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SOME REGIONS OF FORMATION OF DEPRESSIONS IN THE NORTH ATLANTIC

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SOME REGIONS OF FORMATION OF DEPRESSIONS IN THE NORTHERN ATLANTIC

By L. Doris Sawyer, B.A.

The following notes refer to an attempt to find out which parts of the Northern Atlantic are most favourable for the development of depressions. If these are due to the interaction of air masses of different temperature as is now commonly believed there seemed reason to think that they should be most active in formation and development over those parts of the ocean where differences in temperature of the sea surface are favourable for large differences in temperature between neighbouring air masses, as for example in the region of the Newfoundland Banks. The present inquiry was undertaken in order to test this view. The Daily Synoptic Charts of the North Atlantic Ocean, prepared jointly by the Deutsche Seewarte and the Danish Meteorological Institute, for the five years, December 1905–November 1910, were taken as data and twenty-nine 10° squares chosen, bounded by lats. 30° and 70° N. and longs. 0° and 70° W. except between lats. 30° and 40° N. where the western boundary was extended to 80° W. A note was made of each occasion when there was evidence that a depression or fairly well marked secondary had formed, deepened or filled up in any of these squares. Owing to the fact that the charts only represent conditions once in twenty-four hours and that observations are much scantier in some parts than others, some doubt was felt in many cases, so that the figures obtained must not be regarded as exact. If a depression formed in one square and continued to deepen there without moving through an adjacent square it was simply reckoned as forming, but if after passing through one or more neighbouring squares it deepened again on returning to the original square it was reckoned as deepening there also. Any deepening or filling up indicated in the neighbouring squares was credited to the appropriate square or squares. The addition of the figures for forming and deepening might be held to give a more complete idea of the frequency of deepening.

The years were divided into two seasons: a long winter, October to May and a short summer, June to September. This division was chosen on account of the fact that the temperature of the northern Atlantic in general attains its maximum in August and its minimum in February, while October seems to mark the beginning of winter. Some of the figures obtained for each square have been plotted on charts (Figs. 1 and 2) on which approximate mean sea surface isotherms are also shown. These

