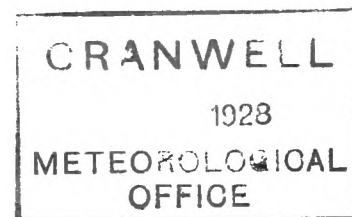


METEOROLOGICAL OFFICE  

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GEOPHYSICAL MEMOIRS No. 31  
*(First Number of Volume IV.)*



# Classification of Monthly Charts of Pressure Anomaly

over the

## Northern Hemisphere

By C. E. P. BROOKS, M.Sc.  
and WINIFRED A. QUENNELL

*Published by Authority of the Meteorological Committee*



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# CLASSIFICATION OF MONTHLY CHARTS OF PRESSURE ANOMALY OVER THE NORTHERN HEMISPHERE

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## § 1. CONSTRUCTION OF THE CHARTS.

THE *Réseau Mondial* (1)\* was initiated in order to provide material for the study of the meteorology of the globe on the basis of monthly values of pressure, temperature and precipitation for a large number of stations. A description of its origin and purpose has been given by Sir Napier Shaw as a preface to the volume of Tables for 1914. The collection, co-ordination and publication of data on such a large scale is necessarily a slow process ; the first volume of the series is that for 1910, and there is at present no probability that the series will at any time be less than two years in arrears. During the preparation of the volumes, however, a large amount of material for earlier years was collected, and in order to extend the period for which monthly charts of pressure were available, these data have been plotted for the period 1873 to 1900 for the northern hemisphere.

The year 1873 was selected as the first year of the series because the comprehensive collection of pressure data for the United States and some neighbouring stations, reduced to homogeneous series by F. H. Bigelow (2) begins with that year. This series concludes with 1899, and there is a very comprehensive collection by Wl. Gorczynski (3) for Europe and Siberia which ends in 1900. For this reason the preparation of the charts was terminated at 1900, since, in order to extend them beyond the latter year, it would have been necessary to refer to a large number of separate year-books, but it is highly desirable that at some time the charts should be extended to 1909 in order to form a continuous series with the *Réseau Mondial*. The basis supplied by Bigelow's and Gorczynski's figures was completed by reference to the collection of the Solar Physics Committee (4), to collections in the *Meteorologische Zeitschrift* and to numerous manuscript compilations in the Meteorological Office. In all 114 stations were employed, and although these do not all run through the whole series, the charts represent the association of more than 25,000 separate monthly means of pressure. The list of stations, with dates, is given in Table I.

The figures plotted were not the actual means of pressure for the month, reduced to mean sea level, but the deviations from the normal pressures for that month. This course was adopted for several reasons. In the first place, the work was regarded as an extension of the *Réseau Mondial* series, in which deviations from normal are regarded as of primary importance. The two sets of *Réseau Mondial* charts which have been published show deviations of pressure and temperature from normal, and not actual values. Secondly, the comparison of one month with another is much easier when the pressure distribution is expressed in the form of isanomalies or lines of equal deviation from normal than when the actual isobars are drawn, especially in winter. Thirdly, the study of anomalies of weather, which it is hoped these charts will facilitate, and which is usually carried out by the method of correlation, deals in departures from normal and not in actual values. Finally, there was the practical consideration that the isanomalies of pressure are usually simpler than the isobars, since the latter express the effect of the irregular land and sea distribution and other local factors, as well as the abnormalities associated with the general meteorological situation. Hence two or three times as many stations would be required to draw the isobars satisfactorily, as are needed for a sufficiently accurate picture of the isanomalies.

\* See "References" on p. 12

TABLE I.—LIST OF STATIONS, WITH PERIODS.

No.	Station	Lat.	Long.	Period	No.	Station	Lat.	Long.	Period
		° N ' /	° E ' /				° N ' /	° E ' /	
1	Franz Josef Land	81 0	E 55 0	1873-74, 1894-96, 1898-1900.	58	Odessa ..	46 26	E 30 46	1873-1900.
2	Jan Mayen	71 0	W 11 0	1882-83.	59	Tiflis ..	41 43	44 48	1873-1900.
3	Pt. Barrow	71 23	156 17	1881-83.	60	Siwantse ..	40 58	E 115 18	1878-82.
4	Kinguaaffjord	66 35	W 67 30	1882-83.	61	San Francisco	37 48	W 122 26	1873-1900.
5	Sagastyr ..	73 23	E 124 5	1882-84.	62	San Diego ..	32 43	117 10	1873-1900.
6	Inglefield Bay	77 20	W 67 30	1873, 1881-84.	63	Denver ..	39 45	105 0	1873-1900.
7	Upemvik ..	72 47	W 56 7	1874-1900.	64	Abilene ..	32 23	99 40	1886-1900.
8	Spitsbergen	78 2	E 14 14	1873, 1882-83, 1894-95, 1899-1900.	65	Saint Louis..	38 38	90 12	1873-1900.
9	Vardö ..	70 22	31 8	1881-1900.	66	Mobile ..	30 41	88 2	1873-1900.
10	Mal'ye	72 23	E 52 43	1882-83, 1896-1900.	67	Nashville ..	36 10	86 47	1873-1900.
11	Karmakouly St. Michael's, Alaska.	63 28	W 161 48	1874-1885.	68	Charleston ..	32 47	79 56	1873-1900.
12	Jacobshavn	69 13	51 2	1873-1900.	69	Washington	38 54	77 3	1873-1900.
13	Godthaab ..	64 11	51 43	1874-1900.	70	Bermuda ..	32 18	64 46	1873-1900.
14	Angmagalik	65 37	37 33	1884-85, 1894-1900.	71	Ponta Delgada	37 44	25 40	1873-1900.
15	Stykkisholm	65 5	22 46	1873-1900.	72	Lisbon ..	38 43	9 9	1873-1900.
16	Berufjord ..	64 40	14 19	1874-1900.	73	Gibraltar ..	36 6	W 5 21	1891-1900.
17	Thorshavn ..	62 3	6 45	1873-1900.	74	Athens ..	37 58	E 23 43	1873-1900.
18	Lerwick ..	60 9	W 1 8	1873-1900.	75	Cairo ..	29 52	31 20	1873-1900.
19	Arkhangelsk	64 35	E 40 36	1873-1900.	76	Nicosia ..	35 9	33 22	1891-99.
20	Markovo-sur-Anadyr.	64 45	E 170 50	1894-1900.	77	Beirut ..	33 54	35 28	1875-1900.
21	St. Paul Is.	57 15	W 170 10	1873-76.	78	Leh ..	34 10	77 42	1875-1900.
22	Sitka ..	57 3	135 10	1873-76.	79	Zi-Ka-Wei ..	31 12	121 26	1873-1900.
23	Port Simpson	54 25	130 10	1887-90, 1895-1900.	80	Nagasaki ..	32 44	129 52	1878-1900.
24	Valencia ..	51 56	10 15	1873-1900.	81	Kioto ..	35 1	135 44	1883-1900.
25	Aberdeen ..	57 10	W 2 6	1873-1900.	82	Tokio ..	35 41	E 139 45	1873-1900.
26	Greenwich ..	51 28	0 0	1873-1900.	83	Honolulu ..	21 19	W 157 52	1873-77, 1883-1900.
27	Uccle ..	50 48	E 4 22	1873-1900.	84	Galveston ..	29 18	94 50	1873-1900.
28	De Bilt ..	52 6	5 11	1873-1900.	85	Havana ..	23 8	82 21	1876-1900.
29	Christiania ..	59 54	10 46	1873-1900.	86	Key West ..	24 33	81 48	1873-1900.
30	Potsdam ..	52 23	13 4	1873-1900.	87	Las Palmas	28 6	15 26	1882-85, 1887-95, 1897-1900.
31	Upsala ..	59 51	17 38	1873-1900.	88	Jedda ..	21 32	39 10	1881-86, 1889-91, 1896-99.
32	Warsaw ..	52 13	21 1	1873-1900.	89	Bushire ..	28 59	50 53	1878-1900.
33	Jurjev ..	58 23	26 43	1873-1900.	90	Calcutta ..	22 36	88 23	1873-1900.
34	Petrograd ..	59 56	30 16	1873-1900.	91	Hong Kong	22 18	E 114 10	1884-1900.
35	Moscow ..	55 50	37 33	1873-1900.	92	Oaxaca ..	17 4	W 96 42	1883-99.
36	Ekaterinburg	56 49	60 38	1873-1900.	93	Guatemala ..	14 38	90 30	1883, 1885-88, 1892, 1894-98.
37	Barnaoul ..	53 20	83 48	1873-1900.	94	Belize ..	17 29	88 12	1894-1900.
38	Nertchinsk ..	51 59	E 116 35	1873-1900.	95	Caracas ..	10 30	66 55	1893-1900.
39	Victoria, B.C.	48 24	W 123 19	1898-1900.	96	Grenada ..	12 5	61 46	1876-1900.
40	Portland, Or.	45 32	122 41	1873-1900.	97	Barbados ..	13 8	59 36	1876-1900.
41	Helena ..	46 34	112 4	1882-1900.	98	San Juan ..	18 25	W 66 7	1876-1900.
42	Salt Lake City	40 46	111 54	1875-1900.	99	Aden ..	12 45	E 45 3	1880-1900.
43	North Platte	41 8	100 45	1875-1900.	100	Bombay ..	18 54	72 49	1873-1900.
44	Bismarck ..	46 47	100 38	1875-1900.	101	Madras ..	13 4	80 14	1873-1900.
45	Duluth ..	46 47	92 6	1873-1900.	102	Port Blair ..	11 40	92 40	1873-1900.
46	Chicago ..	41 53	87 37	1873-1900.	103	Rangoon ..	16 46	95 48	1876-1900.
47	Toronto ..	43 40	79 24	1873-1900.	104	Manila ..	14 35	E 120 59	1878-1900.
48	New York ..	40 46	73 58	1873-1900.	105	Paramaribo	5 49	W 55 9	1876-1900.
49	Sydney, N.S.	46 7	60 18	1874-1900.	106	Sierra Leone	8 30	W 13 9	1877-79, 1882, 1885-86, 1891-1900.
50	Madrid ..	40 24	3 41	1873-1900.	107	Lagos ..	6 27	E 3 24	1891-1900.
51	Nantes ..	47 15	W 1 34	1873-1900.	108	Duala ..	4 5	9 40	1885-86, 1888-1900.
52	Paris ..	48 49	E 2 29	1873-1900.	109	Colombo ..	6 54	79 53	1873-1900.
53	Marseilles ..	43 18	5 23	1873-1900.	110	Singapore ..	1 17	103 51	1873-1900.
54	Geneva ..	46 27	6 30	1873-1900.	111	Zanzibar ..	6 10	39 11	1889-1900.
55	Rome ..	41 54	12 27	1873-1900.	112	Seychelles ..	4 37	55 27	1885-99.
56	Vienna ..	48 15	16 22	1873-1900.	113	Batavia ..	6 11	106 50	1873-1900.
57	Scutari ..	41 1	E 29 2	1873-1900.	114	Port Darwin	12 28	130 51	1883-1900.

