
OBSERVATIONS ON THE TEMPERATURE OF THE
SURFACE WATERS OF THE NORTH SEA DURING
THE YEARS 1906 AND 1907.

BY

FRANK G. YOUNG, B.Sc.

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As in previous years the investigation of the monthly changes in the temperature and salinity of the surface waters of the North Sea has again been conducted, the observations as before having been taken by the captains of passenger ships on various routes between North Sea ports.

EAST COAST INSHORE OBSERVATIONS.

The temperature observations of the surface water along the eastern shores of Scotland and England have been made by Captain Dawson and Captain Thomson of the Edinburgh and London Shipping Company, Ltd. Observations have also been taken at Rattray Head Lighthouse (Mr. Mowat), at the Abertay Light-vessel (Mr. Swadel), and at the North Carr Light-vessel (Mr. Kirkpatrick and Mr. Wilson).

The following tables shew the mean midmonthly temperatures for the years 1906 and 1907 at various points along the east coast from Rattray Head Lighthouse to Orfordness—the temperatures in each case being in degrees centigrade.

TABLE I.—Surface Temperatures at Lightships on the East Coast of Scotland, 1906, 1907 (Mr. Kirkpatrick, Mr. Wilson, Mr. Swadel, Mr. Mowat).

				North Carr.		Abertay.		Rattray Head.	
				1906.	1907.	1906.	1907.	1906.	1907.
Jan.	...	...	...	6·35	5·48	5·78	4·77	5·70	5·34
Feb.	...	...	...	5·01	4·33	4·48	3·77	4·66	4·59
Mar.	...	...	...	4·67	4·94	4·36	4·80	4·58	5·08
Apr.	...	...	...	5·80	6·18	5·87	6·43	5·96	6·11
May	...	...	...	7·32	7·67	7·58	7·88	7·38	7·97
June	...	...	...	10·62	9·21	9·97	9·38	10·21	9·72
July	...	...	...	11·39	11·92	11·99	12·00	11·97	11·44
Aug.	...	...	...	12·61	11·86	12·80	12·19	12·19	12·00
Sept.	...	...	...	12·63	11·70	12·72	11·86	12·22	11·61
Oct.	...	...	...	11·31	10·89	10·88	10·94	10·88	10·52
Nov.	...	...	...	9·29	9·44	10·27	8·69	9·18	9·00
Dec.	...	...	...	7·35	7·58	7·64	6·24	6·88	6·86
Mean	...	...	...	8·69	8·43	8·69	8·25	8·49	8·35

Mean of the three stations (1906), 8·62 ; (1907), 8·34.

TABLE II.—Mean Monthly Surface Temperatures, 1906, 1907, East Coast: Leith to London (Captains Thomson and Dawson).

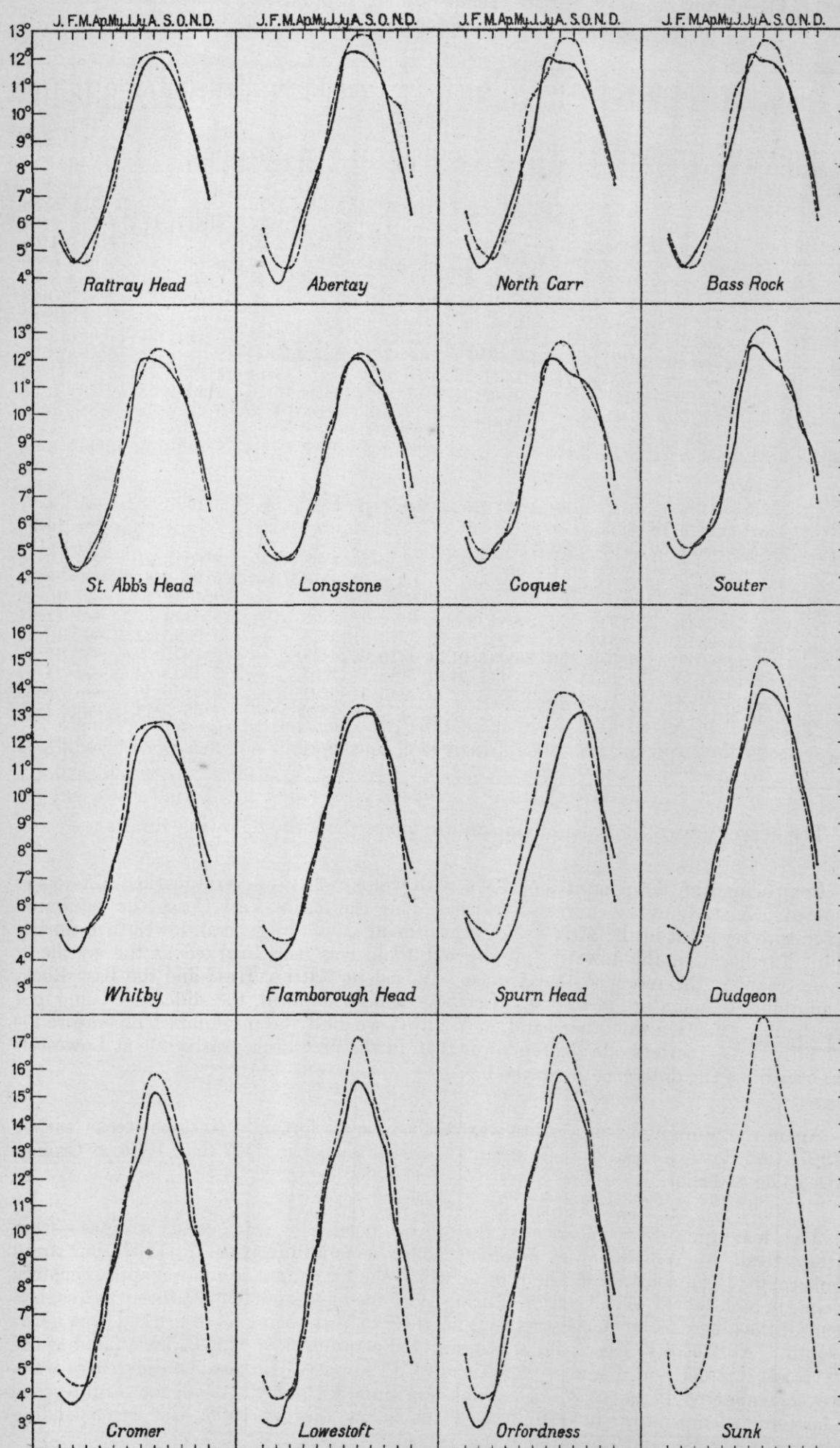
Year.	Bass Rock.	St. Abbs.	Longstone.	Coquet.	Souter.	Whitby.	Flamboro'.	Spurn.	Dudgeon.	Cromer.	[Newarp].	Lowestoft.	Orfordness.	[Sunk].	Mean.
1906.															
Jan. ...	5.52	5.60	5.70	6.04	6.64	6.03	5.26	5.76	5.24	4.96	[4.78]	4.73	5.50	[5.57]	5.58
Feb. ...	4.42	4.44	4.87	5.02	5.17	5.12	4.78	5.16	4.91	4.47	[4.19]	3.93	4.03	[4.12]	4.84
Mar. ...	4.40	4.54	4.67	4.94	5.16	5.17	4.77	4.95	4.57	4.44	[4.35]	4.22	4.10	[4.46]	4.66
April ...	5.67	5.49	5.63	5.75	5.88	5.69	5.89	5.97	6.18	6.22	[6.14]	6.13	5.78	[6.01]	5.86
May ...	7.17	7.04	7.05	7.16	7.30	7.63	8.04	7.65	8.70	9.12	[9.41]	9.70	8.61	[10.01]	8.01
June ...	10.80	10.29	9.64	10.21	10.91	10.93	10.46	10.02	11.04	11.68	[12.28]	12.70	12.33	[12.81]	10.92
July ...	11.61	11.47	11.36	11.79	12.63	12.55	12.69	12.50	13.43	14.42	[14.69]	15.00	15.03	[15.42]	12.87
Aug. ...	12.61	12.35	12.15	12.59	13.14	12.70	13.31	13.75	15.01	15.80	[16.59]	17.14	17.27	[17.95]	13.99
Sept. ...	12.32	12.18	11.94	12.04	12.43	12.73	13.18	13.68	14.72	15.12	[15.44]	15.65	16.26	[16.19]	13.52
Oct. ...	10.73	10.91	10.65	10.72	10.76	11.14	11.98	12.50	12.93	13.07	[13.64]	13.74	14.16	[13.96]	11.96
Nov. ...	8.86	9.09	9.19	9.58	9.42	9.40	9.34	9.67	9.97	10.20	[10.10]	9.93	9.98	[10.26]	9.55
Dec. ...	6.05	6.44	6.08	6.55	6.70	6.66	6.16	6.16	5.50	5.61	[6.20]	5.24	6.02	[4.88]	6.10
Mean ...	8.35	8.32	8.24	8.53	8.85	8.74	8.82	8.98	9.35	9.59	[9.82]	9.84	10.01	[10.14]	8.98
1907.															
Jan. ...	5.40	5.57	5.11	5.46	5.26	4.92	4.52	5.50	4.16	4.11	—	3.10	3.78	—	4.91
Feb. ...	4.38	4.28	4.68	4.53	4.72	4.30	4.01	3.98	3.26	3.74	—	2.94	2.88	—	3.98
Mar. ...	4.95	4.75	4.80	5.00	5.22	5.06	4.58	4.58	4.76	4.40	—	3.98	3.90	—	4.66
April ...	5.87	5.76	5.61	5.56	5.71	5.81	6.23	6.07	6.43	6.63	—	6.80	6.91	—	6.12
May ...	7.68	7.38	7.38	7.10	7.30	7.61	8.21	8.16	8.54	8.76	—	9.50	8.81	—	8.04
June ...	9.52	9.17	9.26	9.39	9.26	9.46	10.11	9.73	10.76	11.60	—	12.46	12.40	—	10.26
July ...	12.02	11.98	11.53	11.93	12.40	12.03	12.08	11.78	12.53	12.98	—	14.03	14.02	—	12.44
Aug. ...	11.86	11.98	12.00	11.86	12.18	12.59	12.96	12.91	13.91	15.11	—	15.53	15.84	—	13.22
Sept. ...	11.67	11.60	11.38	11.38	11.66	12.00	13.01	13.06	13.66	14.18	—	14.72	15.09	—	12.78
Oct. ...	10.71	10.77	10.72	11.01	11.00	11.04	11.94	12.74	12.74	12.98	—	13.19	13.64	—	11.87
Nov. ...	9.02	9.24	9.31	9.65	9.32	9.32	9.42	9.89	10.34	9.91	—	9.98	10.18	—	9.63
Dec. ...	6.46	6.90	7.31	7.57	7.78	7.59	7.36	7.74	7.50	7.32	—	7.56	7.74	—	7.40
Mean ...	8.29	8.28	8.26	8.37	8.48	8.48	8.70	8.85	9.05	9.31	—	9.48	9.60	—	8.77

