 5 S	12	40 E 5 S
					3b	132 W	48 N	20 E 0	2	20 E 10 S
					3ba	116 W	40 N	55 E 35 N	9	5 W 10 S
					3baa	110 W	42 N	50 E 35 N	6	50 W 35 S
					3baaa	83 W	50 N	45 E 10 S	5	25 W 25 S
					3baab	23 W	60 N	45 E 5 S	5	35 E 15 S
4	128 E	26 N	70 E 40 N	6						
5	121 E	36 N	15 E 5 N	4						
6	115 E	39 N	80 E 20 N	7						
7	114 E	46 N	100 E 20 N	10	7a	134 W	33 N	5 E 25 N	9	10 E 30 S
					7aa	112 W	56 N	15 E 10 S	2	20 E 5 S
					7aaa	105 W	41 N	80 E 0	14	5 W 5 S
					7b	106 W	55 N	60 E 5 S	4	40 E 10 S
8	133 E	26 N	15 E 15 N	4						
9	134 E	32 N	15 E 10 N	4						
MIDWAY ISLAND										
10	177 W	22 N	5 W 5 N	8						
NORTH AMERICA										
11	155 W	51 N	5 E 5 N	5						
12	116 W	53 N	55 E 15 N	4	12a	74 W	47 N	60 E 25 N	4	15 W 20 S
					12b	88 W	62 N	75 E 10 N	4	30 W 5 S
13	113 W	68 N	60 E 15 S	4						
14	109 W	66 N	260 E 0	20	14a	13 E	47 N	20 E 0	4	135 W 20 S
					14b	8 W	53 N	15 E 5 S	4	160 W 10 S
					14c	4 E	41 N	40 E 0	5	145 W 25 S
					14d	30 E	58 N	100 E 5 S	11	120 W 5 S
15	107 W	32 N	5 E 0	2						
16	106 W	35 N	35 E 0	4						
17	96 W	56 N	60 E 5 S	5						
18	92 W	64 N	295 E 5 S	16						
NORTHERN AFRICA										
19	7 W	29 N	30 E 15 N	8						
20	26 E	28 N	10 E 0	2						
21	34 E	33 N	0 20 N	9						
BLACK AND CASPIAN SEA REGION										
22	34 E	42 N	25 E 0	2						
23	45 E	40 N	75 E 15 N	8						
24	50 E	38 N	20 E 5 N	3						
INDIA										
25	65 E	29 N	25 E 0	6						
26	69 E	29 N	5 E 0	6						
27	95 E	13 N	5 E 5 N	5						
ANTICYCLONES NOS. 1-18										
COAST OF CHINA										
1	114 E	32 N	15 E 0	3						

TABLE 1.—*Life history of cyclones and anticyclones*—Continued

Primary						Secondary							
No.	Origin		Distance traveled with reference to place of origin		Life	No.	Origin		Distance traveled with reference to place of origin		Life	Beginning, with reference to place of ending of primary or previous secondary	
	Longitude	Latitude					Longitude	Latitude					
APRIL, 1925—Continued													
ANTICYCLONES NOS. 1-18—Continued													
PACIFIC OCEAN													
	°	°	°	°	*Days*		°	°	°	°	*Days*	°	°
2	165 E	35 N	10 E	0	2								
3	179 W	46 N	35 E	10 S	10								
NORTH AMERICA AND ARCTIC REGIONS TO NORTH													
4	132 W	67 N	35 E	25 S	4								
5	121 W	67 N	115 E	35 S	11	5a	65 W	35 N	10 E	0	1	60 W	5 S
6	95 W	75 N	20 E	0	2								
7	101 W	70 N	35 E	35 S	6								
8	94 W	68 N	5 E	10 S	2								
9	109 W	52 N	85 E	10 S	11	9a	108 W	42 N	25 E	10 S	4	85 W	0
						9b	8 W	52 N	80 E	10 S	9	15 E	10 N
10	100 W	52 N	100 E	10 S	11								
11	99 W	58 N	40 E	35 S	9								
12	92 W	57 N	45 E	25 S	5								
EASTERN ATLANTIC OCEAN													
13	12 W	38 N	10 E	10 S	2								
SPITZBERGEN AND NOVA ZEMBLA													
14	15 E	80 N	30 E	5 S	4								
15	22 E	78 N	0	10 S	2								
16	45 E	73 N	105 E	5 N	6								
EUROPE													
17	26 E	41 N	85 E	10 N	7	17a	130 E	50 N	55 E	5 N	7	20 E	0
18	47 E	52 N	95 E	20 S	15								

Beginnings and endings.—The beginnings and endings of cyclones and anticyclones as given in Table 1 are plotted in Figures 7 to 14, inclusive. These figures are self-explanatory.

Number that developed and dissipated.—Figures 15 to 22, inclusive, show the number of cyclones and anticyclones that developed and dissipated in each 10-degree square in the Northern Hemisphere during the months January to April, inclusive, 1925. Figure 15 shows quite clearly that the principal area of development of primary cyclones is off the eastern coast of Asia, and especially over the water south of Korea and southwest of Japan, with another area of frequent development over and near northwestern India. However, the latter cyclones are of minor intensity, as a rule, throughout their life. Figure 17 shows five areas of principal development of secondary cyclones, as follows:

(1) The northeastern Pacific Ocean south of Cordova, Alaska; (2) a large area of continental North America from Alberta and Saskatchewan southward to the middle Plateau and southern Rocky Mountain regions; (3) from New York southward to the vicinity of Cape Hatteras; (4) south of Greenland; (5) France and the northwestern Mediterranean Sea.

It will be noted that no primary cyclone developed within many hundreds of miles of Greenland and no secondaries, except over a limited area south of the extreme southern point of that place, in spite of the fact that much prominence has been given in recent years to the theory that the air rushing down from the great ice cap of Greenland is responsible for the development of many of the storms of the north Atlantic Ocean. On the other hand, many cyclones dissipated over or near Greenland and Iceland (see fig. 18) and only one other 10-degree square in the Northern Hemisphere, shows a greater number than the square embracing much of southern Greenland.

Little evidence has been found by the writer to indicate that Greenland, with its enormous accumulation of ice, materially affects the development or path of movement of cyclones. Of 17 cyclones that moved into the Greenland-Iceland area during January and February, 1925, there were six that showed their greatest 12-hour increase in intensity before reaching Newfoundland, seven between Newfoundland and Greenland, two with equal amounts of increase in intensity during the 12 hours before reaching Newfoundland and Greenland, respectively, and only two that had the greatest 12-hour increase between Greenland and Iceland.

The principal regions of formation of anticyclones as shown in Figures 19–20, inclusive, are referred to in the discussion on page 13. Figure 22 shows that the regions where anticyclones dissipate or merge with other areas of high pressure are quite well distributed over the

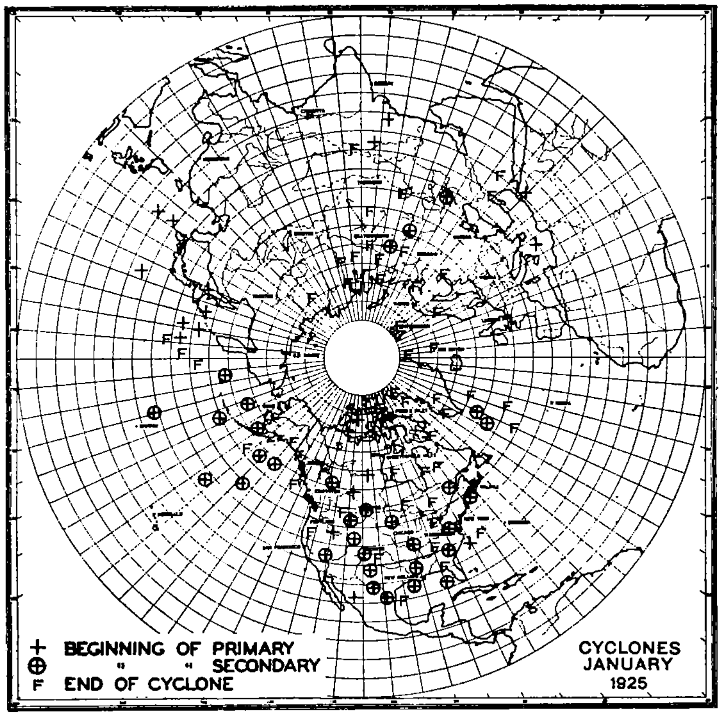

FIGURE 7.—Geographic position of beginnings and endings of cyclones, January, 1925