In order to illustrate the relationships between the isobars and isanomalies of pressure in winter and summer respectively, four charts are given (Figures 1 to 4), showing the actual distribution of pressure in January and July 1883 and the corresponding isanomalies drawn from the land stations. The year 1883 was selected because it was the international "polar year," during which a large number of observations were taken by scientific expeditions in high latitudes. Figures 1 and 3 were drawn from charts published by S. B. Ehrhart (5) who collected and discussed these observations.

In January, 1883, the Icelandic minimum was unusually deep and lay off South

Greenland, somewhat to the west of its normal position ; this is indicated on Figure 2 by the isanomaly of -10 mb. surrounding Cape Farewell. The Aleutian low was also unusually deep, as shown by the isanomaly of -5 mb., and there is a trough of low pressure over the Urals which is not very noticeable in Figure 1, but which is shown in Figure 2 by the isanomaly of -2.5 mb. Similarly a slight wedge of high pressure over the Baltic and Scandinavia is indicated by an isanomaly of + 2.5 mb.

In July, 1883, owing to the relatively slight barometric gradients which characterize the normal pressure distribution in summer, the resemblance between the isobars and the isanomalies is much closer, especially north of 50° N. The area of high pressure north of Iceland and the minima over the Baltic and Hudson Bay, shown in Figure 3, are all reproduced in Figure 4. The Azores anticyclone and the Indian minimum are not shown in Figure 4, because these features of Figure 3 attained only their normal development.

## § 2. CLASSIFICATION.

For convenience in handling the 336 monthly charts, some form of classification was necessary, and after various attempts the scheme given below was evolved.

The basis of the classification is formed by the distribution of the pressure anomaly in the region including Greenland, Iceland, Scandinavia and the British Isles, in which the variations of pressure from month to month are very great. In the centre of this triangle lies the station of Thorshavn (Faroe Islands), and the charts were first divided into two groups, according to whether pressure at Thorshavn was above or below the normal for the month. When the pressure was very nearly normal at that station in any month, the chart for that month was allocated to the positive group (I) if the oceanic region between Iceland and the British Isles was dominated by a positive anomaly of pressure (centre of excess) and to the negative group (II) if it was dominated by a negative anomaly (centre of deficit).

Each of these two groups was next divided into five types, Group I according to the position of the centre of positive anomaly, and Group II according to the position of the centre of negative anomaly. Thus we have :—

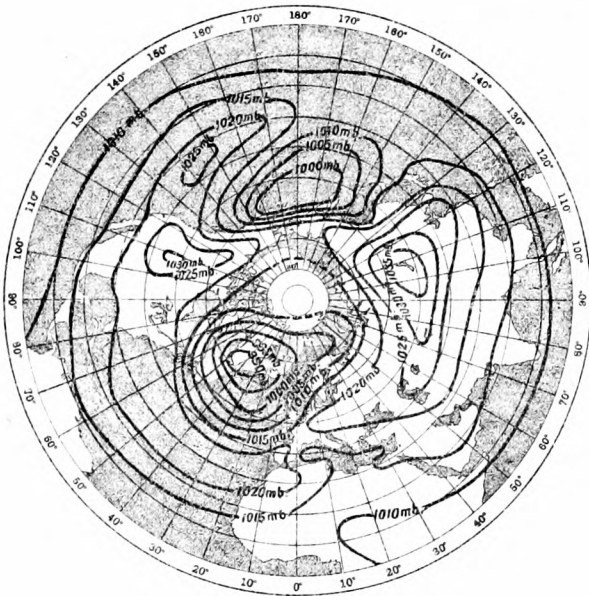
Group I. Pressure at Thorshavn above normal.	Group II. Pressure at Thorshavn below normal.
IA. Centre of excess over or near Scandinavia.	IIA. Centre of deficit over or near Scandinavia.
IB. Belt of excess from British Isles across Europe.	IIB. Belt of deficit from British Isles across Europe.
IC. Centre of excess over British Isles.	IIC. Centre of deficit over British Isles.
ID. Centre of excess over Iceland or Southern Greenland.	IID. Centre of deficit over Iceland or Southern Greenland.
IE. Pressure above normal over the Arctic generally ; belt of deficit across the Atlantic and Southern Europe in 40°-50° N.	IIE. Pressure below normal over the Arctic generally ; belt of excess across the Atlantic and Mediter- ranean in about 40° N.

These ten types were then divided into a number of sub-types. The process was initially empirical, the charts of each type being sorted and arranged until a number of sets were obtained, the members of each set being characterized by a certain family likeness. When this had been done each set was examined in order to find points in common which could be used for classification, and the final allocation was made on the basis of the classification so obtained. This process was adopted in order to make the classification as natural as possible. Types IE and IIE were found to form remarkably homogeneous sets which needed no sub-division.

The sub-types are as follows :—

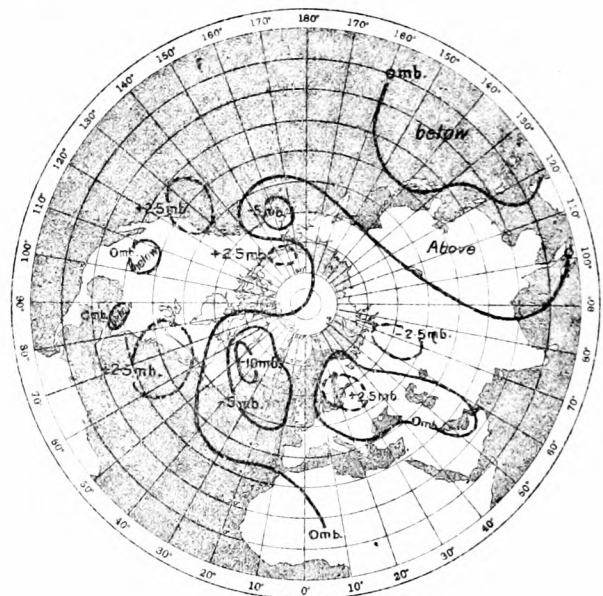
- IA. Centre of excess over or near Scandinavia.
  - IA1. Excess extending over Iceland, Greenland and the whole or part of the British Isles. Azores near or above normal. Deficit over the Mediterranean. Figure 5.
  - IA2. Excess extending from Scandinavia usually to Spitsbergen and north-east Greenland; Mediterranean mainly above normal. Deficit over Azores usually including western North Atlantic; usually a deficit near Lake Baikal. Figure 6.
  - IA3. Excess extending from Urals to the British Isles, centred over Scandinavia. Deficits centred over Baffin Bay and Mediterranean; Azores generally below normal. Figure 7.
- IB. Belt of excess from British Isles across Europe.
  - IB1. Excess extending across the Azores. Deficit over Southern Greenland or Baffin Bay. Figure 8.
  - IB2. Excess extending across Greenland and Baffin Bay and including most of the Arctic. Azores usually below normal. This sub-type is not very characteristic and is not illustrated.
- IC. Excess centred over the British Isles.
  - IC1. Excess extending over western Europe and generally including the Mediterranean. Azores, Baffin Bay and Urals below normal and usually connected by a horseshoe-shaped belt of deficit as shown. Figure 9.
  - IC2. Excess extending over Azores. Deficit from Hudson Bay across Baffin Bay to the White Sea or Urals, and extending over most of Arctic. Figure 10.
  - IC3. Excess extending over Azores; Baffin Bay above normal. Deficit centred over White Sea or Urals. Figure 11.
  - IC4. Excess extending over Iceland and east Greenland. Azores and Urals below normal. Figure 12.
- ID. Excess centred near Iceland or Southern Greenland.
  - (a) Pressure above normal at the Azores.
    - ID1. Excess extending over the British Isles and the Urals. Deficit over Europe. Figure 13.
    - [ID2. Pressure normal or above normal over the British Isles, below normal over the Urals. This sub-type was not represented during the period discussed, and is not illustrated.]
    - ID3. Deficit centred over Europe extending over the British Isles. Figure 14.
  - (b) Pressure below normal over the Azores.
    - ID4. Excess extending over Baffin Bay. Belt of deficit extending from south-eastern U.S.A. across Bermuda, the Azores and Europe, generally to the Urals. Figure 15. This sub-type passes into IE.
    - ID5. Excess over Iceland and the Faroes, extending to Scandinavia. Pressure below normal over Newfoundland, Baffin Bay, Southern Europe and the Mediterranean. Figure 16.
    - ID6. Excess over Iceland extending over Baffin Bay and western Europe; deficit over Urals. Figure 17.
- IE. Pressure above normal over the Arctic generally; belt of deficit across the Atlantic and Southern Europe in 40°—50° N.
  - IE1. Pressure below normal over the Azores. Figure 18. In several examples the belt of pressure deficit extended completely round the world in middle latitudes.

FIG. 1.



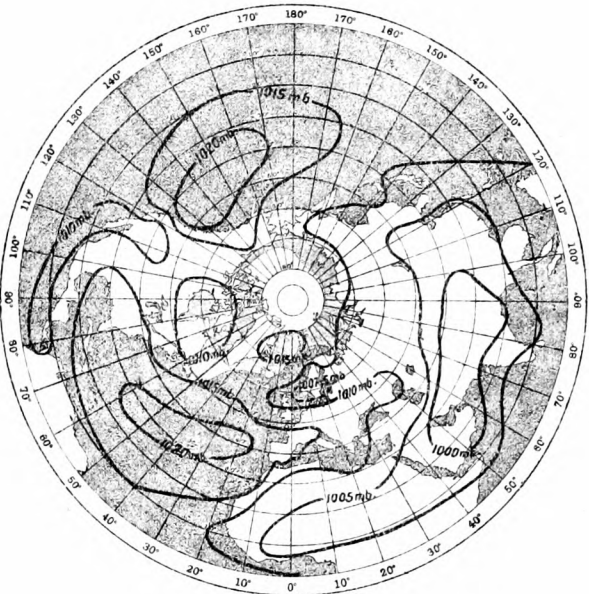
January, 1883. Pressure Distribution.