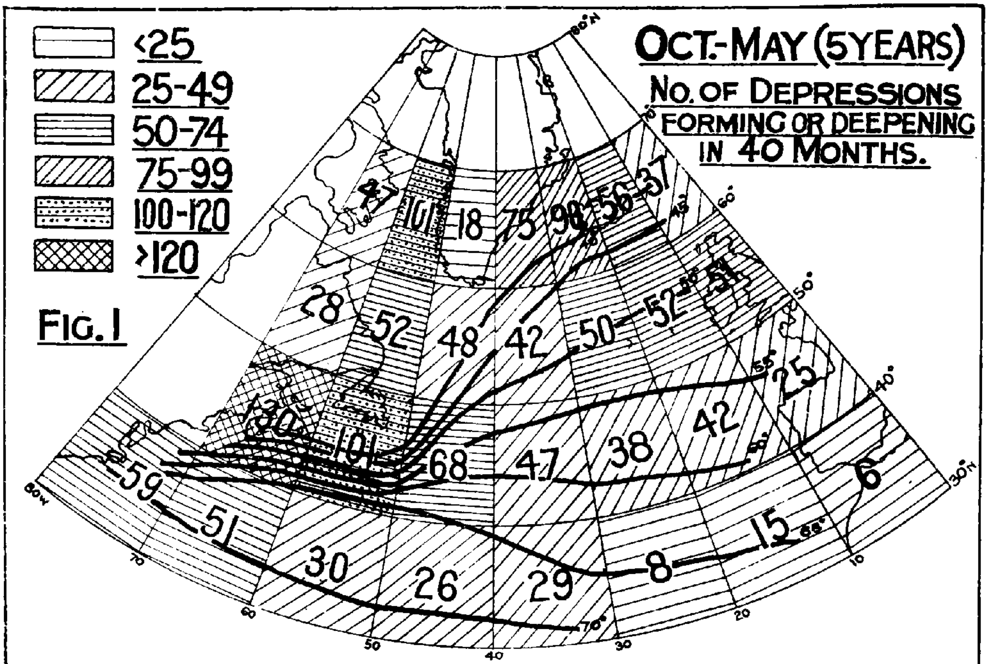

FIG. 1

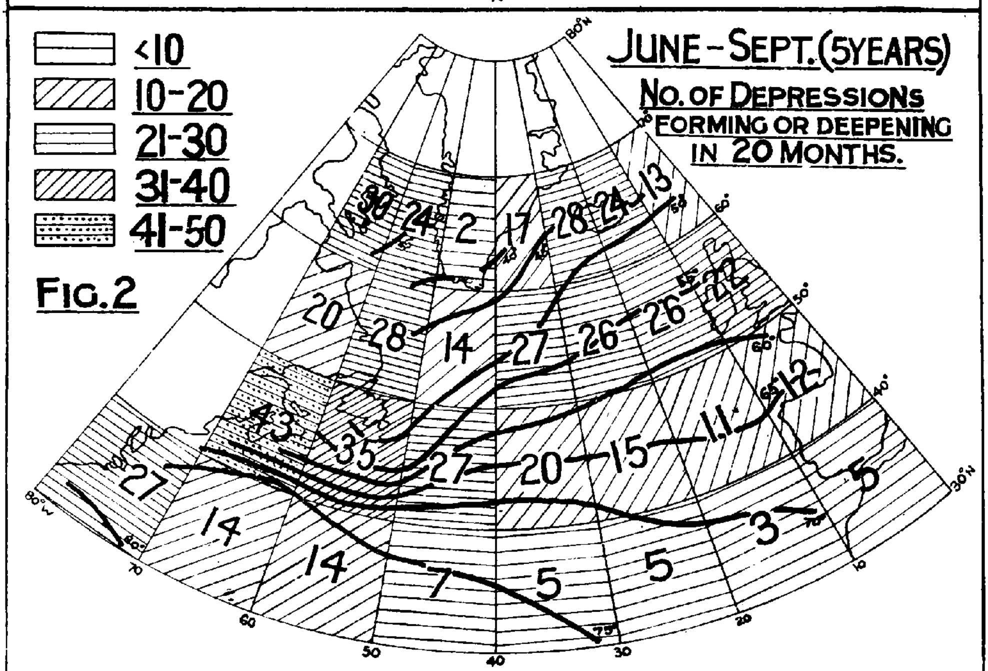

FIG. 2

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Malby & Sons Photo Litho

isotherms were computed from monthly values for about 50 to 60 points in the area under discussion from charts published in the *Marine Observer* for 1926. Winter values are unfortunately missing for the north-west corner where navigation is at that season obstructed by ice.

Figs. 1 and 2 as also the rows of figures marked (*c*) in Tables I and II show the number of depressions that formed or deepened in winter and summer respectively. Both show a decided maximum near Nova Scotia and Newfoundland but in winter there appears to be a well marked secondary maximum near Davis Strait which disappears in summer. The primary cause of the exceptional amount of activity near Nova Scotia is doubtless the steep temperature gradient at the surface of the sea due to the proximity of the Gulf Stream and Labrador Current whereas the cause of the activity indicated near Davis Strait is less obvious. A current flows southward along the east coast of Greenland, rounds Cape Farewell and turns northward near the west coast. This is reinforced by the recurve of the Labrador Current which has been partially warmed by contact with the Gulf Stream near Newfoundland so that in the early part of winter, at least, the waters on the eastern side of Davis Strait must be warmer than those on the western side where the currents flow more directly from the north and ice is more abundant. According to Commander Speerschneider * the vanguard of the polar ice known in those parts as " storis " (great ice) reaches Cape Farewell on a rough average near the middle of January. With the addition of fresh supplies of ice a belt 60 miles broad normally extends by April along the south-west coast of Greenland to some point between Frederikshaab and Godthaab. The maximum is reached in May and a decrease begins sometime in June while as a rule no ice is present along that coast from September to the end of the year. Next to the neighbourhoods of Nova Scotia, Newfoundland and Davis Strait the most active region in winter is between Iceland and Greenland where cold polar currents tend to come near to the north-western part of the North Atlantic Drift. In summer there is a marked decrease near Greenland which may be due in part to the drifting of ice and the consequent increased temperature contrast further south. The isotherms shown on the charts seem to support this a little.

The rows of figures marked (*a*) in Tables I and II show the number of depressions which formed in winter and summer respectively, and the rows marked (*b*) those that deepened having first formed elsewhere. Rows (*a*) Table I show the chief centre of action near the American coast, south of Newfoundland and again in Davis Strait as in row (*c*), but the actual maximum appears further south, near Carolina. If this is a genuine maximum (the number is scarcely great enough to be regarded as certain) it is perhaps to be ascribed to the fact that in addition to the steep gradient of sea-surface temperature near this part of the

* "Arctic Ice." The *Marine Observer*, May 1926.

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coast there is also, frequently, an unusually great difference between the temperature of the air and the sea. North-westerly winds on the eastern side of a high pressure area over North America in winter bring very cold air southwards towards the warm ocean. Along the route from the Channel to New York it was found * that whereas on the eastern side the mean temperature of the air in February was only about 2° F. lower than that of the sea, on the American side about 63° W. it was 10° F. lower. Further west along the route the difference became less again, the sea temperature dropping more rapidly than the air so that it seems probable that sharper contrasts occur further south on approaching the American coast, i.e., near Carolina. In summer the region of maximum development of depressions shifts northwards to near Nova Scotia but the difference is small. It is of more interest to note that in this region the total number of developments in the four months reckoned as summer is somewhat greater than in the remaining eight months. This is presumably due to the contrast between the high temperature over the land and low temperature induced by the cold water from the Labrador Current.

In Table I the figures for deepening depressions in the rows marked (*b*) again show the well marked maximum near Nova Scotia (50°–40° N, 70°–60° W.). Values for (*b*) almost as high are found not only over the Newfoundland Banks and Davis Strait but also between Greenland and Iceland; the latter region, owing to the infrequency with which depressions originate there, is much less prominent in Fig. 1. The region near Carolina is much less noticeable.