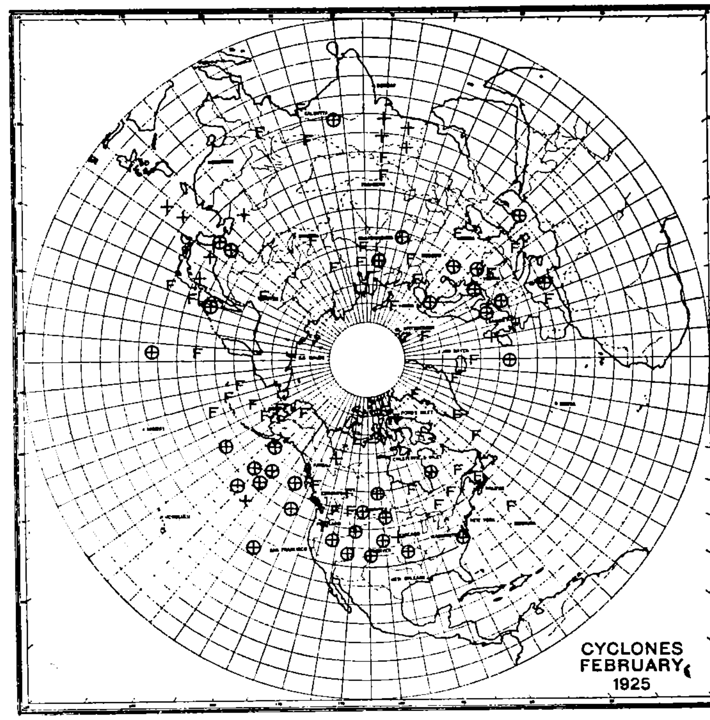

FIGURE 9.—Geographic position of beginnings and endings of cyclones, February, 1925

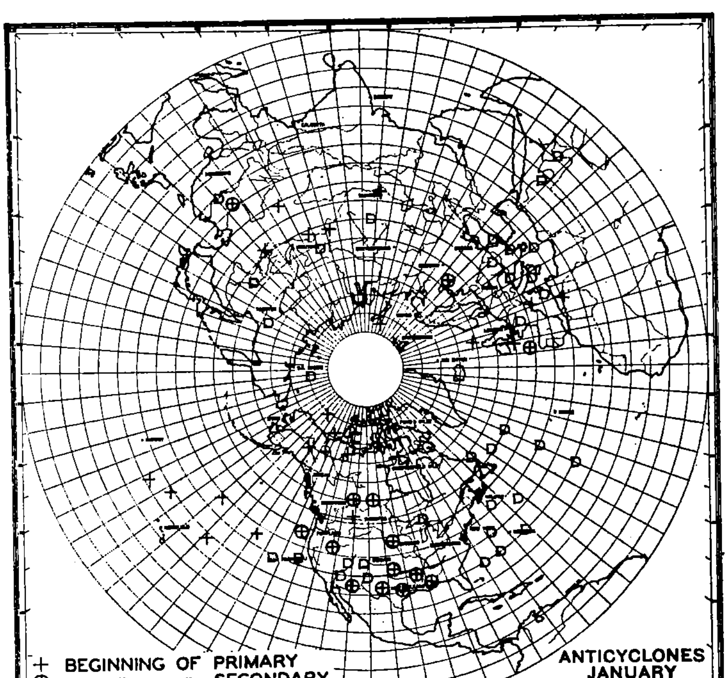

FIGURE 8.—Geographic position of beginnings and endings of anticyclones, January, 1925

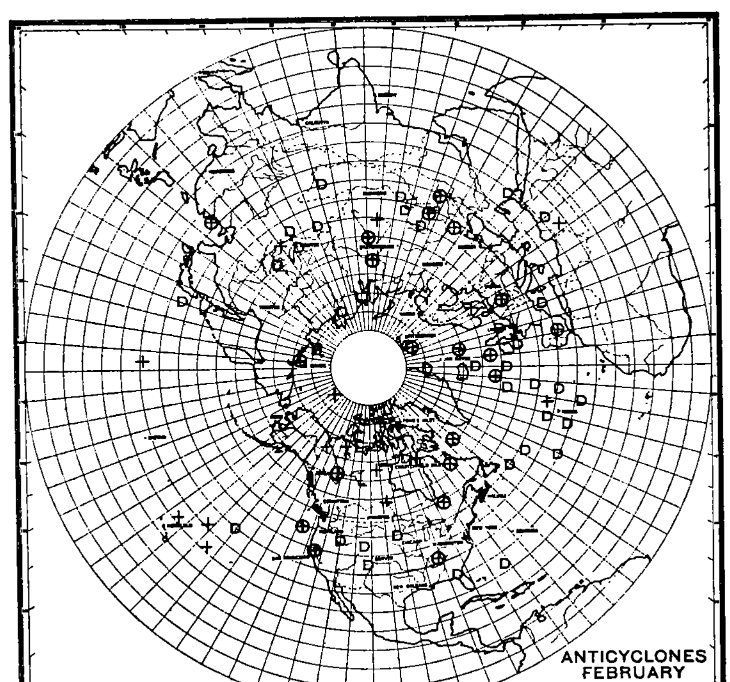

FIGURE 10.—Geographic position of beginnings and endings of anticyclones, February, 1925

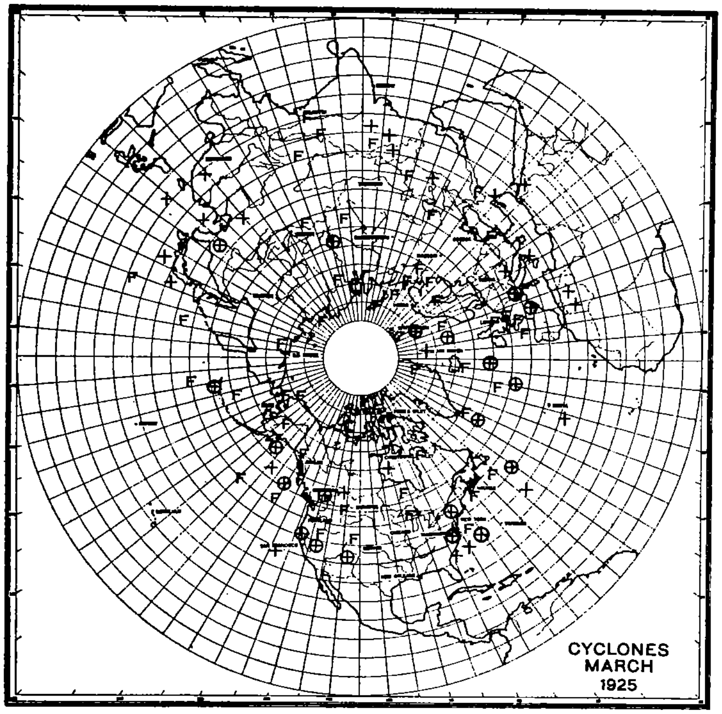

FIGURE 11.—Geographic position of beginnings and endings of cyclones March, 1925

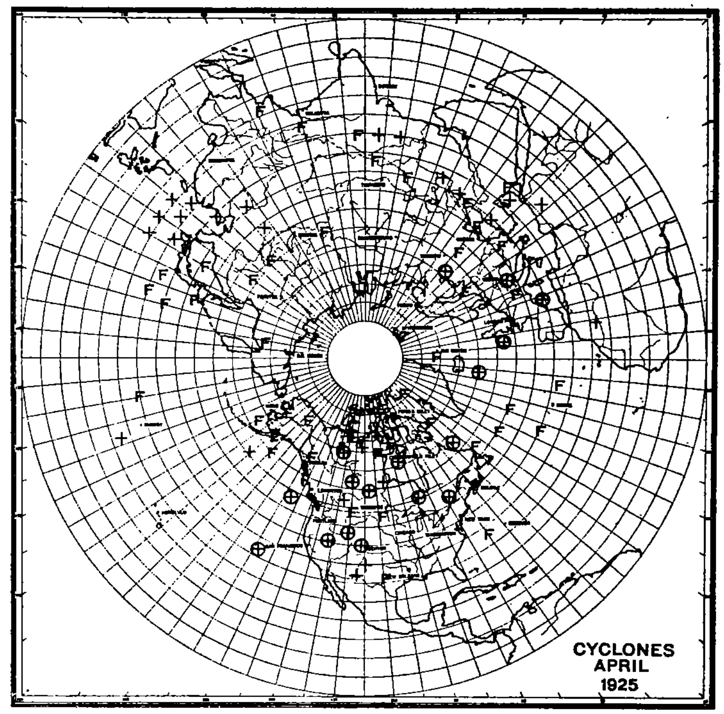

FIGURE 13.—Geographic position of beginnings and endings of cyclones, April, 1925