The curves drawn from these temperature tables show the following results:—

Comparing the temperatures of 1906 with those of 1907, several marked differences are noted. A study of the curves shows that along the entire East Coast the minimum temperature recorded in the early spring was, during 1907, in general, lower than during 1906. Furthermore, this lowering of the minimum was more marked at the southerly stations than at the more northerly ones. Indeed, at Rattray Head and the Bass Rock, the minimum temperature in the two years was almost identical, the difference being not more than $\frac{1}{10}^{\circ}$ C. On the other hand, at Whitby, we find the minimum temperature for 1907 fully three-quarters of a degree lower than in the preceding year, while at Lowestoft and Orfordness the difference is nearly 1° C.

Again the minimum temperature was reached from a fortnight to three weeks earlier in 1907. At Rattray Head the minimum was a week earlier in 1907 than 1906, at Cromer it was 23 days earlier.

The maximum temperature at the more northerly east coast stations—from Rattray Head to Whitby—was recorded about a month earlier in 1907, but from Flamborough Head southwards the time at which the maximum occurs was approximately the same in both years. At all stations during 1907 the maximum temperature was less than in 1906—the difference in the observations for the two years being more marked from north to south. At Rattray Head the maximum temperature was $.25^{\circ}$ C. lower, and at the Bass Rock, Coquet and Flamborough Head $.5^{\circ}$ C. lower. The greatest differences were, however, registered off the coasts of Norfolk and Suffolk. At the Dudgeon Light-vessel the maximum temperature in 1907 was 2° C. below that of 1906, the corresponding difference off Cromer and Lowestoft being 1.5° C.



Surface Temperature at East Coast Lightships.
1906----- 1907—

The mean temperature curve compiled month by month for all stations on the East Coast, between Rattray Head and Orfordness, for the four years—1904 to 1907, affords an interesting comparison.