Unlike the sets of figures previously mentioned, the rows marked (*b*) in Table II do not show a maximum near the American coast south of lat. 50°. The tendency for depressions near the American coast to develop further north in summer than in winter was indicated in discussing rows (*a*) and it therefore seems fairly consistent that the most favourable regions for deepening should also appear further north. The presence of ice seems to play an important part. A maximum, though not a very well marked one, is indicated near Baffin Land. Observations in those parts are comparatively few but sometimes when depressions move in an easterly direction across America, warm, southerly winds would come in contact with cold air over the ice which is likely to be found all the year round in these regions. (Row (*a*) does not suggest that depressions are apt to develop in this part). Similarly renewed activity is indicated near the coast of Labrador and again on the eastern side of the drift ice in the proximity of the extension of the Gulf Stream.

The rows of figures marked (*d*) show the number of times depressions were found to fill up in the various sections. On the whole they seem to indicate the track of depressions. In winter,

* Helland-Hansen & Nansen: Temperaturschwankungen des Nordatlantischen Ozeans. Kristiania, 1917.

rows (*d*), Table I, the largest number are found north of lat. 60° and it is perhaps worth noting here that each row shows very low figures over Greenland where the high table-land forms an effective barrier.

Comparative figures for the western and eastern halves of the Ocean have been obtained by adding together the figures east and west of longitude 35° W. (the figures for the belt between long. 30°–40° W. being halved). They show a large preponderance of development on the western side (more than 140 : 100), but this is due entirely to the great activity on the American side between lats. 30° and 50° N. If attention is confined to the regions north of lat. 50° N. the European side shows a slight preponderance (less than 115 : 100).

TABLE I.—NUMBER OF DEPRESSIONS WHICH FORMED, DEEPENED AND FILLED UP.

OCTOBER TO MAY, FIVE YEARS, 1905–1910.

		Long. ° W.	80–70	70–60	60–50	50–40	40–30	30–20	20–10	10–0
Lat. 70–60° N.	(*a*) Form			11	**25**	0	8	13	8	3
	(*b*) Deepen			36	**76**	18	**67**	**77**	48	34
	(*c*) Form or deepen			47	**101**	18	**75**	**90**	56	37
	(*d*) Fill up			18	**48**	6	**55**	**53**	29	49
Lat. 60–50° N.	(*a*) Form			2	5	4	2	10	14	15
	(*b*) Deepen			26	47	44	40	40	38	36
	(*c*) Form or deepen			28	52	48	42	50	52	51
	(*d*) Fill up			19	25	22	26	29	30	40
Lat. 50–40° N.	(*a*) Form			**21**	22	19	14	10	15	9
	(*b*) Deepen			**109**	**79**	49	33	28	27	16
	(*c*) Form or deepen			**130**	**101**	68	47	38	42	25
	(*d*) Fill up			27	29	31	22	25	21	26
Lat. 40–30° N.	(*a*) Form		**29**	**21**	16	12	14	2	6	4
	(*b*) Deepen		30	30	14	14	15	6	9	2
	(*c*) Form or deepen		59	51	30	26	29	8	15	6
	(*d*) Fill up		8	10	10	7	15	12	18	0

Numbers in heavy type are some of the outstandingly high values in each set (*a*), (*b*), (*c*) and (*d*), regardless of latitude.

TABLE II.—NUMBER OF DEPRESSIONS WHICH FORMED, DEEPENED AND FILLED UP.

JUNE TO SEPTEMBER, FIVE YEARS, 1905–1910.

		Long. ° W.	80–70	70–60	60–50	50–40	40–30	30–20	20–10	10–0
Lat. 70–60° N.	(*a*) Form			1	6	0	1	3	6	0
	(*b*) Deepen			**29**	18	2	16	**25**	18	13
	(*c*) Form or deepen			30	24	2	17	28	24	13
	(*d*) Fill up			10	**18**	2	**16**	**20**	13	13
Lat. 60–50° N.	(*a*) Form			1	5	1	1	1	6	5
	(*b*) Deepen			19	**23**	13	**26**	**25**	20	17
	(*c*) Form or deepen			20	28	14	27	26	26	22
	(*d*) Fill up			9	14	15	14	13	12	14
Lat. 50–40° N.	(*a*) Form			**24**	**17**	8	5	9	6	8
	(*b*) Deepen			19	18	19	15	6	5	4
	(*c*) Form or deepen			**43**	**35**	27	20	15	11	12
	(*d*) Fill up			8	**19**	11	14	8	5	4
Lat. 40–30° N.	(*a*) Form		**20**	9	8	6	4	1	1	5
	(*b*) Deepen		7	5	6	1	1	4	2	0
	(*c*) Form or deepen		27	14	14	7	5	5	3	5
	(*d*) Fill up		2	2	3	4	0	3	1	0

Numbers in heavy type are some of the outstandingly high values in each set (*a*), (*b*), (*c*) and (*d*), regardless of latitude.