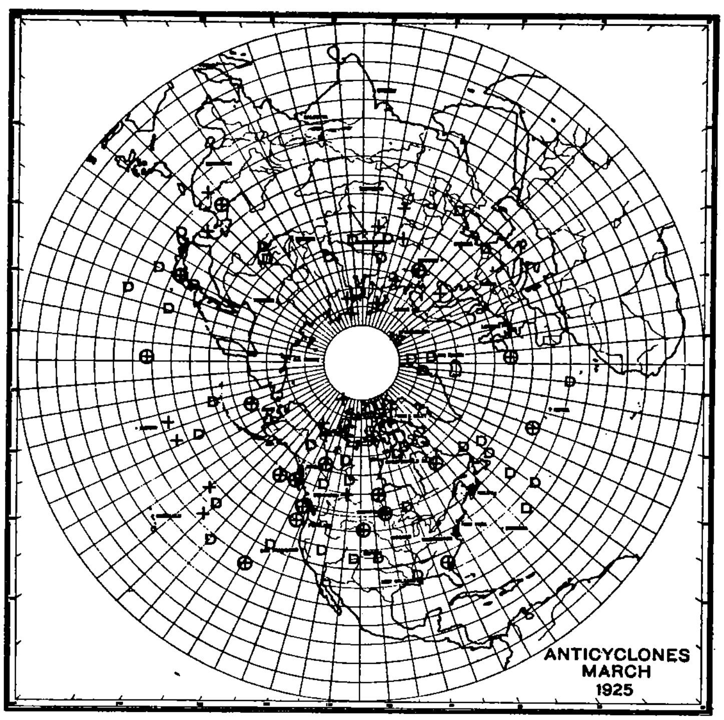

FIGURE 12.—Geographic position of beginnings and endings of anticyclones, March, 1925

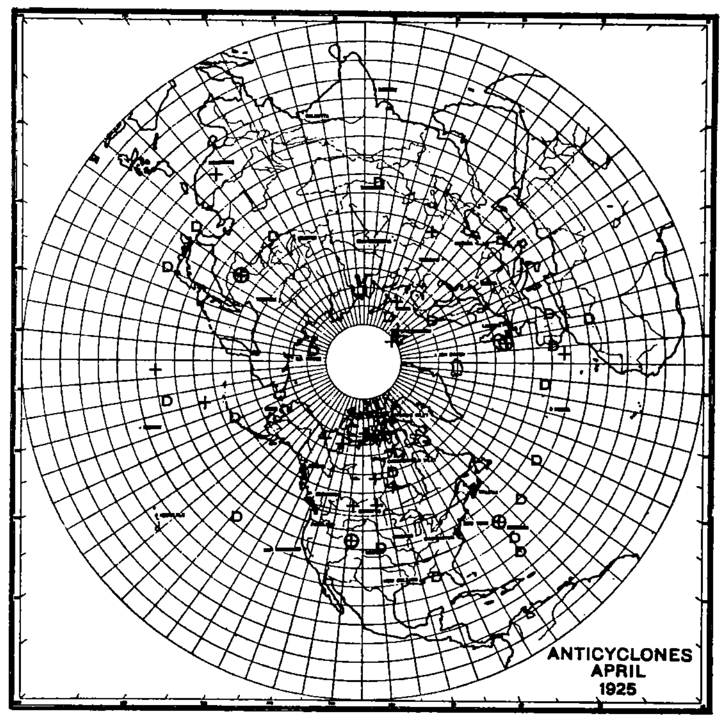

FIGURE 14.—Geographic position of beginnings and endings of anticyclones, April, 1925

Northern Hemisphere north of latitude 30°, with the exception of Greenland and Alaska, and from Russia eastward over northern Siberia.

All cyclones that formed during the first four months of 1925 within the four principal areas of development, together with secondary developments in connection with the primary cyclones, were considered in computing the mean places of origin and dissipation and the length of life of each type of cyclone. There was remarkable uniformity in the behavior of all cyclones, irrespective of the month, that developed off the eastern coast of Asia and south of the island of Sakhalin. Their length of life was greatest in January, nine days, and least in February, four and one-half days, but the shortest distance covered was in April. Only a very small percentage of these cyclones reached the coast of North America. Quite generally they entered the great area of more or less permanent low pressure that extends from the tip of the Aleutian Archipelago, eastward to Juneau, considerably deepening that depression for a time, then losing their identity after sending off to the eastward one or more secondaries, the average place of development of these being west of Puget Sound. These secondaries were rapidly moving disturbances that passed inland over the British Columbia or Washington coast and traveled eastward along the northern border, their average place of dissipation being over the Labrador region after six days of life. The secondaries that frequently developed south of the original offshoots from the North Pacific cyclones formed, on an average, over southern Minnesota and northern Iowa and traveled east-northeastward for six and one-half days, passing south of Greenland and dissipating south of Iceland and west of Ireland. These secondaries usually developed about the time of occlusion of the primary disturbances, and these particular secondaries formed, on an average, 28° west and 12° south of the average place of dissipation of the primary cyclones. The average place of development of the secondaries (see Table 1) was about midway between the Azores and Newfoundland and 10° south and 7° west of the average place of dissipation of the primary 1aa cyclones, and the average place of their dissipation was near Leningrad one week later. Meanwhile most of these, as they became occluded, gave rise to the 1aaaa secondaries that developed southwest of Ireland and dissipated, on an average, four and one-half days later over southern Russia northwest of Odessa.

Primary cyclones, place of origin.—It is the opinion of the author that the only true primary cyclones (if there are any cyclones that develop entirely separate and distinct from other cyclones already in existence) are the cyclones of the western Pacific Ocean that develop off the Asiatic coast and first show a typical cyclonic wind circulation, on an average, near the southwestern end of Japan. Even these, in a small percentage of cases, are rather closely related to cyclones advancing eastward over Siberia. However, an extensive study of data from India, eastern Asia, the Japanese Archipelago, and the Philippines quite clearly shows the pressure distribution and associated air movements that are antecedent to the formation of a cyclonic circulation over the oceanic area to the southwest or south of Japan. It is quite necessary, in the case of extra-tropical cyclones, to have counter air currents with a considerable contrast in temperature, the cold polar air usually moving toward the southwest and the warm tropical air to the east moving toward the northeast. The Siberian anticyclone supplies the polar air that flows southward over China and Japan and later toward the southwest after reaching more southerly latitudes. The question arose as to the source of the warm tropical air needed to complete the requirements for cyclone development. The pressure-change graph of Phu Lien, on the extreme north coast of French Indo-China (pressure graph No. 7 of fig. 24), clearly showed the advent of warmer air at some level over that station a day or two in advance of the actual formation of a cyclonic wind circulation some distance to the east-northeast or northeast of that station. Inasmuch as the pressure change graph of Cape St. Jacques, 11° south of Phu Lien (not reproduced), did not show nearly as well-marked pressure falls as Phu Lien, it became evident that the source of the tropical air was somewhere to the west or southwest of Phu Lien. Inasmuch as no pressure data were available for the region between the coast of Indo-China and the coast of Burmah (India), on the eastern shore of the Bay of Bengal, graphs for a number of stations in various parts of India were made and studied. Mergui, in Lower Burmah, 10° N., and Colombo, Ceylon, 7° N., are so near the Equator that the pressure fluctuations were quite small and little use could be made of them. However, the pressure graph of Dibrugarh, Assam (India), latitude 28° N., longitude 98° E., for the first four months of 1925 (graph No. 49 of fig. 24), bore a striking resemblance to that of Phu Lien, but with the peaks and depressions a day or so earlier, as a rule. The graphs for Nagpur (Central Provinces) (not reproduced), Pasni (Baluchistan) (not reproduced), and Gilgit (Kashmir) (graph No. 48, fig. 24), did not show that the pressure falls at Dibrugarh were due, as a rule, to tropical air that advanced eastward over the main part of India. There was only one other possible source and that was the Bay of Bengal. In order to find further proof that this was the case, a pressure graph for Calcutta (not reproduced) was prepared, and, with minor exceptions, it was almost an exact duplicate of the Dibrugarh graph, allowing a time interval of 12 hours or more between the two places.

Almost invariably when the lowest pressure occurred at Calcutta and Dibrugarh, pressure was at least relatively high over Burmah to the east and over central or southwestern India to the west or southwest of these stations. With this type of pressure distribution the warm tropical air from the Bay of Bengal flowed northward and northeastward over Bengal and Assam to the foothills of the Himalaya Mountains. It seems logical that this warm, moist air, instead of passing over this high and steep barrier, was deflected to the east over a more or less rugged terrain, but still much less elevated than the Himalayas, and a day or two later passed over the Phu Lien section, causing the fall in pressure there, then passing out over the China Sea parallel to (but in opposite direction) from the cold polar air from the Siberian anticyclone. Almost invariably the cyclone definitely formed just about the time the crest of the pressure rise passed Irkutsk, Siberia.

During the first four months of 1925 there were 15 well-marked troughs in the Dibrugarh pressure-change graph that were followed by cyclonic development to the east of Phu Lien and southwest or south of Japan, and only one distinct trough, that of January 14, was not followed by such cyclonic development. The average departure from normal pressure at Dibrugarh at the lowest point in each trough was −0.14 inch, and the average elapsed time thereafter when a cyclonic circulation was definitely established east of Phu Lien (using only one observation per day), was two and one-half days. The cyclones formed, as a rule, from 1,500 to 2,000 miles east of Dibrugarh.