FIG. 2.



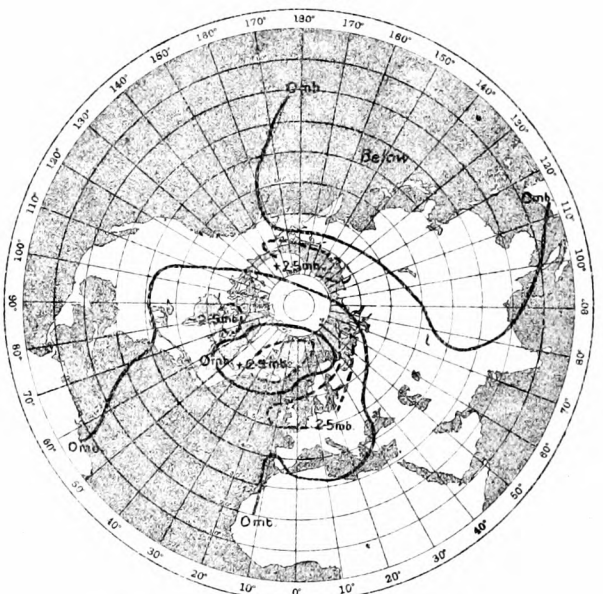
January, 1883. Pressure Difference from Normal.

FIG. 3.



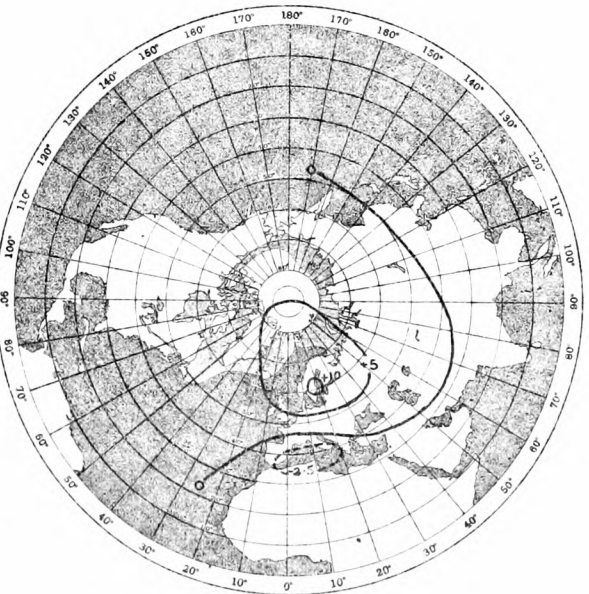
July, 1883. Pressure Distribution.

Fig. 4.



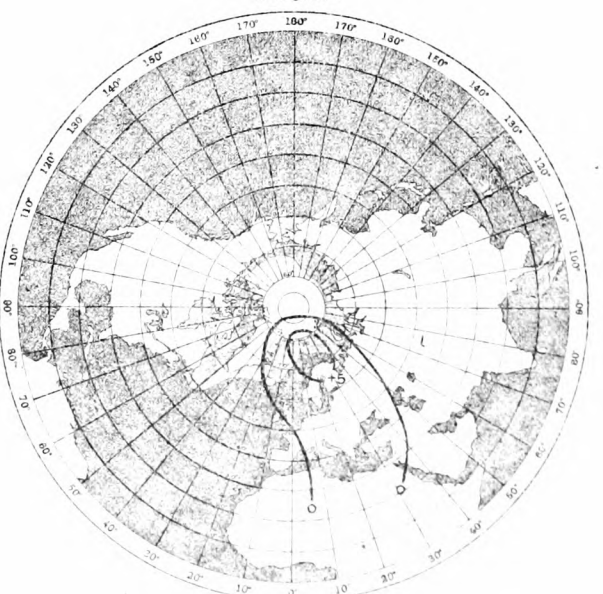
July, 1883. Pressure difference from Normal.

FIG. 5.



IA 1.

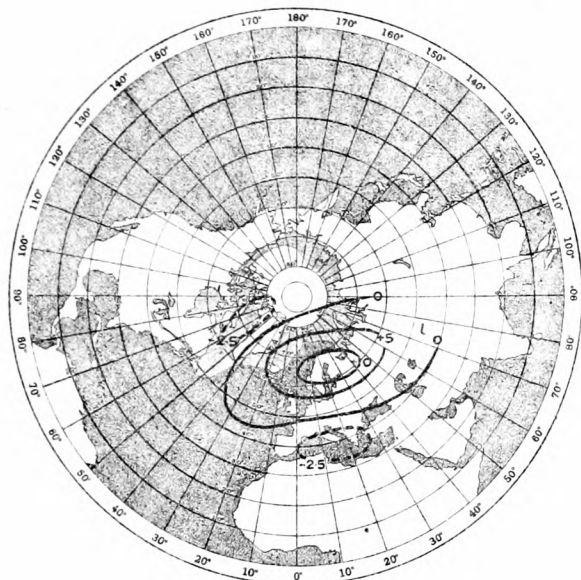
Fig. 6.



I A 2

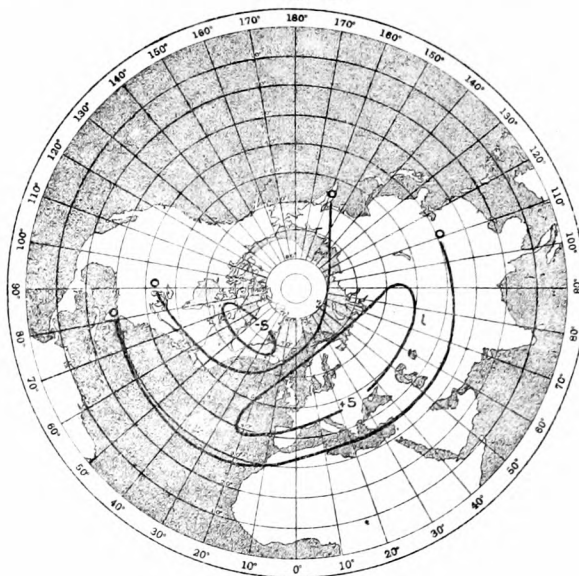


FIG. 7.



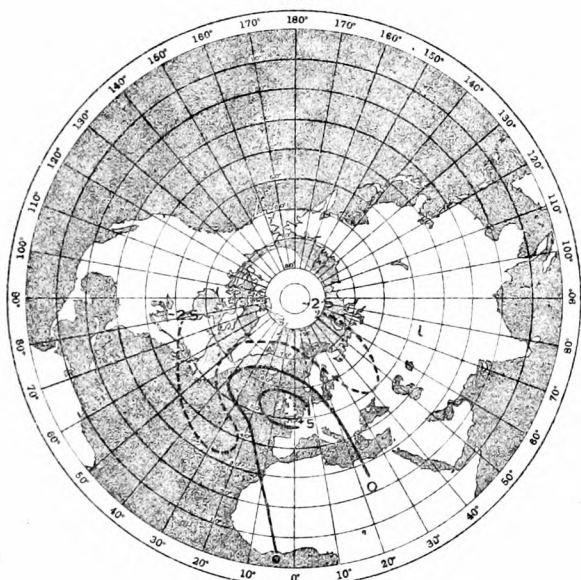
IA 3.

FIG. 8.



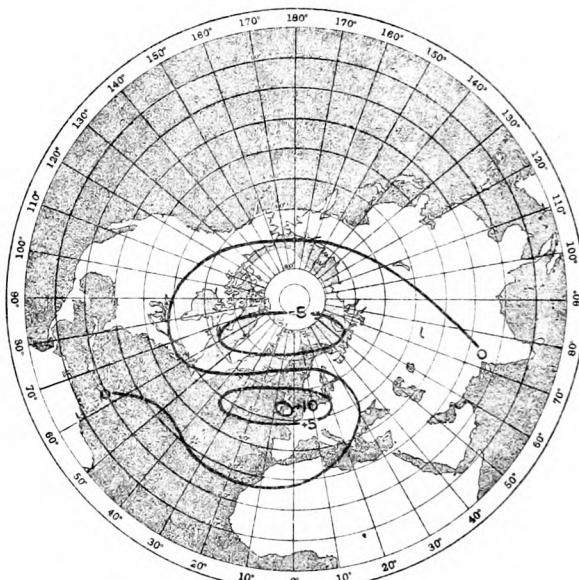
IB 1.

FIG. 9.



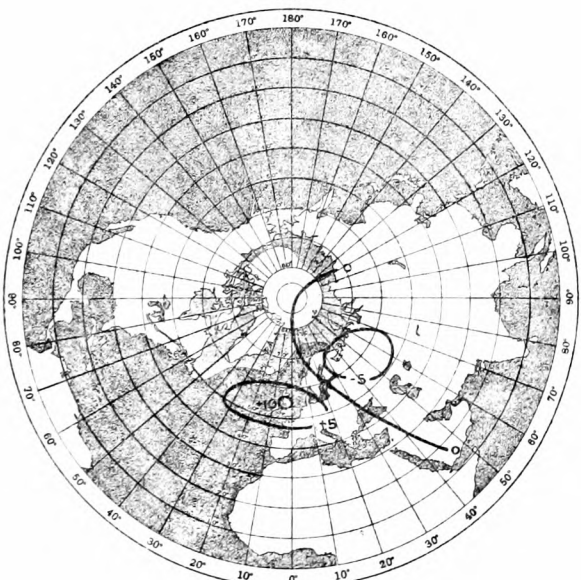
IC 1.

FIG. 10.