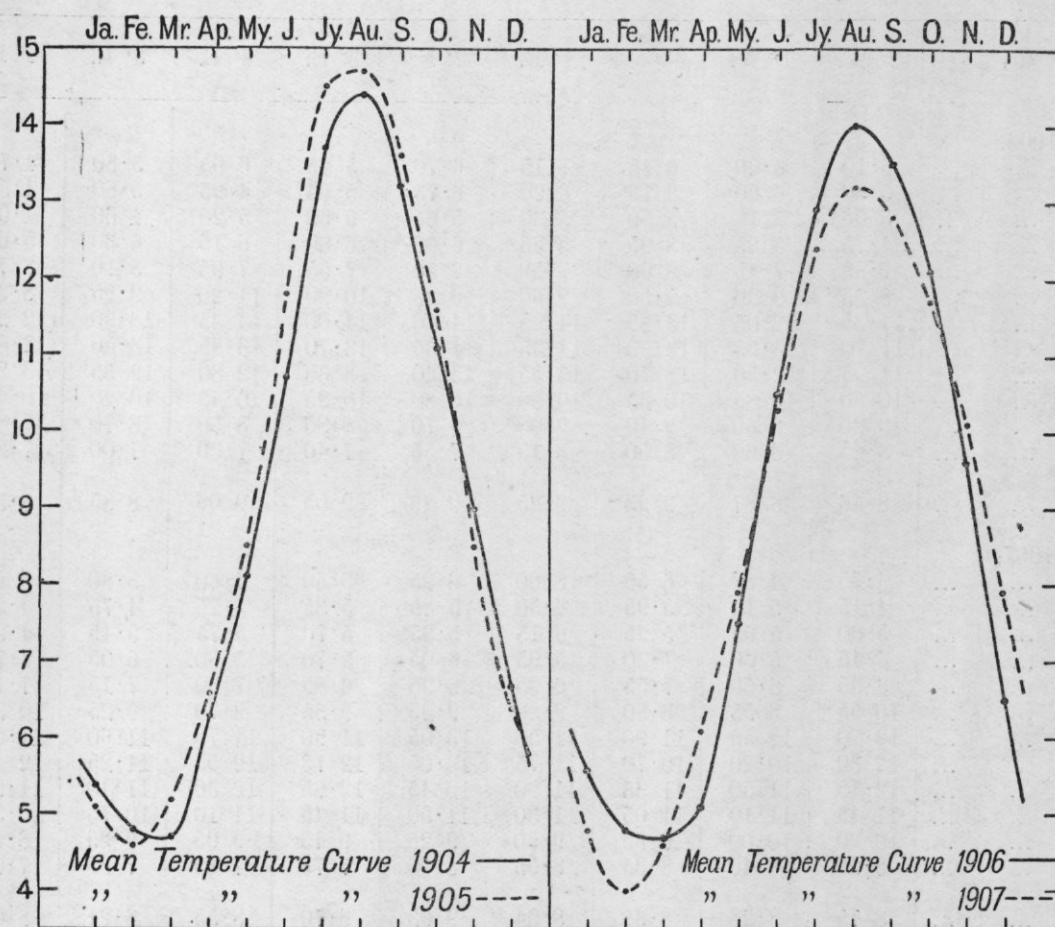


FIG. 2.

The following table shows the most characteristic differences in these curves during the four years :—

Year.	Approximate.			
	Minimum Temperature.	Date of Minimum.	Maximum Temperature.	Date of Maximum.
1904	4·6	Mar. 11th	14·4	Aug. 15th
1905	4·5	Feb. 22nd	14·8	Jul. 28th
1906	4·6	Mar. 4th	14·0	Aug. 17th
1907	4·0	Feb. 15th	13·3	Aug. 21st

In both 1906 and 1907 we have no indication on our curves of the abnormal winter inflow of warm (Atlantic) water which was so conspicuous in the early part of November 1905, and which was then so strongly marked in the records from Rattray Head lighthouse and the Abertay lightship.

CROSS ROUTE WORK.

During the years 1906-1907 temperature readings were made along the following routes :—

Leith to Christiansand—Captain Stark and Captain Parker ; Harwich to Hamburg—Captain Hunnisett and Captain Wright ; Leith to Hamburg—Captain Grierson and Captain Browne ; Newcastle to Bergen—Captain Oxholm and Captain Hovland ; Forth to Aalesund and (1906) to Stavanger—Captain Syrdahl and Captain Jørgensen ; Hamburg to Bergen (1907)—Captain Hensen ; Copenhagen to New York (1907)—Captain Wulff, Captain Hempel, and Captain Holst ; Ostende to Tilbury Dock (1907)—s.s. *Ville D'Anvers*.

The results are embodied in the following tables :—

TABLE III.—Mean Monthly Surface Temperatures, 1906, 1907, Leith to Christiansand (Captain Stark).

Year.	2° W.	1° W.	0°.	1° E.	2° E.	3° E.	4° E.	5° E.	6° E.
1906.									
Jan. ...	6.10	6.00	6.45	7.15	6.70	5.25	6.05	5.80	4.70
Feb. ...	5.30	6.20	6.15	6.20	6.75	5.95	4.95	5.60	4.50
Mar. ...	5.00	5.15	5.50	5.30	5.65	5.65	5.20	4.60	4.05
April ...	4.75	5.25	5.95	5.95	6.00	6.00	6.15	6.30	5.60
May ...	7.35	7.45	8.00	7.50	7.50	7.55	7.95	8.10	8.70
June ...	8.95	9.20	9.50	9.60	10.25	10.90	11.20	9.95	8.90
July ...	11.35	12.05	13.85	14.05	14.10	14.00	14.35	13.95	(12.20)
Aug. ...	11.70	13.55	13.50	14.35	14.35	13.70	13.85	13.50	(12.80)
Sept. ...	11.95	12.50	13.70	13.55	13.20	13.30	12.80	12.55	13.25
Oct. ...	10.60	10.85	10.55	10.20	10.80	10.95	10.45	10.20	10.40
Nov. ...	10.20	9.60	9.10	9.00	8.70	8.80	8.50	8.70	7.85
Dec. ...	8.25	8.60	8.50	8.15	7.55	7.40	7.30	7.00	7.20
Mean ...	8.46	8.87	9.23	9.25	9.29	9.05	9.06	8.85	8.35
1907.									
Jan. ...	3.75	4.80	6.55	8.00	6.95	5.50	4.60	3.80	3.60
Feb. ...	4.15	5.15	5.95	6.50	5.85	5.35	5.25	4.75	4.20
Mar. ...	5.00	5.65	5.95	6.15	5.95	5.70	5.75	5.45	4.25
April ...	6.45	5.00	7.30	5.95	6.05	5.70	5.80	6.05	4.75
May ...	8.35	6.50	7.55	6.95	6.85	6.85	7.00	7.15	7.10
June ...	10.55	8.55	8.80	9.20	9.25	9.35	9.70	9.25	10.30
July ...	12.20	12.55	11.00	11.50	13.05	11.90	11.70	11.60	11.95
Aug. ...	12.30	10.20	10.70	11.75	13.05	12.75	12.55	11.25	12.45
Sept. ...	12.15	11.50	11.35	11.90	12.45	12.65	12.30	11.40	11.95
Oct. ...	11.45	11.10	11.05	11.30	11.50	11.45	11.10	10.75	10.55
Nov. ...	10.20	10.00	9.35	9.50	9.25	9.45	9.05	9.25	8.55
Dec. ...	8.50	8.40	8.35	8.55	8.00	7.75	7.85	7.85	7.00
Mean ...	8.75	8.28	8.66	8.94	9.03	8.70	8.55	8.21	8.05

TABLE IV.—Mean Monthly Surface Temperatures, 1906, 1907, Harwich to Hamburg (Captains Hunnisett and Wright).

Year.	2° E.	3° E.	4° E.	5° E.	6° E.	7° E.	8° E.
1906.							
Jan. ...	6.90	6.04	6.58	6.12	4.60	4.14	4.99
Feb. ...	5.04	4.88	4.33	4.51	4.34	4.01	3.45
Mar. ...	—	4.76	4.79	4.56	4.53	3.99	2.70
April ...	6.85	5.43	6.18	6.41	5.86	5.41	5.09
May ...	8.73	8.41	9.02	9.88	9.96	9.42	8.46
June ...	10.78	10.92	11.70	12.20	12.21	12.47	13.24
July ...	—	13.52	14.51	15.83	15.70	15.25	15.46
Aug. ...	—	15.69	16.11	16.93	16.64	15.53	15.82
Sept. ...	16.08	15.41	15.54	16.34	16.22	16.03	15.67
Oct. ...	15.07	13.94	13.98	14.00	13.73	13.37	13.08
Nov. ...	10.87	11.61	11.38	11.16	10.79	10.47	10.70
Dec. ...	6.70	7.66	7.05	6.88	6.39	6.21	5.73
Mean ...	—	9.86	10.10	10.40	10.08	9.69	9.53
1907.							
Jan. ...	5.31	5.58	5.18	4.93	4.31	4.24	3.71
Feb. ...	3.27	3.45	3.34	2.82	2.32	1.50	0.50
Mar. ...	—	—	—	—	—	—	—
April ...	—	—	—	—	—	—	—
May ...	8.34	8.36	9.44	10.09	10.38	9.67	9.00
June ...	11.62	11.10	11.80	12.73	12.90	12.65	12.65
July ...	13.72	13.09	14.04	14.66	14.50	14.17	14.43
Aug. ...	15.32	14.80	15.27	15.76	15.85	15.51	15.06
Sept. ...	15.95	14.71	14.99	15.26	15.12	15.79	13.75
Oct. ...	14.24	14.09	14.12	14.18	13.75	13.56	13.25
Nov. ...	10.88	11.05	10.55	9.85	8.97	8.59	9.19
Dec. ...	8.15	8.18	7.83	7.20	6.37	5.96	6.25

TABLE V.—Mean Monthly Surface Temperatures, 1906, 1907, Leith to Hamburg
(Captains Browne and Grierson).