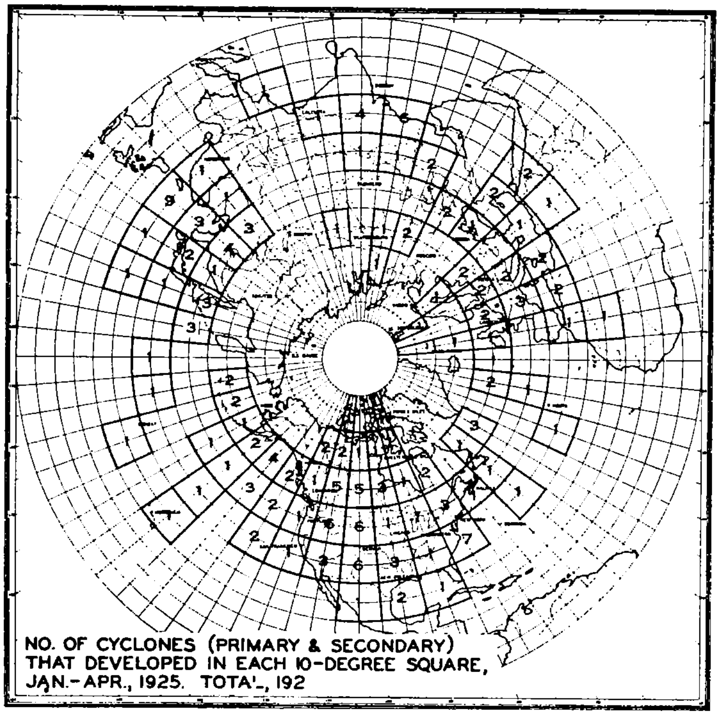

FIGURE 15.—Number of cyclones (primary and secondary) that developed in each 10-degree square, January-April, 1925

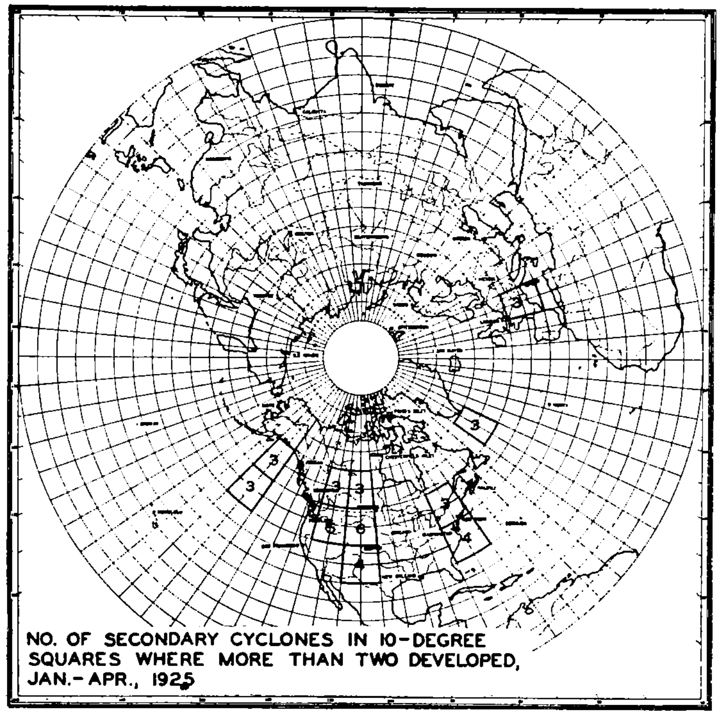

FIGURE 17.—Number of secondary cyclones in 10-degree squares where more than two developed, January-April, 1925

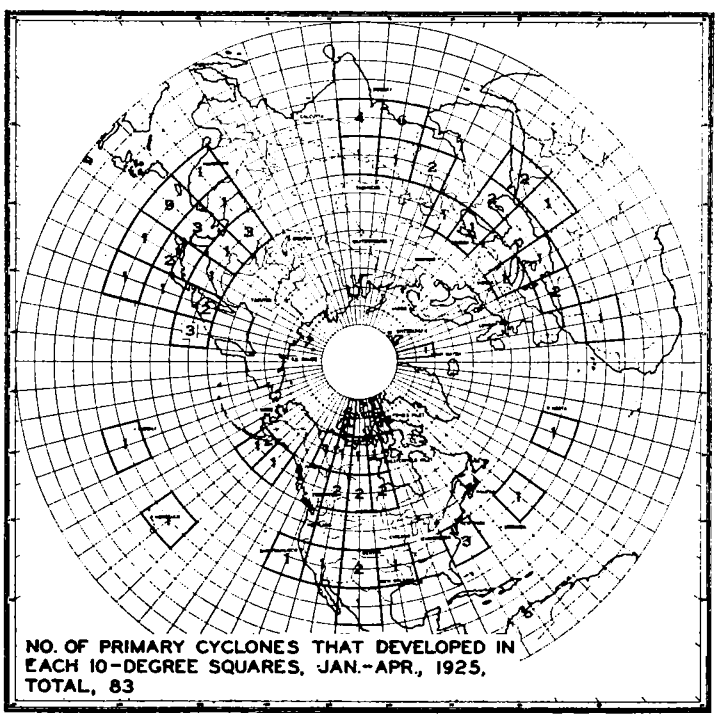

FIGURE 16.—Number of primary cyclones that developed in each 10-degree square, January-April, 1925

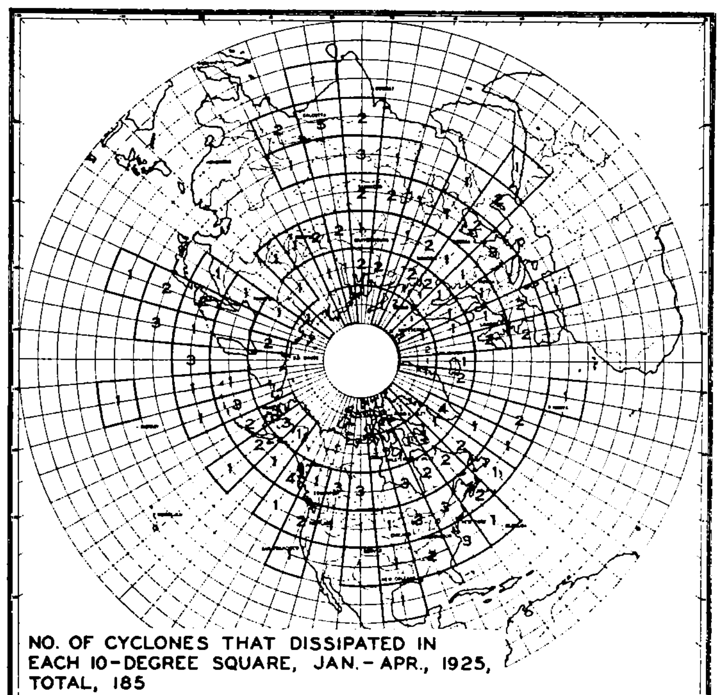

FIGURE 18.—Number of cyclones that dissipated in each 10-degree square, January-April, 1925

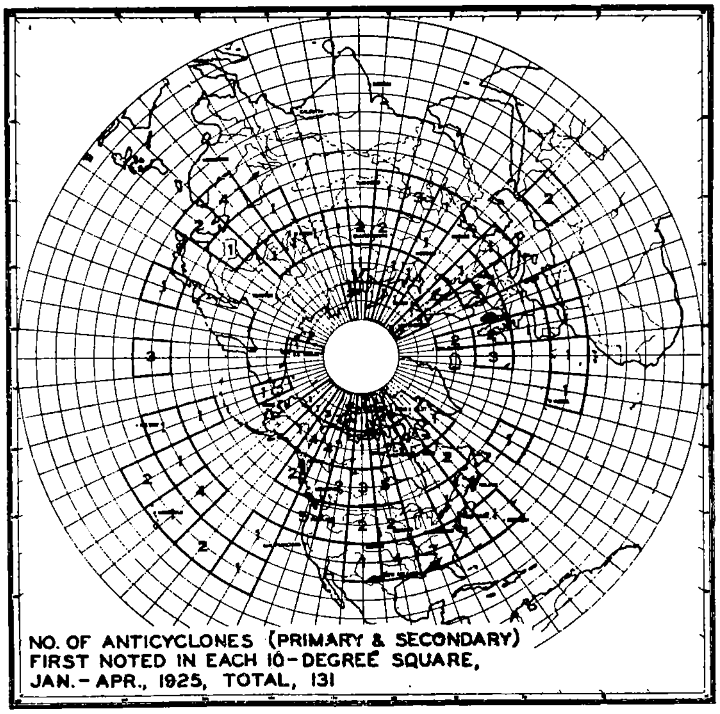

FIGURE 19.—Number of anticyclones (primary and secondary), first noted in each 10-degree square, January-April, 1925