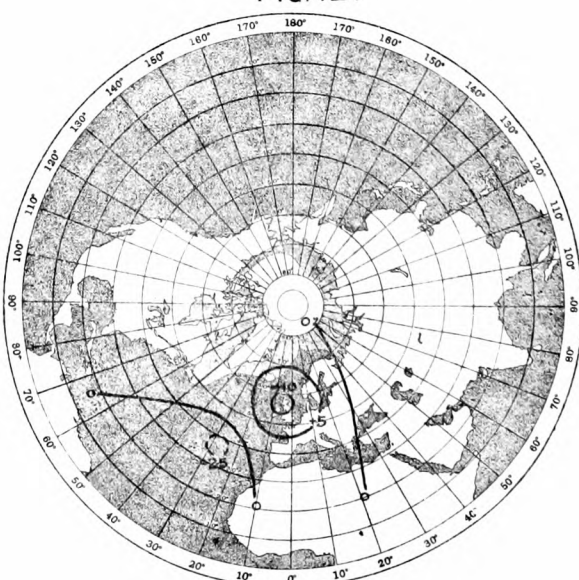
IC 2.

FIG. 11.



IC 3.

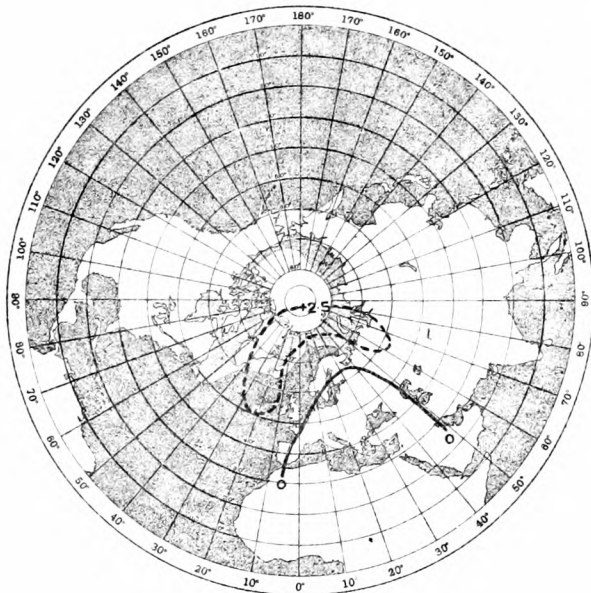
FIG. 12.



IC 4.

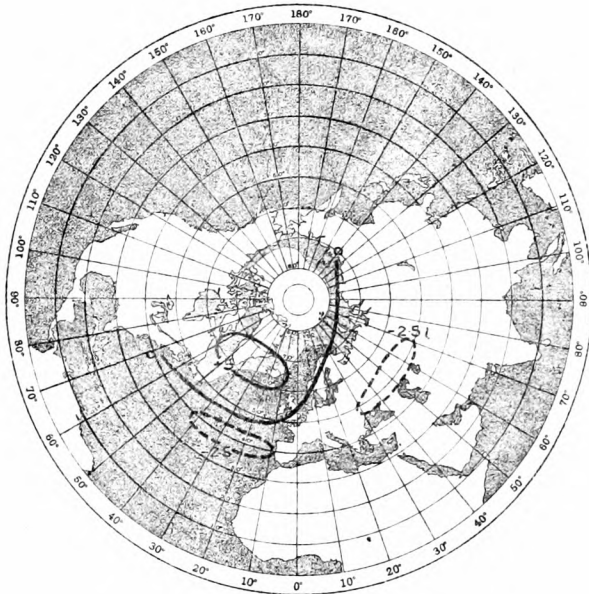


FIG. 13.



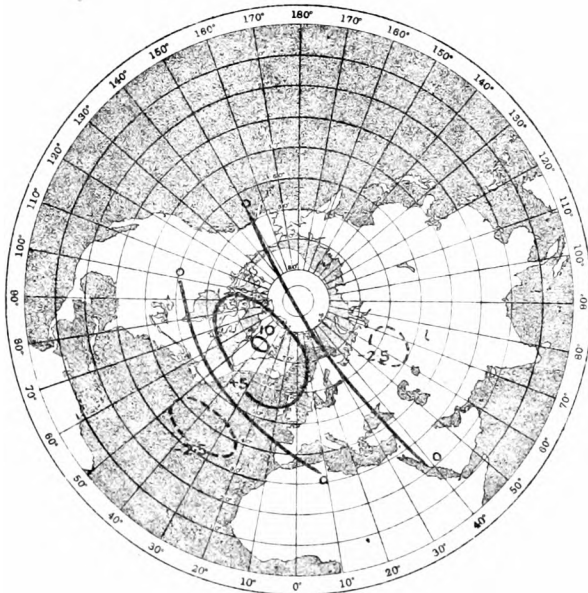
1 D 1

FIG. 15.



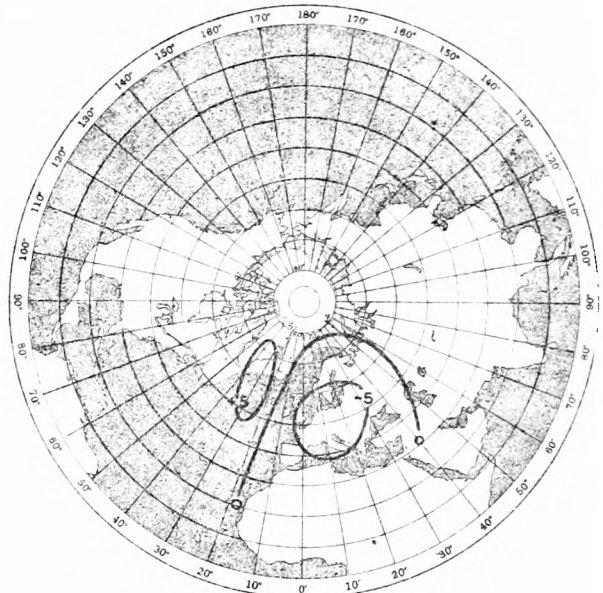
ID.4

FIG. 17.



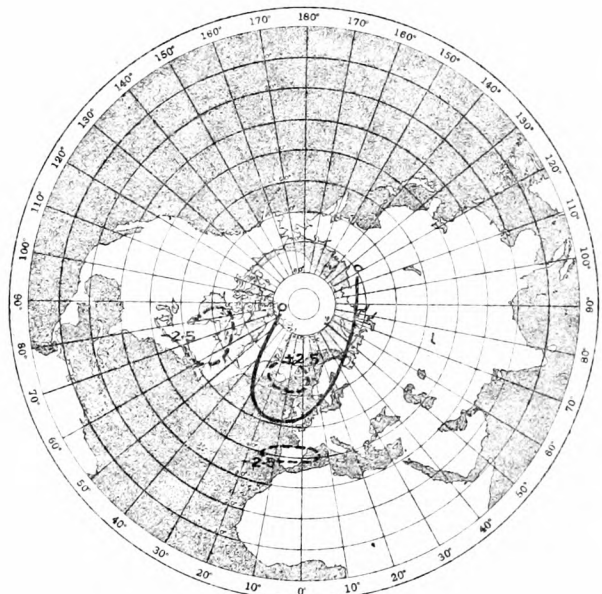
ID 6.

FIG. 14.



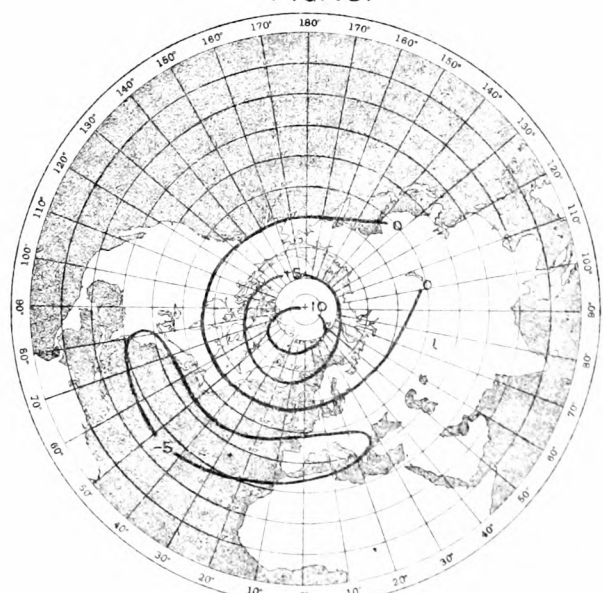
I.D 3

FIG. 16



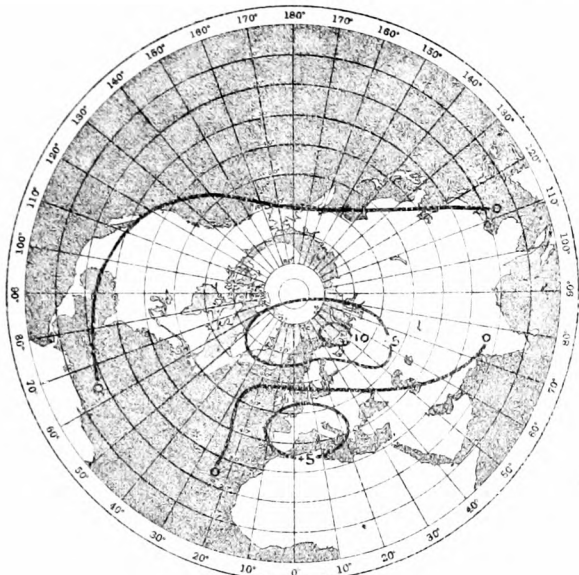
1 D 5

FIG. 18.



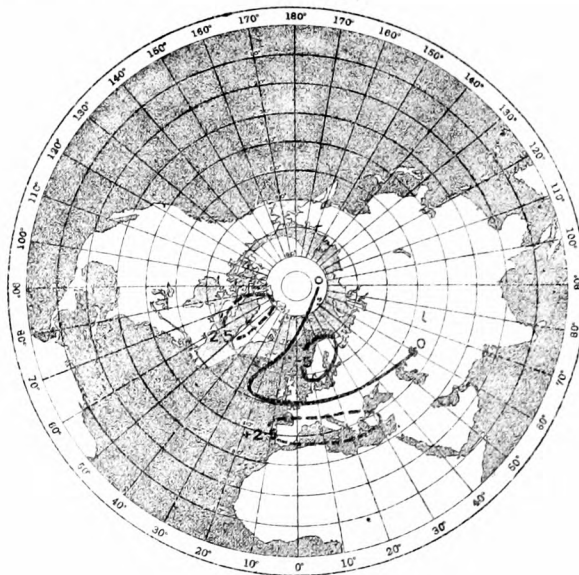
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Fig. 19.