Year.	2° W.	1° W.	0°.	1° E.	2° E.	3° E.	4° E.	5° E.	6° E.	7° E.	8° E.
1906.											
Jan. ...	6·69	6·91	6·61	6·42	6·04	5·60	5·83	5·80	5·37	4·92	4·30
Feb. ...	5·22	5·51	5·78	5·62	5·38	4·90	4·63	4·82	4·64	4·32	3·32
Mar. ...	4·76	4·94	5·21	5·36	5·20	4·95	4·48	4·28	4·10	4·89	3·12
April ...	5·36	5·54	5·76	5·62	5·91	5·87	5·69	5·45	5·61	5·89	5·97
May ...	6·92	6·80	7·11	7·50	7·81	8·07	8·11	8·60	8·70	8·43	8·52
June ...	10·68	10·33	10·65	10·87	11·23	11·56	11·46	11·63	12·01	12·51	13·18
July ...	12·01	12·83	13·68	13·82	14·04	14·38	14·56	14·70	15·18	15·56	15·25
Aug. ...	12·86	13·57	14·90	15·29	15·34	15·68	15·86	16·07	16·06	16·27	16·89
Sept. ...	13·01	13·31	14·10	14·52	14·63	15·25	15·50	15·45	16·09	16·21	16·10
Oct. ...	11·22	11·35	11·73	12·22	13·14	13·79	13·83	14·39	14·77	14·33	13·80
Nov. ...	9·48	9·65	9·26	8·87	9·80	10·72	11·20	11·88	12·04	11·49	11·14
Dec. ...	7·83	7·98	7·91	7·66	7·36	7·30	8·40	9·11	8·82	7·96	6·62
Mean ...	8·84	9·06	9·39	9·48	9·66	9·84	9·96	10·18	10·28	10·23	9·85
1907.											
Jan. ...	6·32	6·49	6·51	6·37	6·21	6·20	5·65	5·92	5·65	4·94	4·12
Feb. ...	4·71	5·34	5·65	5·72	5·45	4·59	4·36	4·40	3·78	2·78	1·94
Mar. ...	4·54	4·96	5·25	5·49	5·60	5·40	4·70	4·29	3·86	3·36	2·98
April ...	5·85	5·82	5·95	6·08	6·41	6·24	5·31	5·08	5·25	5·16	5·28
May ...	7·43	7·14	7·29	7·42	7·84	8·27	8·24	8·38	8·73	9·05	9·16
June ...	9·56	9·29	9·56	9·92	10·13	10·23	10·57	10·86	11·36	11·69	11·76
July ...	11·40	12·04	12·13	12·24	12·59	12·82	12·77	12·86	13·23	13·68	13·91
Aug. ...	11·79	12·49	12·82	12·77	12·92	13·45	13·39	13·71	14·26	14·69	15·04
Sept. ...	11·36	11·93	12·53	12·84	13·08	13·58	13·92	14·13	14·65	14·77	14·49
Oct. ...	11·01	11·53	11·91	11·96	12·57	13·18	13·54	14·00	14·14	13·87	13·81
Nov. ...	9·78	9·54	9·44	9·66	10·25	10·93	11·55	12·09	11·34	10·51	11·11
Dec. ...	7·57	8·10	8·05	7·64	7·52	7·67	8·05	8·60	8·38	7·61	6·85
Mean ...	8·44	8·72	8·92	9·01	9·21	9·38	9·34	9·53	9·55	9·34	9·20

TABLE VI.—Mean Monthly Surface Temperatures at Danish Lightships, 1906, 1907.

Year.	Skaw.		Vyl.		Horn Reef.	
	1906.	1907.	1906.	1907.	1906.	1907.
Jan. ...	3·3	3·2	3·0	3·5	3·8	4·5
Feb. ...	2·6	1·4	2·5	1·0	3·2	2·0
Mar. ...	2·5	2·8	2·7	2·4	3·0	1·7
April ...	4·6	4·9	4·9	4·8	4·5	4·7
May ...	9·6	8·3	9·3	8·2	8·8	7·8
June ...	15·0	11·6	11·5	11·5	11·6	10·9
July ...	15·1	14·5	14·0	13·7	13·9	13·7
Aug. ...	16·1	14·1	16·5	14·6	15·9	14·1
Sept. ...	14·3	12·7	15·5	13·9	15·3	13·7
Oct. ...	11·6	12·2	13·0	13·4	13·4	13·5
Nov. ...	8·5	9·0	9·9	9·4	10·6	10·0
Dec. ...	6·0	5·4	6·1	6·5	7·2	7·4
Mean ...	9·1	8·3	9·1	8·7	9·3	8·7

TABLE VII.—Mean Monthly Surface Temperatures, 1906, 1907, Newcastle to Bergen (Captains Hovland and Oxholm).

Year.	1° W.	0° 30' W.	0°	0° 30' E.	1° E.	1° 30' E.	2° E.	2° 30' E.	3° E.	3° 30' E.	4° E.	4° 30' E.
1906.												
Jan. ...	6·80	7·16	7·31	7·38	7·45	7·20	6·92	6·76	6·35	6·39	5·85	6·00
Feb. ...	5·40	5·53	5·68	5·68	5·85	6·01	5·94	5·83	5·78	5·49	5·08	4·80
Mar. ...	4·96	5·28	5·46	5·19	5·22	5·33	5·34	5·38	5·02	4·94	4·61	4·07
April ...	5·56	5·65	5·67	5·74	6·06	6·14	6·18	6·06	6·62	6·58	5·68	4·85
May ...	6·30	6·43	6·50	6·78	6·88	6·96	7·13	7·11	7·13	7·21	7·06	7·25
June ...	9·18	9·41	9·60	9·50	9·54	9·59	9·84	10·03	10·09	10·21	10·38	10·53
July ...	12·16	12·06	12·06	11·94	11·78	12·11	12·69	13·05	13·06	12·80	12·32	11·98
Aug. ...	13·00	13·30	13·40	13·40	13·40	13·30	13·40	13·40	13·30	13·40	13·60	13·80
Sept. ...	12·98	13·40	13·58	13·72	13·80	13·80	13·57	13·42	13·33	13·30	13·10	13·20
Oct. ...	11·20	11·35	11·40	11·50	11·80	12·03	11·98	11·70	11·45	11·10	11·60	11·70
Nov. ...	9·24	8·90	9·16	8·96	8·97	8·78	8·65	8·80	8·67	8·72	8·65	8·37
Dec. ...	7·32	7·31	7·19	7·12	7·09	7·11	7·21	7·11	7·11	7·16	7·04	6·80
Mean ...	8·68	8·82	8·92	8·91	8·99	9·03	9·07	9·05	8·99	8·94	8·75	8·61
1907.												
Jan. ...	6·39	6·36	6·43	6·44	6·44	6·53	6·35	6·22	6·20	6·28	6·41	6·46
Feb. ...	5·93	6·02	6·10	6·13	5·97	5·81	5·77	5·72	5·66	5·60	5·09	5·47
Mar. ...	6·20	6·00	5·93	6·05	6·18	6·10	6·05	6·03	6·20	6·45	6·43	6·18
April ...	5·45	5·86	6·05	6·07	6·08	6·02	6·01	5·99	5·96	5·94	5·96	5·92
May ...	6·88	6·55	6·45	6·49	6·51	6·48	6·45	6·55	6·84	7·13	7·06	6·68
June ...	9·51	9·39	9·37	9·37	9·27	9·23	9·31	9·50	9·50	9·48	9·68	10·05
July ...	12·12	11·86	11·69	11·62	11·61	11·68	11·81	11·99	12·03	11·96	12·09	12·41
Aug. ...	12·78	12·49	12·27	12·16	12·21	12·27	12·47	12·62	12·63	12·59	12·55	12·79
Sept. ...	11·60	11·95	12·01	12·10	12·05	12·10	12·19	11·96	11·71	11·60	11·68	11·72
Oct. ...	11·15	11·26	11·36	11·36	11·36	11·46	11·51	11·40	11·26	11·18	11·10	10·87
Nov. ...	9·89	9·71	9·68	9·52	9·37	9·41	9·53	9·53	9·50	9·57	9·60	9·25
Dec. ...	7·97	7·97	7·93	7·86	7·79	7·78	7·68	7·63	7·63	7·78	7·76	7·78
Mean ...	8·82	8·79	8·76	8·76	8·74	8·74	8·76	8·76	8·76	8·80	8·78	8·80