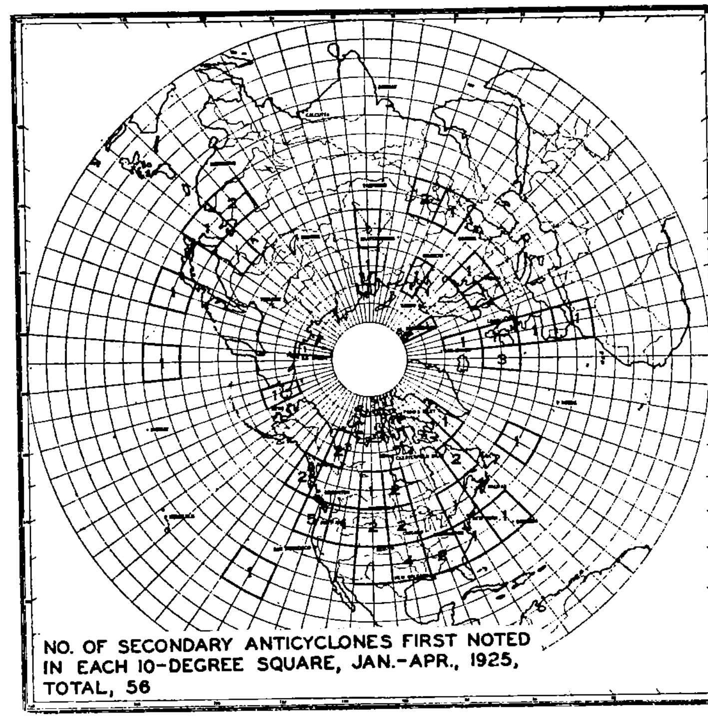

FIGURE 21.—Number of secondary anticyclones first noted in each 10-degree square, January-April, 1925

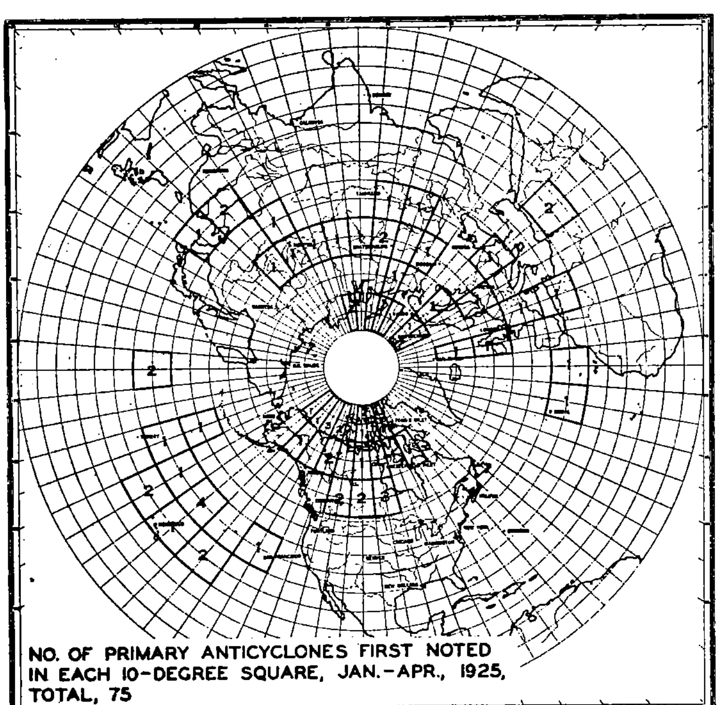

FIGURE 20.—Number of primary anticyclones first noted in each 10-degree square, January-April, 1925

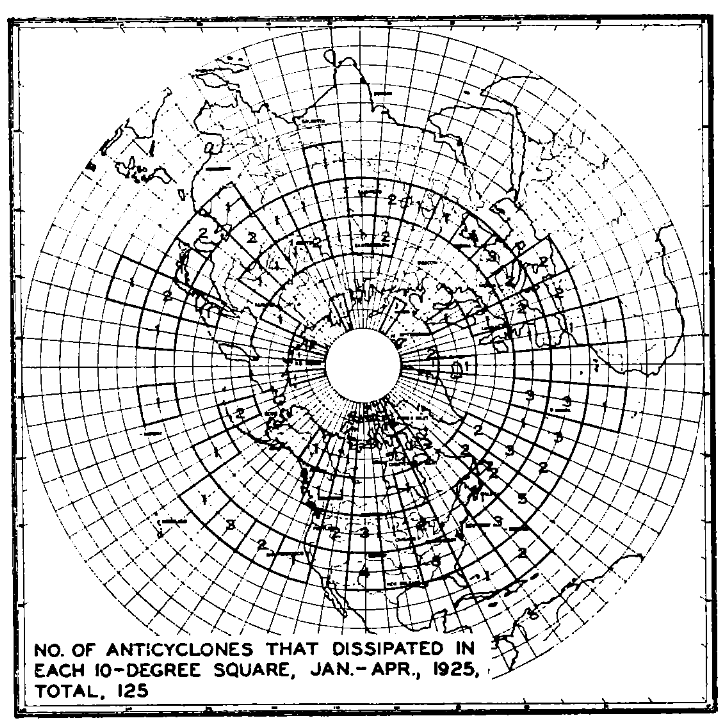

FIGURE 22.—Number of anticyclones that dissipated in each 10-degree square, January-April, 1925

Another interesting, but possibly unrelated, feature of the pressure distribution at the time of cyclonic development over the China Sea region was the presence of a cyclone centered near or somewhat west of Ekaterinburg, Russia, in the Ural Mountain region. During periods of high pressure over and near the head of the Bay of Bengal, when the warm southerly winds from the bay were shut off, cyclones seldom formed over the region southwest of Japan. If an occasional one did form, it was in connection with the temporary breaking down of the Siberian anticyclone and the passage eastward of a cyclone over Siberia.

There were 25 North American cyclones classed as primary cyclones because it was impossible to classify them definitely as secondaries of the North Pacific cyclones. It is quite probable, however, that with more frequent observations at least some of them would have been included with the 1aa secondaries. Anyway the

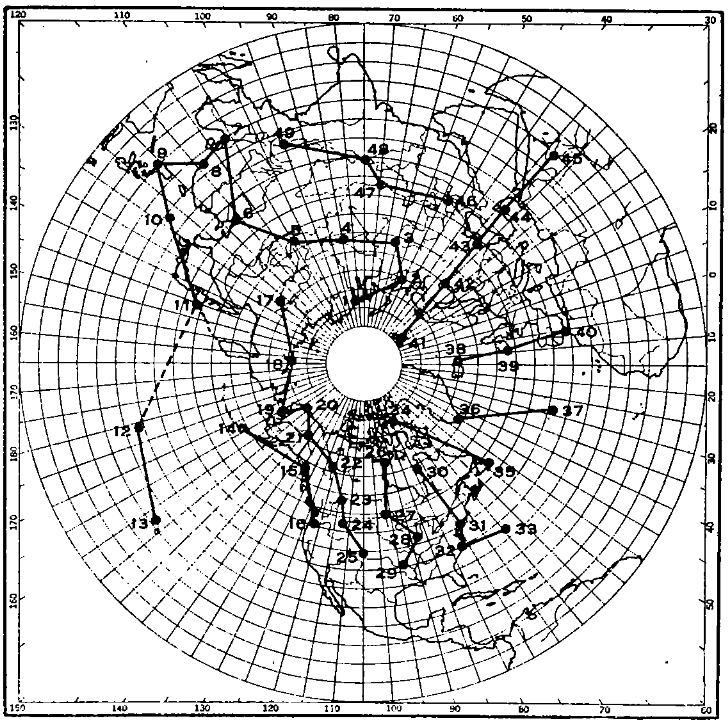

FIGURE 23.—Grouping of stations in pressure graph (see fig. 24)

average places of development and dissipation, the paths and length of life of the No. 2 primaries and the 1aa secondaries are in close agreement. Moreover, the same can be said of the 2a and 1aaa secondaries, both of which types developed, on an average, east of Newfoundland and dissipated south of Leningrad after a life of seven days. The No. 3 primary cyclones of southern Europe that moved northeastward from the Mediterranean region for an average of six days and dissipated north of the Caspian Sea may, in some cases, have been secondaries of the 2a, 1aaa, or 1aaaa cyclones, but once-daily observations from Europe did not permit such classification. The same may be said of the No. 3½ cyclones shown as originating between the Black Sea and the Caspian Sea and dissipating northeast of Tashkent, Turkestan, three and one-half days afterwards. The cyclones that originated over northwestern India moved east-northeastward slowly for about four days and dissipated just short of the Himalaya Mountains.