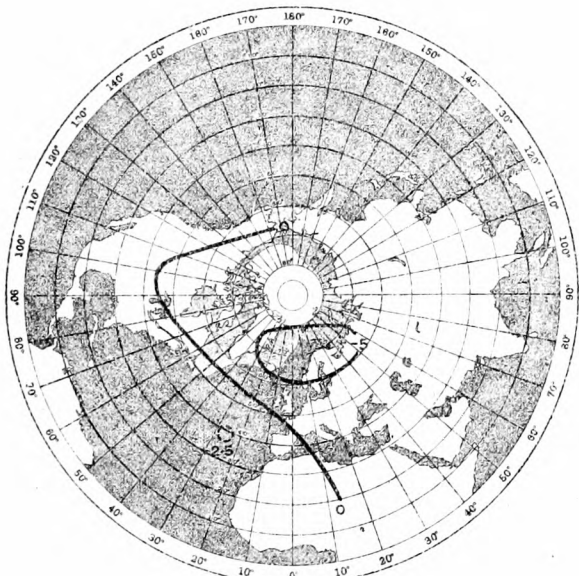
II A. 1.

Fig. 20.



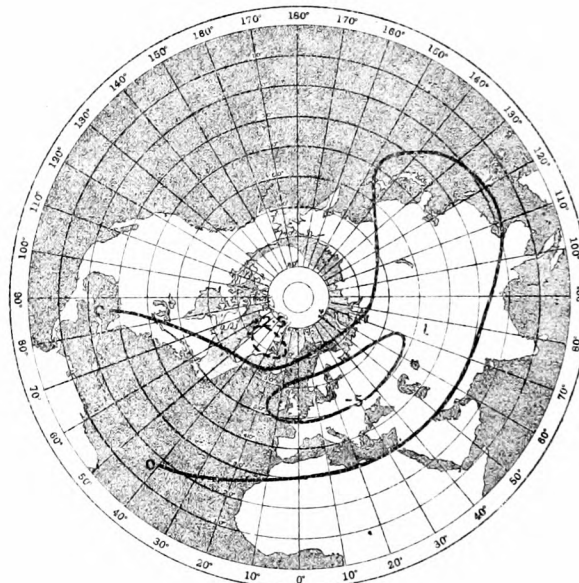
II A. 3.

Fig. 21.



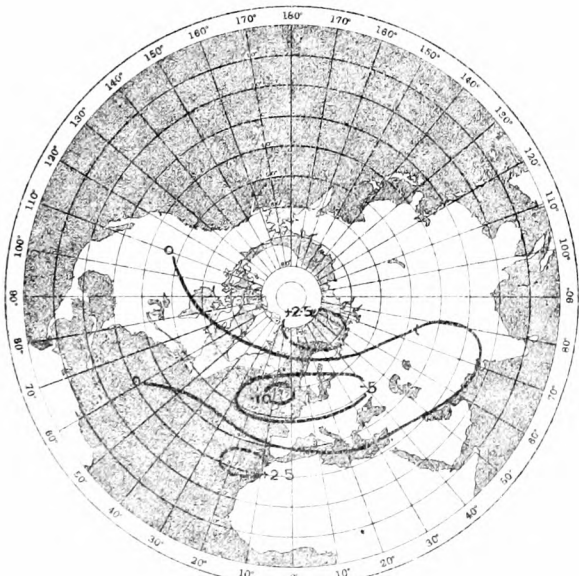
II A. 4.

Fig. 22.



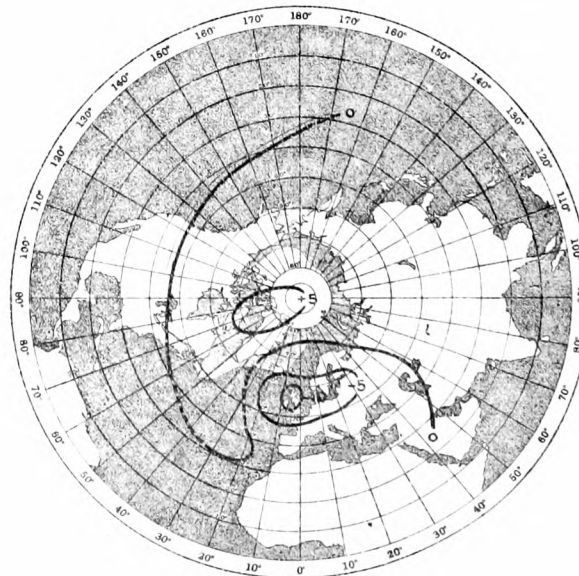
II B. 1.

Fig. 23.



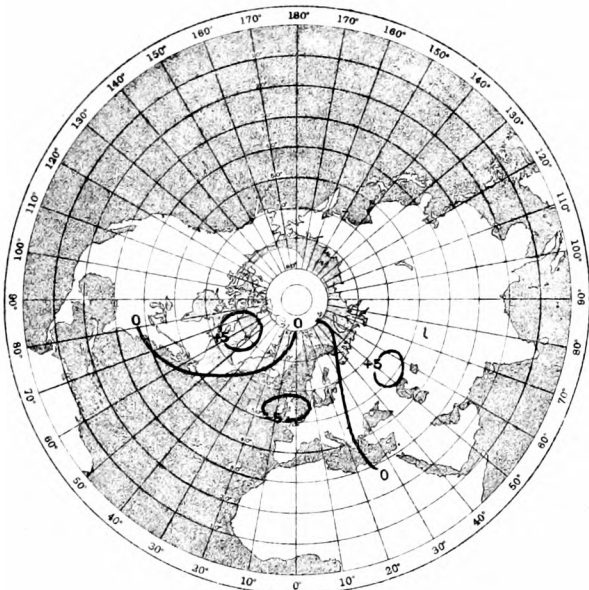
II B. 2.

Fig. 24.



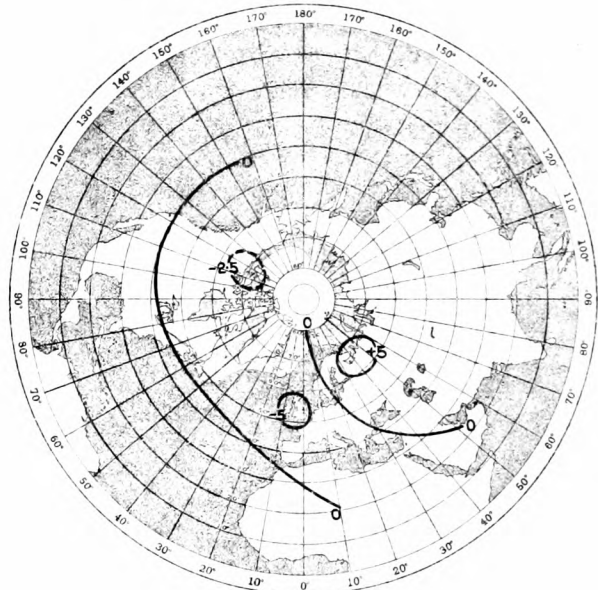
II C. 1.

FIG 25.



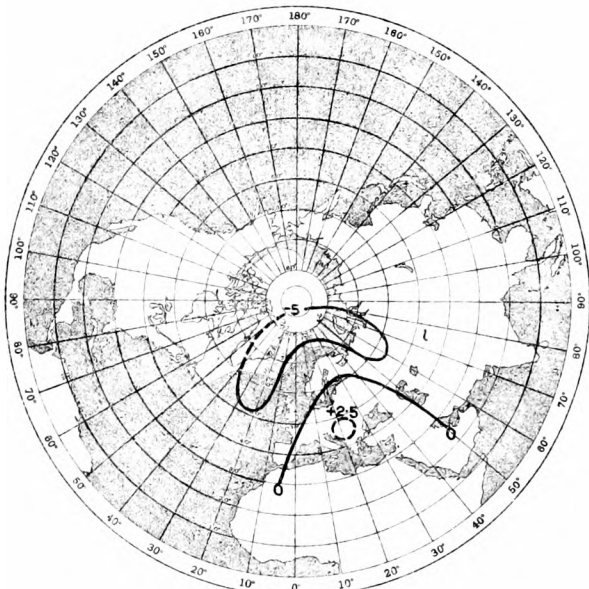
П C 2.

FIG 26.



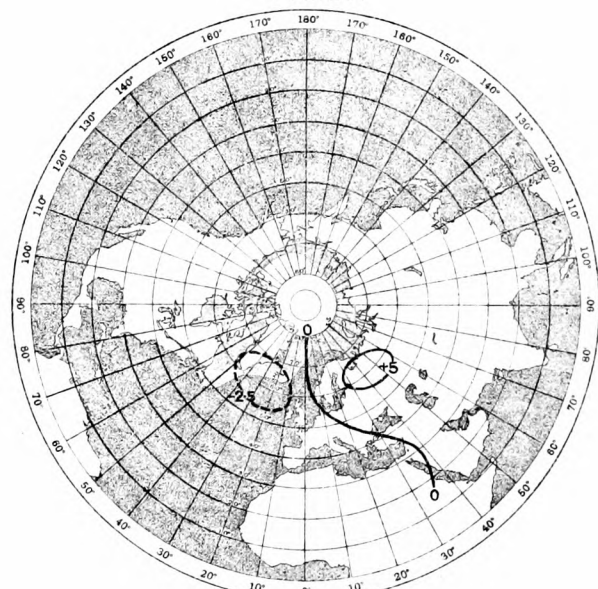
П C 3.

FIG 27.