TABLE VIII.—Mean Monthly Surface Temperatures, Firth of Forth to Aalesund (Captains Syrdahl and Jörgensen).

Year.	2° W.	1° W.	0°.	1° E.	2° E.	3° E.	4° E.	5° E.
1906.								
Jan. ...	6·55	7·33	7·56	7·19	7·38	8·10	6·94	5·98
Feb. ...	5·40	6·77	6·82	7·07	7·25	6·70	5·28	4·65
Mar. ...	5·40	6·05	6·25	6·05	5·35	5·10	5·00	4·80
April ...	5·90	6·20	6·05	6·40	6·55	6·65	5·25	5·40
May ...	7·70	7·50	7·50	7·20	7·05	7·05	6·55	6·70
June ...	—	11·60	10·40	11·15	11·30	11·55	10·45	—
July ...	—	10·75	11·40	9·95	10·30	10·55	11·65	12·60
Aug. ...	—	12·45	13·75	13·75	14·05	14·50	14·50	14·05
Sept. ...	12·30	11·60	11·75	12·05	12·30	11·55	13·05	13·35
Oct. ...	11·43	11·25	11·13	10·93	10·60	10·43	10·60	—
Nov. ...	10·35	9·60	7·95	8·40	8·50	9·40	9·55	9·40
Dec. ...	—	7·78	7·53	7·23	6·98	7·15	6·98	6·05
Mean ...	—	9·08	9·01	8·96	8·97	9·06	8·82	—
1907.								
Jan. ...	6·85	7·30	7·25	7·40	7·50	7·25	6·55	—
Feb. ...	5·40	6·50	6·50	6·00	6·10	6·80	6·05	—
Mar. ...	5·40	6·05	6·10	5·70	6·15	6·50	5·95	—
April ...	6·10	6·10	6·30	6·05	6·80	6·70	6·10	—
May ...	7·30	7·50	7·25	7·35	7·90	7·60	6·60	—
June ...	8·95	9·60	9·00	9·10	8·85	9·10	9·75	—
July ...	10·65	10·50	10·75	10·75	11·15	11·00	11·30	—
Aug. ...	11·75	11·50	11·20	11·25	11·50	10·75	11·55	—
Sept. ...	11·95	11·50	10·85	11·05	10·80	9·95	11·45	—
Oct. ...	11·25	10·65	10·10	10·25	9·90	9·55	10·95	—
Nov. ...	9·95	9·60	9·60	9·05	9·00	9·00	9·40	—
Dec. ...	8·25	8·50	8·40	7·90	8·00	8·20	7·70	—
Mean ...	8·65	8·77	8·61	8·49	8·64	8·53	8·61	—

TABLE IX.—Mean Monthly Surface Temperatures, Firth of Forth to Stavanger
(Captains Syrdahl and Jörgensen).

Year.	2° W.	1° W.	0°.	1° E.	2° E.	3° E.	4° E.	5° E.
1906.								
Jan. ...	6.65	7.00	7.20	7.45	7.50	6.30	4.55	4.50
Feb. ...	5.53	5.53	5.87	6.33	6.20	6.38	5.90	4.95
Mar. ...	4.70	5.05	5.25	5.40	5.50	5.55	4.85	4.10
April ...	4.50	6.00	6.20	6.25	5.85	5.90	4.70	4.45
May ...	5.90	6.20	6.40	6.45	6.50	6.50	6.05	5.35
June ...	7.75	7.70	7.60	7.90	7.60	9.00	9.15	7.00
July ...	12.30	12.75	13.55	13.70	14.10	14.70	15.20	16.55
Aug. ...		11.70	13.20	13.10	13.35	12.85	13.60	13.25
Sept. ...	—	11.70	13.20	13.10	13.35	12.85	13.60	13.25
Oct. ...	11.30	10.95	10.65	10.50	10.50	10.25	10.00	9.85
Nov. ...	8.85	8.95	9.25	9.30	9.05	9.00	8.65	8.45
Dec. ...	7.10	7.80	8.00	8.00	7.70	7.50	7.40	6.80
Mean ...	—	8.53	8.89	9.01	9.00	9.05	8.75	8.47

TABLE X.—Mean Monthly Surface Temperatures, Bergen to Hamburg
(Captain Hansen).

Year.	Lat. Long.	58° 00' N. 6° 30' E.	57° 30' N. 6° 43' E.	57° 00' N. 6° 55' E.	56° 30' N. 7° 6' E.	56° 00' N. 7° 16' E.	55° 30' N. 7° 26' E.	55° 00' N. 7° 36' E.
1907.								
Jan. ...	...	4.2	4.65	6.25	4.80	4.95	4.45	3.20
Feb. ...	...	3.15	4.25	4.75	4.05	3.90	3.25	2.75
Mar. ...	...	3.35	4.30	3.90	4.10	3.50	3.40	3.15
April ...	...	4.45	4.85	4.50	4.95	4.75	4.85	5.20
May ...	...	6.45	6.40	6.35	6.65	6.70	7.75	8.50
June ...	...	8.60	9.15	9.10	9.45	9.45	11.85	11.95
July ...	...	10.80	12.20	12.05	12.75	12.40	14.50	14.25
Aug. ...	...	12.35	12.95	13.10	13.80	13.95	14.45	13.85
Sept. ...	...	12.35	11.85	12.15	13.35	13.65	13.80	13.91
Oct. ...	...	11.00	11.35	12.25	13.20	13.60	13.70	14.30
Nov. ...	...	8.70	9.50	11.20	11.45	11.15	10.90	10.45
Dec. ...	...	6.50	7.30	7.40	8.05	7.25	6.55	6.00
Mean ...	...	7.66	8.23	8.58	8.88	8.77	9.12	8.96

TABLE XI.—Mean Monthly Surface Temperatures, Ostende to Tilbury Dock
(S.S. "Ville D'Anvers").