Anticyclones, place of origin.—Anticyclones that appeared on the daily weather maps during the first four months of 1925 were divided, according to place of origin, into five groups, as follows: (1) Those that first appeared over the Pacific Ocean several hundred miles south of Dutch Harbor, Aleutian Islands; (2) those that moved southeastward from the Arctic Ocean over or east of the Mackenzie Valley; (3) those that appeared to build up over southern Europe; (4) those that moved southeastward or southward from the Spitzbergen-Nova Zembla region; and, finally, (5) the extensive anticyclones that built up over Siberia, most often in the Tomsk-Ekaterinburg area. The No. 1 anticyclones were of the familiar type that builds up over the middle and eastern Pacific Ocean and moves eastward toward the Pacific coast of the United States. The average life of the 15 whose tracks were plotted was seven days and they ceased to exist as separate anticyclones off the northern California coast, but before doing so, offshoots from them appeared as separate areas over the western half of the United States. These offshoots and others that they in turn sent off to the eastward lasted on an average five days and disappeared northwest of Bermuda or merged with the permanent Atlantic anticyclone. The numerous No. 2 anticyclones (27 in number) moved southeastward from the Arctic Ocean over the British Northwest Territory, and, after an average life of seven days, disappeared east of Newfoundland. The 2*a* anticyclones were centers of portions that became detached from the No. 2 anticyclones, either in advance or in the rear of the original centers. The average movement was from eastern Ontario to the Azores and their average life, eight days. A number of anticyclonic areas apparently built up over southern Europe and moved, on an average from south of Vienna to the region south of the Caspian Sea in seven and one-half days. The No. 4 anticyclones moved southeastward from the vicinity of Nova Zembla for eight days, on an average, and disappeared or merged with other high pressure areas near Irkutsk. The anticyclones that built up over Siberia (No. 5) became, in some instances, of vast extent, and, while the centers remained between Irkutsk and Yakutsk, extensions from them stretched east-northeastward to the Bering Sea region. Their centers were first noted between Tomsk and Ekaterinburg, on an average and they dissipated near Yakutsk six days afterwards. Meanwhile, in the case of some of them, part of the extensions referred to became detached from the main areas and formed separate anticyclones over the northeastern Pacific Ocean and they moved east-southeastward to the lower Mississippi Valley, lasting six days, on an average.

There are two Arctic areas from which nearly all outbursts of polar air take place. The first area is that part of the Arctic Ocean north and northeast, and occasionally northwest, of Alaska, extending, roughly, from longitude 120° to 180° west. The second is the area north and northeast of Scandinavia, and this area extends, approximately, from Spitzbergen to Nova Zembla. By far the greater number of anticyclones, which may be designated polar anticyclones, move out and spread southward and southeastward from the first area. During the first four months of 1925 there were 27 from this area and only 4 from the second (Spitzbergen-Nova Zembla). It is because of the numerous polar anticyclones, together with the large number of cyclones from the Pacific Ocean, that Canada and the northern and middle portions of the United States east of the Rocky Mountains experience more frequent material fluctuations of temperature than any other area in the northern hemisphere.

The other anticyclones (Nos. 1, 3, and 5) are of the mid-latitude type. They build up between latitudes 30° and 50° north, except the Siberian anticyclones whose centers first appeared, as a rule, between 50° and 60° north. It was not possible to determine in most cases at least whether or not masses of polar air arrived over these several areas simultaneously with the building up of the anticyclones. Their rate of movement was considerably slower than that of the polar anticyclones.

PRESSURE CHANGE GRAPHS

Briefly, these graphs (figs. 24, 24A, and 24B) are designed to show the progressive movement of rises and falls in pressure that are associated with cyclones and anticyclones which cross the meridian of any place. The ordinates of the graph are the days of the month and the abscissæ are the changes above and below the normal pressure for the time and place. The normals were scaled from Bartholomew's Physical Atlas, Volume III, plate 12.

Figure 23 shows the grouping of stations for which graphs have been given and the stations themselves with their geographical coordinates appear in the table below:

TABLE 2.—*Names and approximate geographical coordinates of stations used in pressure departure graphs (fig. 24)*

No.		Latitude	Longitude	No.		Latitude	Longitude
1	Dickson	73 N.	82 E.	26	Chesterfield Inlet	63 N.	91 W.
2	Oust Tsylma	66	53 E.	27	Winnipeg	50	97 W.
3	Ekaterinburg	56	61 E.	28	Chicago	42	88 W.
4	Tomsk	57	85 E.	29	Fort Smith	35	94 W.
5	Irkutsk	53	105 E.	30	Port Harrison	58	78 W.
6	Peking	40	116 E.	31	New York	41	74 W.
7	Phu Lien	21	107 E.	32	Hatteras	35	76 W.
8	Hong Kong	22	114 E.	33	Bermuda	32	65 W.
9	Manila	15	121 E.	34	Ponds Inlet	73	78 W.
10	Naha	26	128 E.	35	Saint Johns, Newfoundland	48	53 W.
11	Nemuro	43	145 E.				
12	Midway	28	177 E.	36	Ivigtut	61	48 W.
13	Honolulu	21	158 W.	37	Horta	39	29 W.
14	Dutch Harbor	54	164 W.	38	Seydisfjord	65	15 W.
15	Juneau	58	134 W.	39	Valencia	52	10 W.
16	Portland, Oreg	46	123 W.	40	Gibraltar	36	5 W.
17	Iakutsk	62	130 E.	41	Spitzbergen	78	14 E.
18	S. S. Maud	71	162 E.	42	Leningrad	60	30 E.
19	Nome	64	165 W.	43	Odessa	46	31 E.
20	Point Barrow	71	156 W.	44	Limasol	35	33 E.
21	Eagle	65	141 W.	45	Khartoum	16	33 E.
22	Simpson	62	122 W.	46	Baku	40	50 E.
23	Edmonton	54	113 W.	47	Tashkent	42	70 E.
24	Helena	47	112 W.	48	Gilgit	36	75 E.
25	Denver	40	105 W.	49	Dibrugarh	28	95 E.

If, for example, group No. 1 be considered with origin at 73° N.82° E., the movement of pressure changes, if they occur simultaneously at any two stations will appear in the north/south line, and in the graph in question they should next appear at Tomsk, this station being almost due south of Dickson. As a rule, however, the changes appear later and later and with a drift toward the east when the several stations of the group are favorably situated. The reader should trace for himself the sequence of marked pressure changes from one point to another as pictured on the graphs.

This method of comparison fails when the stations are too sparsely located. In the group being considered there is some suggestion that the station Oust Tsylma feels the pressure changes before Dickson does, and there is also unmistakable evidence that both stations do not experience changes of the same intensity as might be inferred from the fact that the same depression may not pass centrally over both stations.

TIME INTERVAL AND MAGNITUDE OF PRESSURE FLUCTUATIONS

In studying the pressure-change graphs it was noted that the rises and falls were much more prolonged at certain stations than at others, so that the time intervals between peaks of high pressure and between troughs of low pressure varied greatly. The total number during the first four months of 1925 at each of 22 stations selected from a much larger number for which graphs were prepared is shown in Figure 15. Leaving out of consideration Honolulu and Midway Island which are in or near the Tropics, Yakutsk, in northeastern Siberia, had the smallest number, 10, or an average of 6.3 days between peaks or between troughs, Leningrad, Russia, next with 20, Dickson, Siberia, at the mouth of the Yenesei River, next with 22, then Spitzbergen with 23, Point Barrow, Alaska, with 26, and the S. S. *Maud*, off the northeastern Siberian coast at longitude 162° E., with 28. At the other extreme, Juneau showed the greatest number, 40, or an average of only three days between peaks (or between troughs), Dutch Harbor, Alaska, and Edmonton, Alberta, next with 39, and then several stations with about 35 each. A number of stations showed marked fluctuations in pressure, one of these, Dickson, Siberia (graph No. 7, fig. 24), having had an average rise of 0.56 inch in 20 rises of from two to six days duration, and an average fall of 0.51 inch in 21 falls during the four months.

AROUND-THE-WORLD CYCLONE OF FEBRUARY 23–MARCH 23, 1925

On the morning map of February 23, 1925, there appeared near Havre, Mont., a secondary disturbance, inclosed by a single isobar and apparently of little consequence, that was destined to become famous. Primary cyclone No. 4, Figure 4, developed southwest of Vladivostok, Siberia, on February 9 and dissipated near the western extremity of the Aleutian Archipelago on the 14th, immediately after secondary cyclone 4a appeared far to the south of Kamchatka. This secondary moved east-northeastward very slowly and was last noted some distance southwest of Dutch Harbor, Alaska, on the 20th, its secondary, 4aba, appearing about latitude 44° N., longitude 148° W., the morning of the 21st. This disturbance became quite severe off the coast of Washington during the 22d, but it diminished rapidly in intensity after it reached the British Columbia coast and disappeared entirely during the night of the 23d–24th, less than 24 hours after its secondary 4ab formed over Montana.

During the four weeks following February 23, the cyclone encircled the globe and it was 2,000 miles past its starting point, well started on another encircling trip, when it suffered an ignominious death over the Gulf of St. Lawrence on March 23 in a region where most cyclones are increasing in intensity and where few slacken their rate of movement. So far as is known this is the first cyclone ever tracked entirely around the world. It is possible, but not certain, that other cyclones have done likewise, but no other investigator ever had such complete weather maps of the Northern Hemisphere and without which it would have been impossible to have plotted the entire path of this one. As computed by the Hydrographic Office of the Navy Department, the approximate length of the cyclone and its secondaries was 18,565 nautical miles, or 21,379 statute miles. The approximate distance traveled by the center each 24 hours is shown in the center of Figure 25.