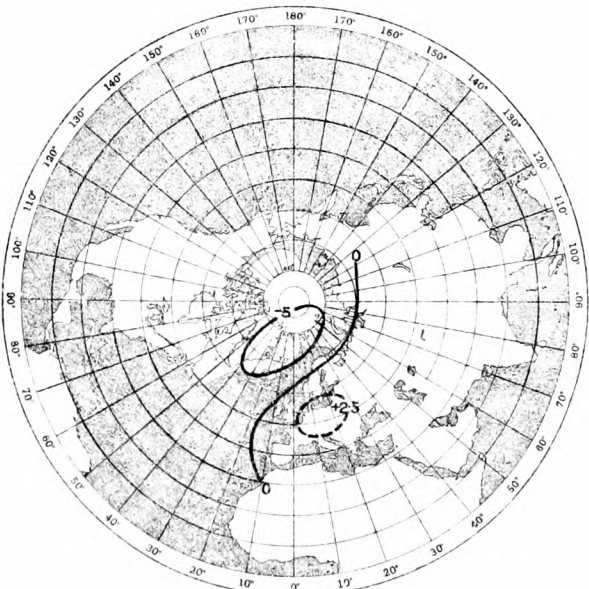
П D 1.

FIG 28.



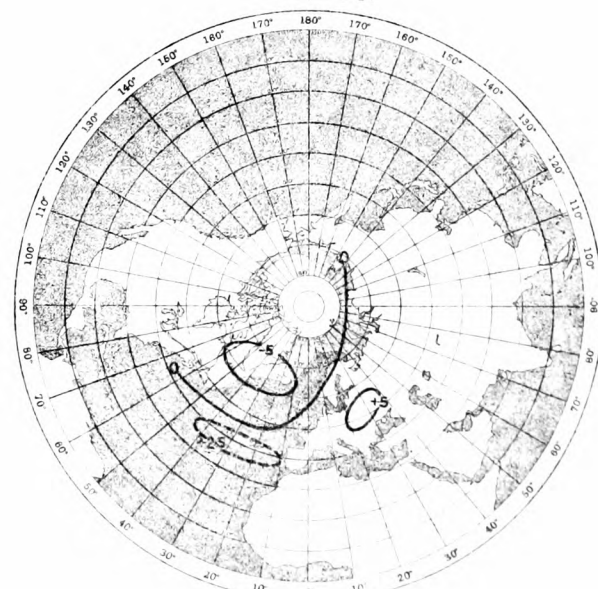
П D 2.

FIG 29.



П D 3.

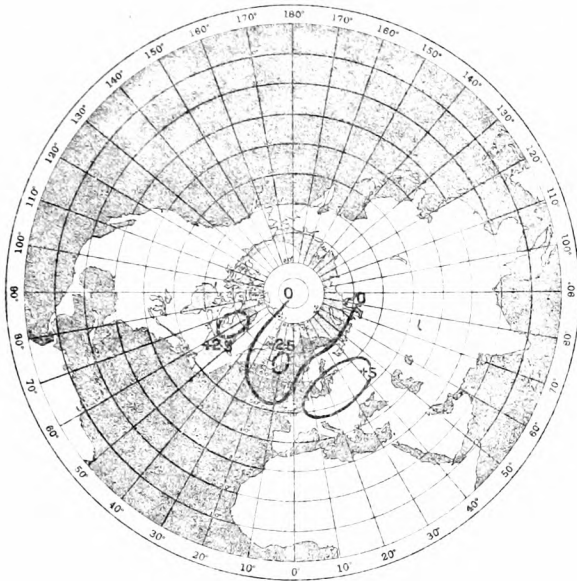
FIG 30.



П D 4.

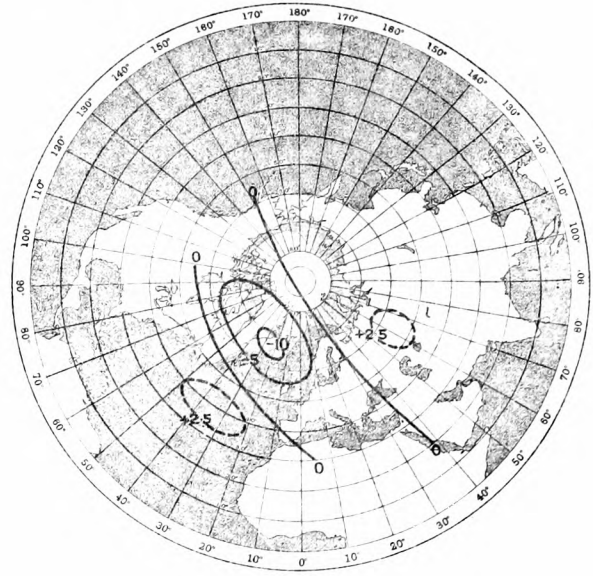


FIG. 31.



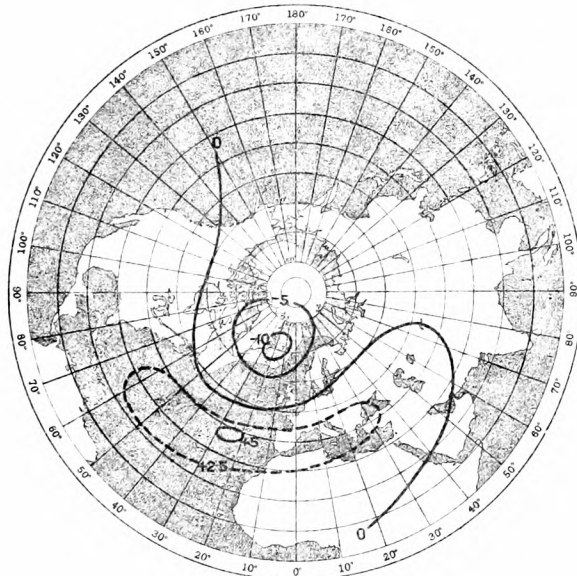
Π Δ 5.

FIG. 32.



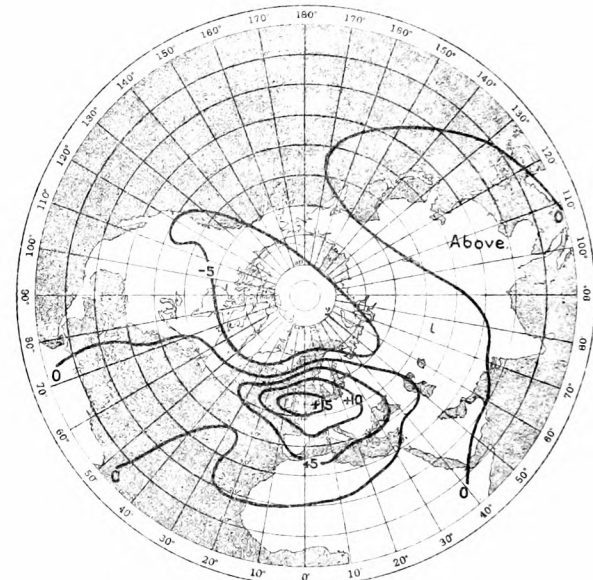
Π Δ 6.

FIG. 33.



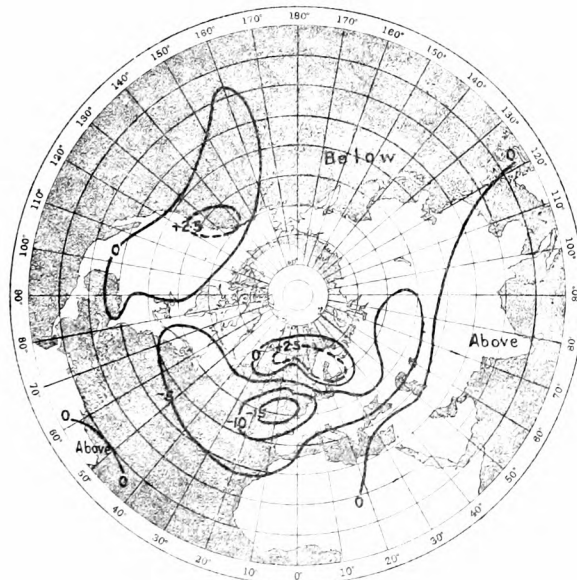
ПЕ 1.

FIG. 34.



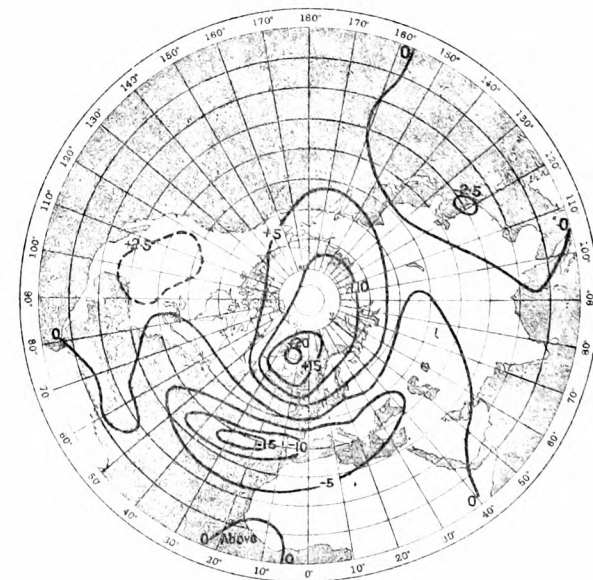
February, 1891. I C 2.

FIG. 35.



December, 1876. II B1.

FIG. 36.



February, 1895. I E 1.

The specifications of the sub-types in Group II are generally the reverse of those in Group I, but there are occasional differences which are noted.

**IIA. Centre of deficit over or near Scandinavia.**

**IIA1.** Deficit centred over Scandinavia, Finland or the White Sea, extending over Iceland and Greenland, but not necessarily including any part of the British Isles. Excess centred over south-western Europe. Figure 19. The centre of excess lies to the north-east of the centre of deficit in I A1, and the centre of deficit has usually a corresponding shift to the north-east.

**IIA2.** Deficit extending from Scandinavia to Spitsbergen and eastern Greenland and also including the Mediterranean. Excess extending from the Azores to Baffin Bay. This type, which is the reverse of I A2, includes few examples and is not illustrated.

**IIA3.** Deficit extending from Scandinavia over the Urals or Novaya Zemlya, and including part or the whole of the British Isles. Excess over the Mediterranean, excess over Baffin Bay and part or the whole of Greenland. Figure 20. This sub-type is nearly the reverse of I A3.

**IIA4.** Deficit extending from Scandinavia over Greenland, Baffin Bay and Spitsbergen, the greater part of Europe and the Mediterranean; the British Isles generally below normal. Pressure above normal over the Azores. Figure 21. The reverse of this type has not been recognized, so that there is no sub-type I A4.