Year.	Lat. Long.	51° 30' N. 1° 00' E.	50° 30' N. 1° 30' E.	51° 24' N. 2° 00' E.	51° 20' N. 2° 30' E.	51° 16' N. 2° 50' E.
1907.						
Jan. ...	...	5.35	5.03	6.20	4.63	3.63
Feb. ...	...	—	—	—	—	—
Mar. ...	...	5.35	4.85	4.76	4.71	5.50
April ...	...	8.65	6.77	6.98	7.52	7.88
May ...	...	9.18	9.26	9.13	9.73	10.96
June ...	...	—	—	—	—	—
July ...	...	16.45	14.70	14.10	14.85	15.90
Aug. ...	...	16.90	15.47	15.97	16.95	16.92
Sept. ...	...	15.55	15.63	15.73	15.82	16.37
Oct. ...	...	12.75	14.08	14.65	14.62	13.78
Nov. ...	...	—	—	—	—	—
Dec. ...	...	7.53	8.98	10.45	9.97	8.30
Mean ...	...	—	—	—	—	—

TABLE XII.—Mean Monthly Surface Temperatures on the Eastern Part of the Route from Copenhagen to Pentland Firth (on Route to New York), (Captains Wulff, Holst and Hempel).

Year.	Lat. Long.	57° 52' N. 8° 00' E.	57° 58' N. 7° 00' E.	58° 3' N. 6° 00' E.	58° 8' N. 5° 00' E.	58° 12' N. 4° 00' E.	58° 17' N. 3° 00' E.	58° 21' N. 2° 00' E.	58° 25' N. 1° 00' E.	58° 28' N. 0° 00'	58° 32' N. 1° 00' W.	58° 36' N. 2° 00' W.
1907.												
Jan.	...	6.30	5.45	5.00	5.50	6.05	6.65	7.15	7.75	8.00	8.00	8.00
Feb.	...	1.70	3.13	3.95	4.55	5.15	5.75	6.25	6.30	6.35	6.70	6.70
Mar.	...	3.40	3.05	2.35	1.98	2.90	3.68	4.33	4.87	5.33	5.64	6.04
April	...	6.25	5.02	5.48	5.83	6.18	6.33	6.02	5.34	6.05	6.92	7.23
May	...	8.35	8.30	8.30	7.45	6.33	6.60	6.65	6.70	7.13	7.48	7.63
June	...	11.25	10.93	10.43	9.84	9.29	9.28	9.35	9.16	8.89	9.54	9.59
July	...	13.93	13.53	13.19	12.90	12.50	12.33	12.11	11.81	11.58	11.33	10.99
Aug.	...	13.38	13.20	12.81	12.46	12.20	12.01	11.90	11.44	10.85	10.38	10.21
Sept.	...	11.45	9.05	9.90	10.15	10.35	10.30	10.27	10.30	10.75	10.80	10.50
Oct.	...	12.00	12.15	11.95	11.40	10.90	10.75	11.00	10.75	10.45	10.45	11.00
Nov.	...	11.05	10.70	8.53	9.10	9.48	9.55	9.50	9.50	9.50	9.78	10.00
Dec.	...	10.50	9.60	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10
Mean	...	9.13	8.68	8.25	8.19	8.20	8.36	8.47	8.42	8.50	8.68	8.75

An examination of these tables bears out the remarks made when considering the surface temperatures of the stations on the East Coast of Scotland and England.

Especially at the inshore stations on our cross routes is it noticeable that the temperatures during the early months of 1907 were much lower than during the corresponding period of 1906. For instance a study of the Harwich-Hamburg route shows us that during February 1906 the mean temperature on this route was 4.35, while a year later it was about a couple of degrees lower, namely 2.45.

Further north this difference in the mean monthly temperatures for the two years under consideration was not so well marked, although still noticeable to an appreciable extent. Thus, on the Leith-Christiansand route during February 1906 the mean temperature was 5.7, during February 1907 it was 5.2—a difference of only half a degree. Again at the Leith-Aalesund stations the mean temperature during February 1906 was 6.0° C., and only 5.4° C. during February 1907. In the autumn months also the temperature of the surface waters was less in 1907 than in the previous year. On the Harwich-Hamburg route—the most southerly line of stations for which we have readings for both years—the following table gives the mean surface readings for the four months when the temperature was in the region of its maximum:—

	1906.	1907.
July ...	15.1	14.1
August ...	16.1	15.4
September ...	15.9	15.1
October ...	13.9	13.9

On the Leith-Christiansand route the mean surface temperature for the same four months of the two years was as follows:—

	1906.	1907.
July ...	12.0	12.0
August ...	13.7	11.9
September ...	13.0	11.9
October ...	10.6	11.4

A comparison of the temperatures for the two years shows accordingly that during the earlier months of 1906 the temperatures were higher than during the corresponding months of 1907, as were also the temperatures during the summer and autumn months. We also observe that these temperature differences were more marked in the more southerly shallower portions of the North Sea basin.

HARMONIC FORMULÆ.

The harmonic formulæ derived from the mean monthly temperatures at the different stations at which observations were taken have been calculated by Fourier's

equation in the simplified form

$$f(\beta) = A_0 + a_1 \sin(\theta + e_1) + a_2 \sin(2\theta + e_2) +$$

These harmonic formulæ give us the mean annual temperature, the half range and the phase of each curve—factors which give us in their turn the mean maximum temperature, the mean minimum temperature, and the approximate date of these. These latter factors have been calculated for each North Sea station at which temperature records were made during 1906 and 1907, the results being included in the following tables:—

TABLE XIII.—Harmonic Constants for Mean Monthly Surface Temperatures at Scottish East Coast Lightships, 1906, 1907.

Station.	Longi- tude.	Latitude.	Year.	A.	A.	Mean Maxi- mum.	Mean Mini- mum.	e.	Approx- imate date of Mini- mum.	A.	e.
	° /	° /						° /			°
North Carr Lightship ...	2 33 W.	56 18 N.	1906	8·69	3·98	12·67	4·71	47 3	Feb. 27	·25	79
			1907	8·43	3·77	12·20	4·66	48 14	„ 26	·16	3
Abertay Lightship ...	2 41 W.	56 27 N.	1906	8·09	4·22	12·91	4·47	46 3	„ 28	·23	-47
			1907	8·25	4·29	12·54	3·96	49 27	„ 25	·247	75
Rattray Head Lightship	1 49 W.	57 37 N.	1906	8·49	4·00	12·49	4·49	50 47	„ 23	·02	74
			1907	8·35	3·63	11·98	4·72	44 3	Mar. 2	·075	58

TABLE XIV.—Harmonic Constants for Mean Monthly Surface Temperatures, Leith to London.