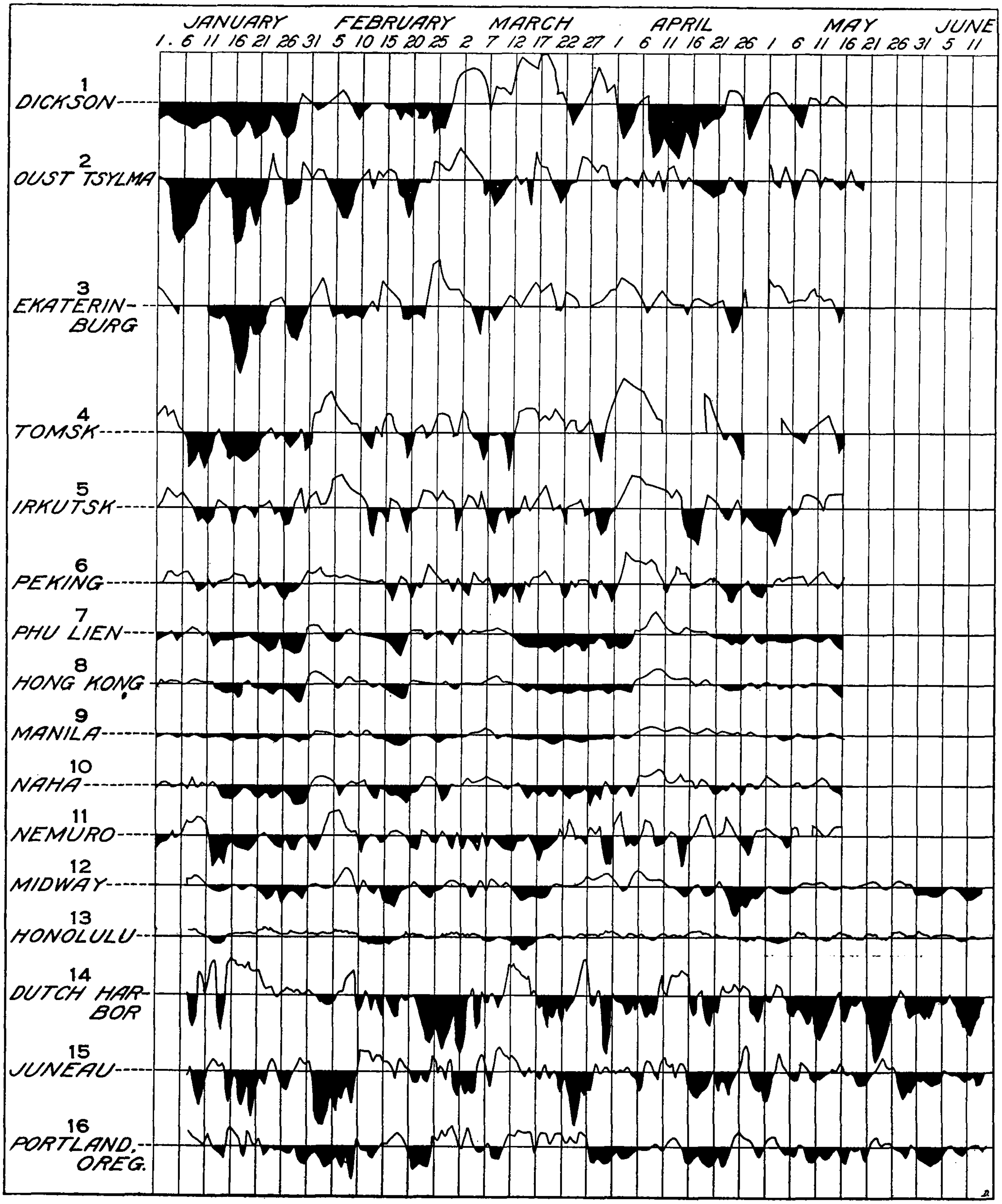

FIGURE 24.—Departure from normal pressure (daily) for 49 stations January-April, 1925


JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
1 6 11 16 21 26 31 5 10 15 20 25 2 7 12 17 22 27 1 6 11 16 21 26 1 6 11 16 21 26 31 5 11
17 YAKUTSK
18 S.S. MAUD
19 NOME
20 POINT BARROW
21 EAGLE
22 SIMPSON
23 EDMONTON
24 HELENA
25 DENVER
26 CHESTERFIELD INLET
27 WINNIPEG
28 CHICAGO
29 FT. SMITH
30 PT. HARRISON
31 NEW YORK
32 HATTERAS
33 BERMUDA
34 PONDS INLET

FIGURE 24-A

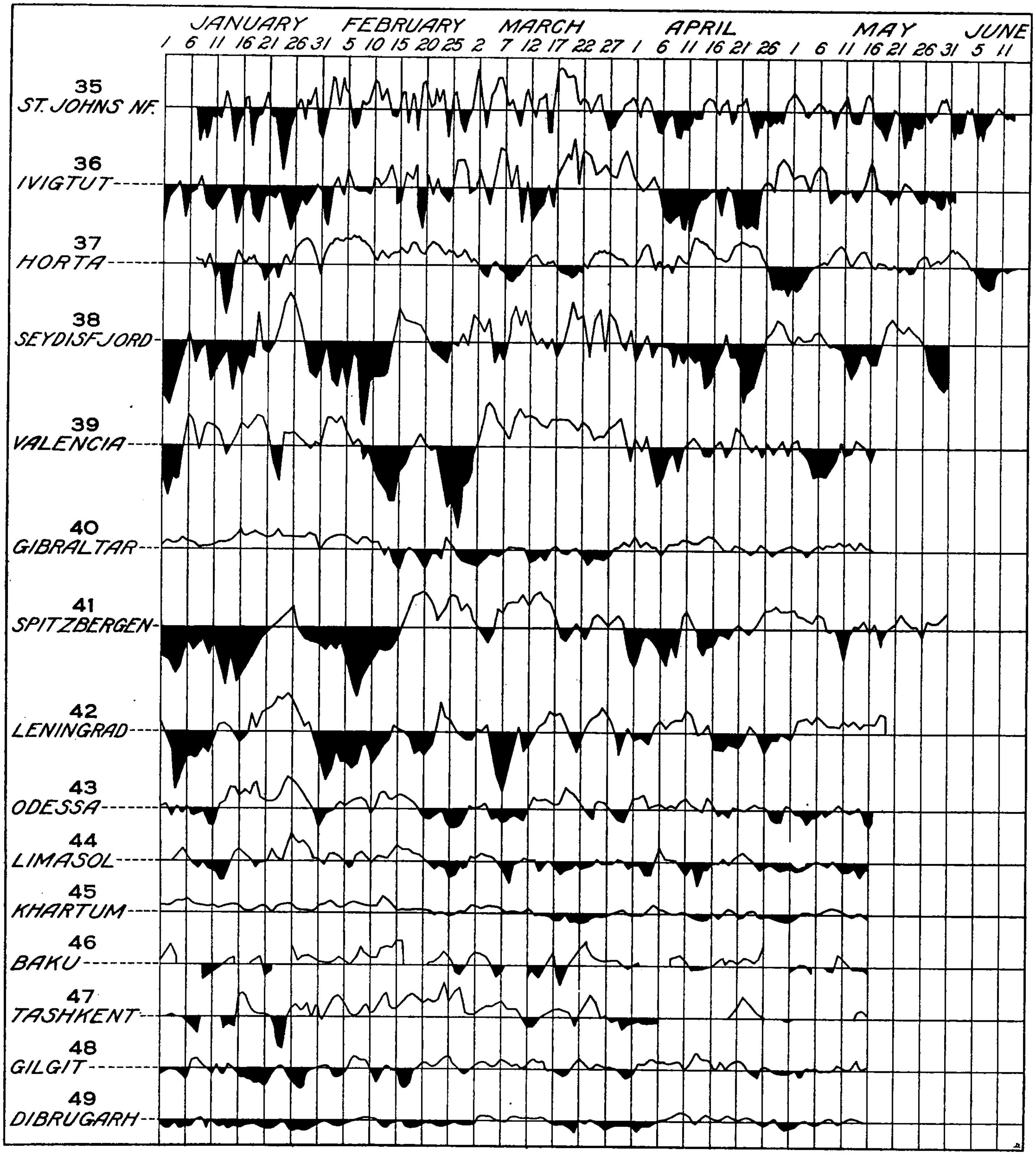
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
1 6 11 16 21 26 31 5 10 15 20 25 2 7 12 17 22 27 1 6 11 16 21 26 1 6 11 16 21 26 31 5 11
35
ST. JOHNS NF.
36
IVIGTUT
37
HORTA
38
SEYDISFJORD
39
VALENCIA
40
GIBRALTAR
41
SPITZBERGEN
42
LENINGRAD
43
ODESSA
44
LIMASOL
45
KHARTUM
46
BAKU
47
TASHKENT
48
GILGIT
49
DIBRUGARH