**IIB. Belt of deficit from British Isles across Europe.**

**IIB1.** Deficit extending across the Azores. Usually an excess over part or the whole of Greenland. Figure 22. This is very nearly the reverse of I B1.

**IIB2.** Deficit extending from South Greenland across the British Isles to the Black Sea. Azores above normal. Generally an excess over the White Sea. Figure 23. This sub-type is much more characteristic than I B2.

**IIC. Deficit centred over the British Isles.**

**IIC1.** Deficit extending over western Europe and generally including the Mediterranean. Azores and Baffin Bay above normal; belt of excess continuing across Arctic and over or east of the Urals. Figure 24. This sub-type is nearly the reverse of I C1, but the deficit over Europe appears to extend further eastward than the excess in the latter type.

**IIC2.** Deficit extending over the Azores. Excess over Baffin Bay, excess over Urals. Figure 25. This sub-type differs from the reverse of I C2 in having the belt of excess from Baffin Bay to the Urals generally broken at Spitsbergen or Vardo.

**IIC3.** Deficit extending from the Mediterranean across the British Isles to the north of Canada. Pressure nearly normal over the Azores. Excess centred over the White Sea. Figure 26. This sub-type differs from the reverse of I C3 in that the deficit does not always extend over the Azores. It may therefore be considered as, to some extent, a combination of IIC3 and IIC4; but, as during the period 1873-1900 it includes only seven charts which are otherwise very similar, it was not split up.

**IID. Deficit centred over Iceland or Southern Greenland.**

(a) Pressure below normal over the Azores.

**IID1.** Deficit extending over the British Isles and the Urals. Excess over Europe. Figure 27. This is the reverse of I D1.

**IID2.** Deficit extending over part or the whole of the British Isles. Excess centred over the Urals. Figure 28. Sub-type I D2 has not been recognized.

**IID3.** Excess centred over Europe extending over the British Isles. Figure 29. This is the reverse of I D3.

(b) Pressure above normal over the Azores.

IID4. Deficit extending over Baffin Bay. Belt of excess extending from south-eastern U.S.A. across Bermuda, the Azores and Europe to the Black Sea or Urals. Figure 30. This sub-type is the reverse of ID4 and passes into IIE.

IID5. Deficit over Iceland and the Faröes. Centres of excess over Baffin Bay, and over Europe. Pressure above normal over the British Isles. Figure 31. The centres of excess lie more to the North-east than the centres of deficit in sub-type ID5.

IID6. Deficit over Iceland extending over Baffin Bay and Western Europe; excess over Urals. Figure 32. This sub-type is the reverse of ID6.

IIE. Pressure below normal over the Arctic generally; belt of excess across the Atlantic and Mediterranean in about 40° N.

TABLE II.—OCCURRENCE OF TYPES OF PRESSURE DISTRIBUTION.

Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1873	IIC3	IC3	IA3	ID4	ID1	(IIE1)	IID5	IIE1	IIA3	IIA4	ID4	IC2
74	IIE1	IC2	IC2	IIE1	ID5	IC3	IID4	IIA4	IIA3	IID4	(IC3)	ID3
75	IIB1	IA3	IC4	IC1	IID4	IIA4	IA1	(IA3)	IC1	IIC3	IE1	(IC1)
76	IB1	IIB1	IIC1	ID3	IC2	IID6	IID3	(IID4)	IIC2	IA2	IE1	IIB1
77	IID2	IIA4	(IIA4)	ID4	ID4	IID1	IID4	ID4	ID4	IID3	IID6	IB1
78	IC2	IC1	IC3	IE1	IIB1	IIC2	IC2	(IIB1)	IIA2	IIC2	ID4	ID4
79	IA3	IIB2	IC2	IIB2	IB1	(IIB1)	IIC1	IIB1	IID6	IC2	IC4	IC4
1880	IC4	IID1	IC1	IID6	IC1	IIC1	(ID4)	IA3	(IA2)	ID4	IIE1	IIA3
1881	ID4	IA1	IIC2	ID5	IC2	IIA4	IIA4	IIB1	IA3	IA1	IID1	IID4
82	IC2	IC3	IIE1	(ID3)	(IA2)	IIC1	IIC3	(IIA4)	IIC3	IA2	IIC1	IE1
83	IID1	IID4	ID4	IA3	(IIA4)	IA3	ID5	IID5	IIB2	IIE1	IID4	IC3
84	IIA1	IID1	IID4	IE1	(IID5)	(IIE1)	IE1	IA2	IID4	IIA1	IB2	IID6
85	IA3	IC2	IC2	IIC1	IIC2	IID4	IB1	IE1	IIB2	IIC1	IE1	IC4
86	IIC1	IA1	IA2	IA2	(IIC1)	IID1	(IIA1)	(IID4)	(ID6)	IID6	IID6	IIC2
87	IID4	IC2	ID6	ID6	IC2	IC1	IID3	ID4	ID3	IC4	ID3	IIB1
88	ID6	IE1	IIB1	ID3	IIA3	(ID5)	(IIC2)	(IB2)	IC4	ID6	IIE1	IID4
89	IB1	ID3	ID1	IIB2	IID2	(IA3)	ID4	IIE1	ID1	IIC3	IB1	IB1
1890	IIE1	IA3	IID6	IID6	IIC2	IID5	IIA4	IIA4	(IB1)	IC3	IID6	IA3
1891	IA1	IC2	IIA3	IA1	IIB2	IE1	(IIB1)	IIC1	IIE1	IIC3	(IIC1)	IIE1
92	IIB1	ID4	IA1	IC3	(ID6)	IIA3	IC2	(IIA3)	IIE1	ID4	(IID5)	ID4
93	IE1	IIC1	IC1	IC4	IA3	ID4	ID3	ID6	IIA2	IIA3	ID4	IID4
94	(IID4)	IIE1	IIE1	IID6	ID1	(IIE1)	(ID3)	IIA4	ID6	IIA4	ID4	IC3
95	ID4	IE1	IIB2	IIA4	IC2	(IB2)	(IIA3)	IIC2	IID3	IIB1	IID1	IIC2
96	IC4	IC2	IID6	IC3	IC2	(IIC2)	(IA1)	(IB2)	IIC1	IIC2	IC1	IID6
97	IE1	IIA1	IIB2	IID6	(IID2)	ID6	IC1	IIC1	IIA1	IC1	IC3	IID4
98	IC2	IIC1	IA1	IID6	(IIB1)	(IID2)	IC1	IID3	IIA3	IA1	IID6	IIA1
99	IIB1	IE1	ID6	IIA3	ID6	IA3	IB1	IC4	IIC3	(IC4)	IIA1	IA1
1900	IID6	ID4	ID4	IIA1	(IIA4)	IIB1	ID6	IA1	IC2	IIA1	IID6	IIA4
1901	IA	ID	ID	IID	IA	IID	IA	IID	IID	(IID)	ID	ID
02	IC	ID	IIC	ID	(IC)	ID	ID	ID	ID	ID	IA	IA
03	IIB	IIE	IID	IIA	IID	ID	ID	IIA	IA	IIC	IC	IA
04	IID	IIC	IA	IID	IID	IC	IA	ID	IA	IID	IC	ID
05	IC	IC	ID	ID	IC	IA	IID	IID	IID	ID	IIC	IB
06	IID	IIA	IC	IB	IIC	IC	IID	ID	IA	IID	IIA	IC
07	IC	IIA	IID	(IID)	ID	IIC	ID	IIA	IB	IIC	IA	(IIC)
08	IC	IIA	IA	ID	IID	IB	ID	IC	IID	IA	IID	IID
1909	IID	IB	ID	(IID)	(IE)	ID	(IIE)	IID	IC	IIC	IC	IIB
1910	IIA2	IID6	IB1	IIA2	IIB2	IIC1	ID3	ID3	IB2	IA2	ID4	IIC2
11	IB1	IIA1	ID1	IIA2	IID4	(ID1)	IB2	(IB2)	(IIE1)	ID2	(IIB1)	IID2
12	ID5	IIB1	IIC3	IC2	IIA1	IIC2	IA1	IIC2	IB2	IID4	IIA4	IID4
13	IID2	IC1	IID4	IID6	IIC3	IIE1	IB1	IB1	IA3	(IIC2)	IID4	IC2
14	IC1	IID4	IIB2	IE1	IIE1	IC2	(IIB2)	IA2	(IIA3)	IA3	IIA4	IIC3
15	IIB2	IIC1	ID4	IID4	(IB2)	ID2	IIB2	ID4	ID4	IB1	ID4	ID4
16	IIE1	IID6	IE1	IID6	IIB2	(IA2)	(IB1)	ID5	ID4	IID4	IIC2	IE1
17	ID5	ID5	IE1	IIA3	IB2	IID5	ID6	IIC1	IIA1	IIC1	(IIA1)	(ID1)
1918	ID4	IID4	IA2	IB1	(IA2)	IID4	ID4	(IC3)	IIA3	IID4	IID3	IIC3



**IIEl.** Pressure above normal over the Azores. Figure 33. This sub-type is nearly the reverse of IE1, but the belt of excess tends to lie slightly further south than the belt of deficit in IE1.

The sequence of types from 1873 to 1918 is shown in Table II. The period 1873 to 1900 is represented by the "Northern Hemisphere" charts on which this study is based. From 1901 to 1909 the types have been allocated from a series of small (unpublished) charts covering the area Greenland, Iceland, British Isles, Norway, which had been drawn for another purpose. These charts did not suffice to give the sub-types. From 1910 to 1918 the working charts of the *Réseau Mondial* were employed. Months in which the excess or deficit exceeded 10 mb. are shown in heavy type; indefinite examples are in brackets.

### § 3. FREQUENCY AND SUCCESSION OF TYPES.

The frequency of the various types and sub-types is shown in Table III, from which it will be seen that types IID, ID and IC are of most frequent occurrence, together accounting for half the months. In view of the great variability of pressure in the Icelandic region, the frequency of types IID and ID (deficit or excess centred near Iceland) is to be expected; the frequency of type IC (excess centred over British Isles) is more surprising. The most frequent of the sub-types are ID4 and IID4, especially in winter.

TABLE III.—FREQUENCY OF TYPES AND SUB-TYPES.

W=Winter (October to March), S=Summer (April to September).