Station.	A ₀ .	A ₁ .	Mean Maximum.	Mean Minimum.	e ₁ .	Approximate date of Minimum.	A ₂ .	e ₂ .
					° /			° /
1906.								
Bass Rock ...	8·35	4·24	12·59	4·11	53 3	Feb. 21	·25	48 11
St. Abbs ...	8·32	4·13	12·45	4·19	50 33	„ 24	·19	6 53
Longstone ...	8·24	3·89	12·13	4·35	49 43	„ 24	·32	31 13
Coquet Island ...	8·53	3·90	12·43	4·63	49 35	„ 24	·33	59 58
Souter Point ...	8·85	4·04	12·89	4·81	52 8	„ 22	·62	67 50
Whitby ...	8·74	4·15	12·89	4·59	52 21	„ 22	·38	65 56
Flamboro' Head ...	8·82	4·63	13·45	4·19	53 19	„ 21	·36	- 9 7
Spurn Point ...	8·98	4·64	13·62	4·34	48 56	„ 25	·58	-11 24
Dudgeon Light ...	9·36	5·39	14·73	3·97	54 13	„ 20	·61	-18 56
Cromer ...	9·59	5·93	15·52	3·66	56 7	„ 18	·53	-18 38
Newarp Light ...	9·82	6·25	16·07	3·57	56 8	„ 18	·40	- 5 53
Lowestoft ...	9·84	6·39	16·23	3·45	58 29	„ 16	·51	3 50
Orfordness ...	10·01	6·62	16·63	3·39	52 19	„ 21	·56	7 4
Sunk Light ...	10·14	6·73	16·87	3·41	58 30	„ 16	·68	5 14
1907.								
Bass Rock ...	8·29	3·86	12·15	4·43	52 41	„ 21	·055	59 13
St. Abbs Head ...	8·28	3·88	12·16	4·40	48 52	„ 25	·12	84 18
Longstone ...	8·26	3·77	12·03	4·49	47 48	„ 26	·085	47 52
Coquet Island ...	8·37	3·80	12·17	4·57	45 38	„ 28	·21	48 49
Souter Point ...	8·48	3·86	12·34	4·62	47 38	„ 26	·196	84 44
Whitby ...	8·48	4·08	12·56	4·40	49 17	„ 25	·014	68 58
Flamboro' Head ...	8·70	4·56	13·26	4·14	51 9	„ 23	·34	76 35
Spurn Head ...	8·85	4·48	13·33	4·37	45 11	Mar. 1	·39	68 45
Dudgeon Light ...	9·05	5·12	14·17	3·93	51 11	Feb. 23	·61	68 27
Cromer ...	9·31	5·51	14·82	3·80	54 5	„ 20	·38	86 31
Lowestoft ...	9·48	6·17	15·65	3·31	57 22	„ 17	·56	53 20
Orfordness ...	9·60	6·24	15·84	3·36	54 24	„ 20	·44	62 5

TABLE XV.—Harmonic Constants for Mean Monthly Surface Temperatures, Leith to Christiansand.

Longitude.	Latitude.	A_0 .	A_1 .	Mean Maximum.	Mean Minimum.	e_1 .	Approximate date of Minimum.	A_2 .	e_2 .
°	°					°			°
1906.									
2 W.	56 18 N.	8.46	3.63	12.09	4.83	38 4	Mar. 8	.35	-70
1 W.	56 28 N.	8.87	3.85	12.72	5.02	42 48	" 3	.69	55
0 W.	56 40 N.	9.23	4.02	13.25	5.21	49 14	Feb. 25	.97	55
1 E.	56 50 N.	9.25	4.09	13.34	5.16	48 57	" 25	1.36	52
2 E.	57 01 N.	9.29	4.09	13.38	5.20	52 30	" 21	1.27	52
3 E.	57 11 N.	9.05	4.38	13.43	4.67	55 55	" 18	.86	48
4 E.	57 21 N.	9.06	4.47	13.53	4.59	58 17	" 16	.86	70
5 E.	57 32 N.	9.85	4.33	13.18	4.52	57 16	" 17	.87	58
6 E.	57 43 N.	8.35	4.70	13.05	3.65	55 57	" 18	.60	45
1907.									
2 W.	—	8.75	4.25	13.00	4.50	51 35	" 22	.67	30
1 W.	—	8.28	3.57	11.85	4.71	39 40	" 6	.22	-34
0 W.	—	8.66	2.70	11.36	5.96	41 33	" 2	.17	85
1 E.	—	8.94	3.00	11.94	5.94	34 32	" 11	.59	59
2 E.	—	9.03	3.77	12.80	5.26	44 54	" 1	.71	39
3 E.	—	8.70	3.92	12.62	4.78	44 4	Mar. 2	.45	11
4 E.	—	8.55	3.87	12.42	4.68	48 8	" 26	.33	0
5 E.	—	8.21	3.64	11.85	4.57	58 37	" 15	.26	69
6 E.	—	8.05	4.48	12.53	3.57	52 59	" 21	.22	-87

TABLE XVI.—Harmonic Constants for Mean Monthly Surface Temperatures, Harwich to Hamburg, 1906.

Longitude.	Latitude.	A_0 .	A_1 .	Mean Maximum.	Mean Minimum.	e_1 .	Approximate date of Minimum.	A_2 .	e_2 .
°	°					°			°
1906.									
3 E.	52 40 N.	9.86	5.65	15.51	4.21	43 45	Mar. 2	.37	1
4 E.	53 6 N.	10.10	5.81	15.91	4.29	48 55	Feb. 25	.30	11
5 E.	53 30 N.	10.40	6.28	16.68	4.12	53 40	" 20	.44	28
6 E.	53 45 N.	10.08	6.53	16.61	3.55	55 36	" 18	.36	3
7 E.	53 53 N.	9.69	6.72	16.41	2.97	56 14	" 18	.43	8
8 E.	53 59 N.	9.53	6.78	16.31	2.75	54 31	" 19	.45	-79
1907.									
2 E.	—	9.41	6.51	15.92	2.90	45 0	Mar. 1	.15	-23
3 E.	—	9.47	5.90	15.37	3.57	43 29	" 3	.42	21
4 E.	—	9.78	5.84	15.62	3.94	50 58	" 23	.35	50
5 E.	—	9.77	6.25	16.02	3.52	56 41	" 17	.26	46
6 E.	—	9.23	6.68	15.91	2.55	59 6	" 15	.11	-15
7 E.	—	8.85	6.78	15.63	2.07	58 8	" 16	.24	-22
8 E.	—	8.66	7.09	15.75	1.57	56 27	" 18	1.04	-20

TABLE XVII.—Harmonic Constants for Mean Monthly Surface Temperatures at Continental Lightships.

Station.	Latitude.	Longitude.	Year.	A_0 .	A_1 .	Mean Maxi- mum.	Mean Mini- mum.	e_1 .	Approximate date of Mini- mum.	A_2 .	e_2 .
	°	°						°			°
Skaw Light Vessel.	57 46 N.	10 43 E.	1906	9.10	7.01	16.11	2.09	63 50	Feb. 10	.93	-55 58
			1907	8.30	6.31	14.61	1.99	58 33	" 15	.49	9 29
Vyl Light Vessel.	55 23.6 N.	7 45 E.	1906	9.10	6.92	16.02	2.18	54 42	" 19	.23	-74 45
			1907	8.70	6.59	15.29	2.11	52 43	" 21	.57	19 42
Horns Reef Light Vessel.	55 34 N.	7 19.5 E.	1906	9.30	6.56	15.86	2.74	50 3	" 24	.12	8 16
			1907	8.70	6.25	14.95	2.45	47 24	" 27	.67	-7 38

TABLE XVIII.—Harmonic Constants for Mean Monthly Surface Temperatures.
Leith to Hamburg.