FIGURE 24-B

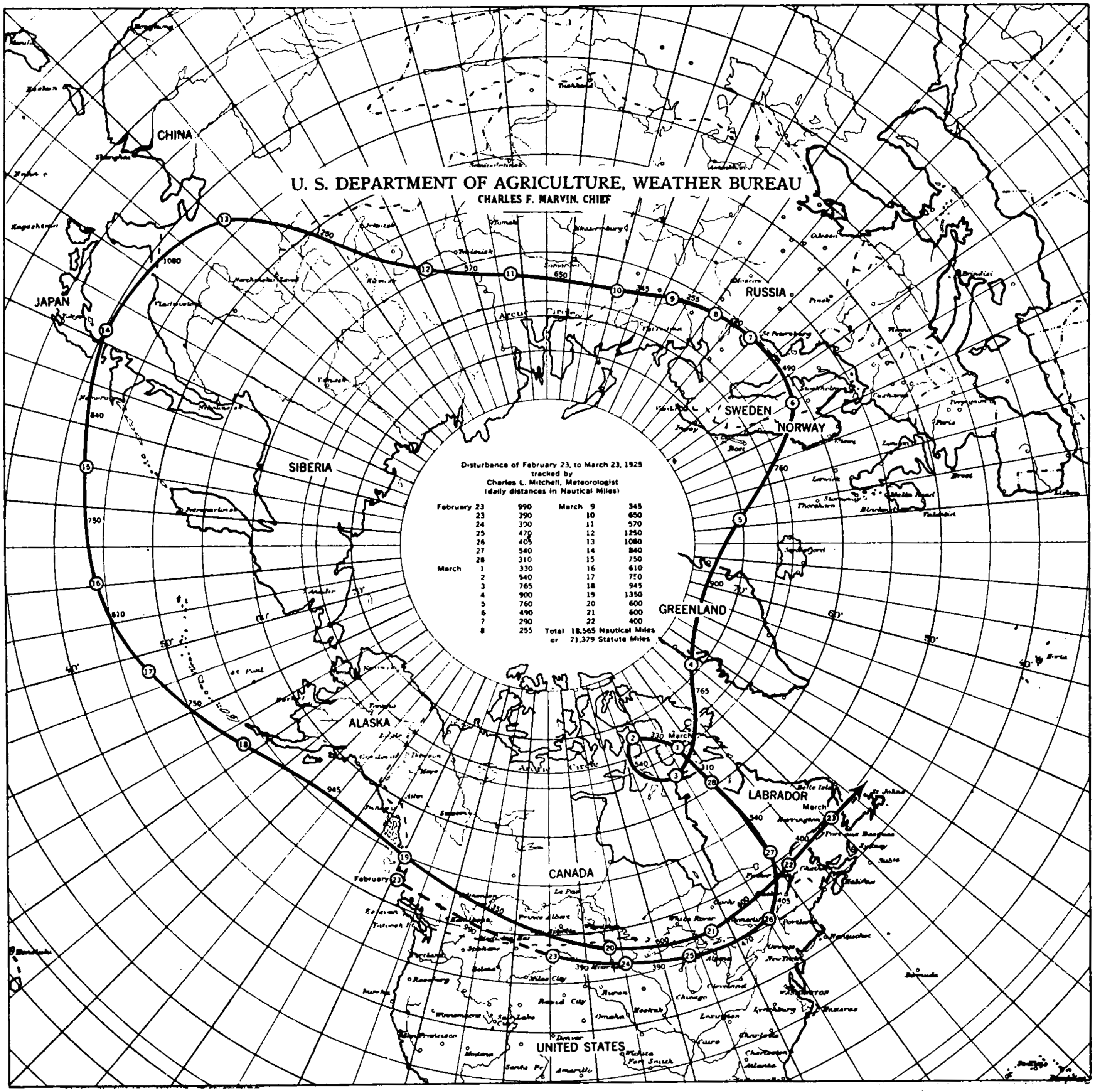

FIGURE 25.—Around-the-world cyclone of February 23–March 23, 1925

This cyclone increased rapidly in intensity after leaving Montana, the central pressure falling below 29 inches over northern New England and the lower St. Lawrence Valley on February 26. Its further progress toward the east was blocked by an area of high pressure that covered Greenland and extended southeastward to the Azores at that time. Consequently it moved almost directly northward to the Hudson Strait region, reaching its greatest intensity near Fort Chimo where the barometer read 28.51 inches the evening of the 27th. By the morning of March 2 the center was near Ponds Inlet, Baffin Land, but rising pressure to the north and northeast and a change in wind direction aloft caused the center to shift southward to the western end of Hudson Strait by the morning of the 3d. Within 12 hours thereafter there was a decided decrease in pressure over Greenland and the center (29.11 inches) was near Upernivik, on the western coast of Greenland at 73° north latitude at 8 p. m. of the 3d. Passing rapidly eastward over northern Greenland and then turning toward the southeast, the center of this cyclone reached Sweden (28.74 inches) on the 6th and Leningrad, Russia, (28.74 inches) on the 7th. The rate of movement lessened greatly and the cyclone decreased in intensity while moving almost directly eastward over northern Russia and Siberia during the next three days, after which its path turned more to the southeast and it was central some distance northwest of Irkutsk on the 12th. At this time a strong anticyclone that was spreading rapidly southward and southeastward from the Spitzbergen-Nova Zembla region seemed to furnish the impetus that caused a rapid southeastward movement of the cyclone, the center of which was over the region northwest of Korea the morning of the 13th. By the 14th it was near Tokyo, after which the cyclone moved quite rapidly across the Pacific Ocean, reaching the British Columbia coast by the 19th and the northern Lake Region by the 21st. This cyclone became occluded during the night of the 20th–21st and it diminished rapidly in intensity as it advanced eastward to the Gulf of St. Lawrence during the next two days. By the 22d a solid wall of high pressure surrounded the now very weak cyclone and it finally disappeared on the 23d.

METEOROLOGICAL NOTES ON THE FORMATION OF ICE ON AIRCRAFT

By C. G. ANDRUS

[Cleveland Airport, Ohio, December 15, 1929]

Throughout the entire gamut of weather activities, fog and ice are the greatest dangers to air transport. Of these dangers either by itself is a hazard against which all possible precautions are taken. Fog is still a bewildering thing to penetrate at modern airplane speeds—beacons, radio, instruments, and an experienced hand at the stick notwithstanding. When to this danger, bad in itself, is added that of icing up, the hazard is, indeed, great. To accumulate ice it is generally necessary to fly "blind" through clouds, and flying through cloud masses is equivalent to flying through dense fog. There is, however, a great difference between the effect of fog and that of ice upon flight. Fog bewilders, obscures, distorts, and blinds the pilot's vision, but flight as a mechanical process goes on, requiring only expert guidance. But ice increases drag, distorts wings, sets up terrifying vibrations, and may even destroy the aircraft; it is not a navigational difficulty so much as a matter of maintaining flight and retaining control of the craft; in the last analysis a matter of ability to stay up. Hence, its great danger and its record of disastrous results.

In the winter of 1926–27 pilots flying between New York and Cleveland related astonishing experiences with ice, which at that time was considered as a matter of contact with snowflakes and freezing rain. Experiments farther South were going on, indicating a tendency to freeze ice on the planes in temperatures a few degrees below freezing. The following winter previous experiences were corroborated, and it was clearly indicated that certain conditions hitherto only suspected produced ice and were especially prevalent near the Great Lakes. A previous discussion (1) deals with the reports of the pilots and the conclusions drawn. Many students of the subject were prone to believe that the surprisingly low temperature reports were unacceptable and theoretically unlikely, although there was persistent repetition of the reports of temperatures far below freezing, all however obtained from personal observations or from none too reliable instruments

It was but a short step to the self-recording aerograph. From it can be obtained verifiable records of temperature, humidity, and altitude; if properly exposed there can be little question as to the accuracy of its records. Thus, last winter (1928–29) plans were made by the Weather Bureau to mount two of these, when opportunity offered, on the wings of the transport planes of the National Air Transport (Inc.), mail contractor carriers, who volunteered the use of the planes between Cleveland and New York, the cooperation of its personnel and an offer to construct special streamlined containers to be made fast to the wings. These containers were mounted so far from the motor that no influence of heat from that source could reach them. The pilots told at what time ice was taken; the aerograph showed what conditions then existed. The initial offensive to track down this "bete noir" of flying has yielded recorded aerograms which wholly support the earlier personal accounts of a noninstrumental nature.

Out of many flights, made between February 6 and mid-April, 1929, eight yielded records while the carrier planes were taking ice. Some of the instances were mild, others moderately severe, but of course none was disastrous. Collectively, they show agreement on several features, (1) subfreezing temperatures down to at least −23 C. (−10 F.); and (2) relative humidities above 90, as prerequisites for taking ice. In the vicinity of 100 per cent humidity the accumulation is faster than in conditions less saturate. When the temperature is below freezing its reading is most useful to determine how great the quantity of moisture may be at saturation. Owing to the higher amount of moisture per mass at the higher temperatures, it appears that the ice accretions of the planes would be greatest at temperatures just below freezing tapering slowly as temperatures reduce. The process appears to be the same throughout, the mass alone varying.

The collection of ice at relative humidities under 100 per cent warrants comment. In forging through clouds at airplane speeds the aircraft and the aerograph may pass rapidly through varying densities of clouds. The air is usually turbulent in clouds, and the intensity of the opaque curtain of gray-white is usually noted by