Type	IA		IB		IC		ID		IE		IIA		IIB		IIC		IID		IIE		
Season	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	
Sub-type																					
1873-1900, 1910-1918	1	8	5	8	8	6	3	4	12	5	8	5	10	8	9	10	5	2	10	12	
	2	5	7	1	9	13	10	1	1	-	-	1	4	5	9	9	9	3	3	-	-
	3	7	9	-	-	8	4	3	8	-	-	3	10	-	-	7	4	2	5	-	-
	4	0	0	-	-	8	3	19	13	-	-	6	11	-	-	-	-	19	10	-	-
	5	-	-	-	-	-	-	3	5	-	-	-	-	-	-	-	-	1	5	-	-
	6	-	-	-	-	-	-	4	9	-	-	-	-	-	-	-	-	13	9	-	-
Total	20	21	9	17	37	23	33	40	12	5	18	30	15	17	25	23	43	34	10	12	
1901-1909	8	7	2	4	10	5	8	15	0	1	4	3	2	0	7	2	12	16	1	1	
1873-1918	28	28	11	21	47	28	41	55	12	6	22	33	17	17	32	25	55	50	11	13	
Per cent.	10	10	4	8	17	10	15	20	4	2	8	12	6	6	12	9	20	18	4	5	

The frequent occurrence of these two sub-types is to be expected in view of the relationship which exists between the pressure in different latitudes in the northern hemisphere. F. M. Exner has shown (6) that when pressure at Iceland in winter is correlated with the synchronous pressure at places further south, the coefficient which is positive in the north, falls to zero in about latitude 50° N., and becomes negative in a belt from Bermuda across the Azores to the Black Sea. Thus there is a natural tendency for the pressure deviations to be opposite over Iceland and over the southern part of Europe and the North Atlantic.

In Table IV the sequence of types in successive months is shown. The roman figures in the upper of each pair of lines give the frequency of the different types immediately succeeding each type. The italic figures in the lower of each pair of lines gives the frequency which would be expected if the distribution were due purely to chance. The figures are divided into winter (preceding months October to March, succeeding months November to April) and summer (preceding months April to September, succeeding months May to October). Groups I and II are

separated by heavy lines, and the persistence of the same type through two successive months is shown by the figures enclosed in heavy squares.

A comparison of the roman and italic figures shows very little indication of any ordered sequence. There is a slight tendency for the persistence of types from one month to the next, the same type occurring in two successive months in 44 cases in winter and 41 in summer, compared with an expectancy of 35 and 36 respectively; type IC (centre of excess over British Isles) is especially persistent in winter. Type ID in summer tends to be followed by either ID or IC. Type IIC (centre of deficit over British Isles) in winter tends to be followed by Group I (pressure above normal at Thorshavn), this sequence occurring on 25 occasions out of 31.

TABLE IV.—SEQUENCE OF TYPES IN SUCCESSIVE MONTHS, 1873—1918.

Preceding Month.		Succeeding Month.									
		IA W S	IB W S	IC W S	ID W S	IE W S	IIA W S	IIB W S	IIC W S	IID W S	IIE W S
		4 3 3 3	1 3 1 2	3 2 5 3	4 5 4 6	1 0 1 1	1 2 2 3	2 1 2 2	4 5 3 3	8 7 6 5	0 0 1 1
Preceding Month.	IA ..	4 3 3 3	1 3 1 2	3 2 5 3	4 5 4 6	1 0 1 1	1 2 2 3	2 1 2 2	4 5 3 3	8 7 6 5	0 0 1 1
	IB ..	0 3 1 2	1 2 0 2	1 3 2 2	3 3 2 4	0 1 0 0	1 1 1 3	1 1 1 1	0 4 1 2	2 2 2 4	1 1 0 1
	IC ..	2 3 5 3	2 1 2 2	14 2 8 3	6 3 7 6	1 0 2 1	6 5 4 3	2 2 3 2	3 5 6 3	9 7 9 5	3 0 2 1
	ID ..	4 6 4 5	0 3 2 4	3 10 7 5	9 14 6 11	4 0 2 1	3 6 3 6	5 1 2 3	3 4 5 5	7 7 8 10	3 5 2 3
	IE ..	0 1 1 1	0 0 0 0	2 0 2 1	2 1 2 1	0 0 0 0	2 0 1 1	3 3 1 0	1 0 1 1	2 1 2 1	0 0 0 0
	IIA ..	4 4 2 3	1 3 1 3	2 3 4 3	6 3 3 7	0 0 1 1	1 6 2 4	2 3 1 2	1 5 3 3	5 5 4 6	0 1 1 2
	IIB ..	1 3 2 2	0 1 1 1	1 0 3 2	3 2 3 3	0 1 1 0	2 1 1 2	0 0 1 1	4 5 2 2	4 3 3 3	2 1 1 1
	IIC ..	4 4 3 3	3 2 1 2	9 3 5 3	5 3 5 5	4 0 1 1	1 3 3 3	1 1 2 1	1 3 4 2	2 4 6 5	1 2 1 1
	IID ..	4 5 6 5	4 3 2 4	11 5 9 5	6 12 8 10	3 1 2 1	7 5 4 6	1 4 3 3	4 3 7 5	13 10 11 9	1 2 2 3
	IIE ..	1 0 1 1	0 1 0 1	1 1 2 1	1 5 2 3	0 1 0 0	1 1 1 2	1 0 1 1	0 1 1 1	5 2 2 2	1 1 0 1

The sequence of separate sub-types was only investigated where the total frequency of the sub-type during the period 1873-1900, 1910-1918 reached 15. In the majority of these, the distribution of the sub-types in the following months was very irregular, but a few interesting peculiarities were revealed:—

Sub-type IA3 was followed mainly by ID4, IA or IC. Out of 16 examples, 11 were followed by a type in Group I.

Sub-type IB1 was followed mainly by IA, IC or ID. Out of 16 examples, 11 were followed by a type in Group I.

Sub-type IC2 was followed by IC in 6 instances (IC1 in 3) and by IIA in 5 instances. Out of 23 examples, 15 were followed by a type in Group II.

Sub-type ID4 was followed in winter mainly by type IID (6 examples, including 5 of IID4) or IA (4 out of 19). In summer ID4 was followed in 6 instances out of 13 by type ID.

Sub-type IIA4 was followed mainly by IIA, IA or ID.

Sub-type IIB1 was followed mainly by IIC, IID (5 each) and ID (4 out of 18.)

Sub-type IIC1 was followed by a variety of types.

Sub-type IIC2 was followed by a type in Group I in 13 instances out of 18. The remaining five examples were all followed by type IID.

Sub-type IID4 was followed in winter mainly by IC2 or 3 (7 instances) or IID (4 out of 19). In summer, however, it was not followed by either IC or IID on any occasion, the most frequent successors being ID (4 instances) and IIA (3 out of 10).

Sub-type IID6 was followed by a variety of types.

#### § 4. COMPARISON WITH THE WEATHER.

It is of interest to examine briefly the types associated with abnormal weather in the British Isles. Charts of pressure distribution were constructed for the periods selected by R. Abercromby (7) to illustrate his four types of British weather. These gave the following comparisons :—

*Southerly type.*—Pressure much below normal over the region between Iceland and the west of Ireland, above normal over eastern Europe, and above normal over the Azores. This distribution is that of sub-type IID4.

*Westerly type.*—Deficit centred over Scandinavia, extending over the British Isles ; pressure above normal over the Atlantic. This approximates to sub-type IIA3.

*Northerly type.*—Excess centred over Iceland, extending to the Azores. Deficit centred over the Baltic and including most of Europe. This is sub-type ID3.

*Easterly type.*—Excess centred over Iceland and the Faroes, deficits centred over France and over Labrador. This falls definitely within sub-type ID5.

The following marked droughts in the British Isles (8) fall within the period covered by Table II :—

October 1879 to January 1880, February to October 1887, March to June 1893, February to June 1895, January to May 1896, July to October 1911.

Of these 31 months 26 fall in Group I and 5 in Group II. Type IC includes 15 months, distributed as follows : two in IC1, six in IC2, one in IC3 and six in IC4. Eleven of the fifteen months show a pressure deviation exceeding + 10 mb. Type ID includes six months, and type IB three, all of the latter falling in sub-type IB2.

Figure 34 shows the chart for February 1891, the driest month of the period 1873 to 1900 ; this is a good example of sub-type IC2. Figure 35 illustrates December 1876 (IIB1), which was nearly, if not quite, the wettest month.

Finally, Figure 36 shows the chart for the exceptionally cold month of February 1895 ; this is an intense example of sub-type IE1.

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## REFERENCES

- (1) London, Air Ministry, Meteorological Office. *British Meteorological and Magnetic Year-Book, part V., Réseau Mondial*; monthly and annual summaries of pressure, temperature and precipitation at land stations, generally two for each ten-degree square of latitude and longitude. Tables, 1910-1918, charts 1910, 1911.
  - (2) Washington, D.C., U.S. Department of Agriculture, Weather Bureau. Report on barometry in the United States, by F. H. Bigelow. *Annual Report*, 1899, part II.
  - (3) Gorczynski, Wl. "Pression atmosphérique en Pologne et en Europe." Warsaw, 1917.
  - (4) Solar Physics Committee. "Monthly mean values of barometric pressure for 73 stations over the earth's surface." London, 1908.
  - (5) Ehrhart, S. B. "Die Verteilung der Temperatur und des Luftdruckes auf der Erdoberfläche im Polarjahre 1882-1883." Diss., Stuttgart, 1902.
  - (6) Exner, F. M. "Monatliche Luftdruck und Temperaturanomalien auf der Erde. Korrelationen des Luftdrucks auf Island mit dem anderer Orte" *Sitzungsber. Akad. Wiss., Wien*, 133, 1924, p. 307.  
Exner, F. M. "Über monatlichen Witterungsanomalien auf nördlichen Erdhälfte im Winter." *Sitzungsber. Akad. Wiss., Wien*, 122, 2a, 1913, p. 1165.
  - (7) Abercromby, Ralph. "Weather." (London, International Scientific Series, 1887.)
  - (8) Brooks, C. E. P. and J. Glasspoole. The drought of 1921. London, *Q. J. R. Meteor. Soc.*, 48, 1922, p. 139.
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