Longitude.	Latitude.		A ₀ .	A	Mean Maximum.	Mean Minimum.	e ₁ .		Approximate date of Minimum.	A ₂ .	e ₂ .
°	°	'					°	'			°
1906.											
2 W.	56	0 N.	8.84	4.00	12.84	4.84	44	24	Mar. 2	.62	76
1 W.	55	49 N.	9.06	4.27	13.33	4.79	44	7	" 2	.83	59
0	55	37 N.	9.39	4.67	14.06	4.72	47	48	Feb. 26	1.06	41
1 E.	55	25 N.	9.48	4.84	14.32	4.64	49	5	" 25	1.05	30
2 E.	55	12 N.	9.66	5.21	14.87	4.45	49	20	" 25	.74	23
3 E.	55	2 N.	9.84	5.66	15.50	4.18	48	37	" 25	.53	11
4 E.	54	49 N.	9.96	5.82	15.78	4.14	45	51	" 28	.33	41
5 E.	54	38 N.	10.18	5.96	16.14	4.22	43	58	Mar. 2	.20	-35
6 E.	54	28 N.	10.28	6.27	16.55	4.01	45	16	" 1	.13	-26
7 E.	54	16 N.	10.23	6.51	16.74	3.72	49	28	Feb. 25	.23	-20
8 E.	54	2 N.	9.85	6.97	16.82	2.88	53	27	" 21	.21	38
1907.											
2 W.	—	—	8.44	3.44	11.88	5.00	40	38	Mar. 5	.60	-18
1 W.	—	—	8.72	3.76	12.48	4.96	41	52	" 4	.45	73
0	—	—	8.92	3.75	12.67	5.17	41	11	" 5	.29	63
1 E.	—	—	9.01	3.90	12.91	5.11	44	53	" 2	.35	25
2 E.	—	—	9.21	4.10	13.31	5.11	45	50	Feb. 28	.35	-26
3 E.	—	—	9.38	4.57	13.95	4.81	44	42	Mar. 1	.25	87
4 E.	—	—	9.34	5.00	14.34	4.34	41	56	" 4	.38	39
5 E.	—	—	9.53	5.23	14.76	4.30	39	40	" 6	.48	18
6 E.	—	—	9.55	5.61	15.16	3.94	43	54	" 2	.49	18
7 E.	—	—	9.34	6.07	15.41	3.27	49	13	Feb. 24	.49	17
8 E.	—	—	9.20	6.46	15.66	2.74	51	10	" 23	.73	29

TABLE XIX.—Harmonic Constants for Mean Monthly Surface Temperatures.
Newcastle to Bergen.

Longitude.	Latitude.		A ₀ .	A ₁ .	Mean Maximum.	Mean Minimum.	e ₁ .		Approximate date of Minimum.	A ₂ .	e ₂ .	
°	°	'					°	'			°	'
1906.												
1 W.	—	—	8.68	4.03	12.71	4.65	41	53	Mar. 4	.79	38	19
0	—	—	8.92	4.01	12.93	4.91	42	42	" 3	.95	30	21
1 E.	—	—	8.99	3.98	12.97	5.01	42	40	" 3	.89	20	29
2 E.	—	—	9.07	3.96	13.03	5.11	47	6	Feb. 27	.87	25	29
3 E.	—	—	8.99	4.13	13.12	4.86	58	48	" 15	.76	32	00
4 E.	—	—	8.75	4.40	13.15	4.35	49	23	" 24	.61	37	37
1907.												
1 W.	—	—	8.82	3.52	12.34	5.30	42	14	Mar. 4	.56	54	2
0	—	—	8.76	3.43	12.19	5.33	40	9	" 6	.49	30	58
1 E.	—	—	8.74	3.38	12.12	5.36	41	17	" 5	.54	21	30
2 E.	—	—	8.76	3.57	12.33	5.19	41	36	" 4	.54	20	26
3 E.	—	—	8.76	3.52	12.28	5.24	44	58	" 1	.48	34	12
4 E.	—	—	8.78	3.51	12.29	5.27	45	57	Feb. 28	.36	48	3

TABLE XX.—Harmonic Constants for Mean Monthly Surface Temperatures.
The Forth to Aalesund.

Longitude.	Latitude.	A ₀ .	A ₁ .	Mean Maximum.	Mean Minimum.	e ₁ .	Approximate date of Minimum.	A ₂ .	e ₂ .
°	°					°			°
1906									
1 W.	35 30 N.	9·08	3·15	12·23	5·93	45 56	Feb. 28	·39	66
0	58 20 N.	9·01	3·25	12·26	5·76	49 27	„ 25	1·00	45
1 E.	59 10 N.	8·96	3·13	12·09	5·83	48 57	„ 25	·85	32
2 E.	60 0 N.	8·97	3·27	12·24	5·70	49 47	„ 24	·92	42
3 E.	60 45 N.	9·06	3·35	12·41	5·71	48 28	„ 26	·92	62
4 E.	61 33 N.	8·82	4·22	13·04	4·60	45 9	Mar. 1	·94	51
1907.									
2 W.	56 40 N.	8·65	3·32	11·97	5·33	36 40	Mar. 9	·01	31
1 W.	57 30 N.	8·77	2·75	11·52	6·02	37 55	„ 8	·30	80
0	58 20 N.	8·61	2·62	11·23	5·99	41 50	„ 4	·38	77
1 E.	59 10 N.	8·49	2·73	11·22	5·76	40 59	„ 5	·41	77
2 E.	60 0 N.	8·64	2·49	11·13	6·15	46 14	Feb. 28	·39	72
3 E.	60 45 N.	8·53	2·07	10·60	6·46	46 19	„ 28	·48	87
4 E.	61 33 N.	8·61	3·11	11·72	5·50	42 40	Mar. 3	·35	50

TABLE XXI.—Harmonic Constants for Mean Monthly Surface Temperatures.
The Forth to Stavanger.

Longitude.	Latitude.	A ₀ .	A ₁ .	Mean Maximum.	Mean Minimum.	e ₁ .	Approximate date of Minimum.	A ₂ .	e ₂ .
°	°					°			°
1906.									
2 W.	56 22 N.	8·38	3·59	11·97	4·79	29 8	Mar. 17	·39	47
1 W.	56 44 N.	8·53	3·59	12·12	4·94	35 35	„ 10	·70	42
0	57 6 N.	8·89	3·80	12·69	5·09	38 36	„ 7	1·14	30
1 E.	57 27 N.	9·01	3·75	12·76	5·26	39 39	„ 6	1·21	35
2 E.	57 48 N.	9·00	3·88	12·88	5·12	40 47	„ 5	1·40	37
3 E.	58 8 N.	9·05	4·16	13·21	4·89	47 18	Feb. 27	1·45	44
4 E.	58 29 N.	8·75	4·96	13·71	3·79	48 25	„ 26	1·52	40
5 E.	58 49 N.	8·47	5·56	14·03	2·91	49 22	„ 25	2·19	42

TABLE XXII.—Harmonic Constants for Mean Monthly Surface Temperatures.
Hamburg to Bergen.

Latitude.	Longitude.	A ₀ .	A ₁ .	Mean Maximum.	Mean Minimum.	e ₁ .	Approximate date of Minimum.	A ₂ .	e ₂ .
°	°					°			°
1907.									
55 N.	7 36 E.	8·96	6·29	15·25	2·67	53 5	Feb. 21	·66	44
55 30 N.	7 26 E.	9·12	6·09	15·21	3·03	49 56	„ 24	·32	—16
56 N.	7 16 E.	8·77	5·48	14·25	3·29	39 23	Mar. 7	·21	—72
56 30 N.	7 6 E.	8·88	5·27	14·15	3·61	38 55	„ 7	·12	69
57 0 N.	6 55 E.	8·58	4·60	13·18	3·98	35 54	„ 10	·39	—86
57 30 N.	6 43 E.	8·23	4·48	12·71	3·75	44 38	„ 2	·28	58
58 N.	6 30 E.	7·66	4·67	12·33	2·99	44 49	„ 1	·17	—35

TABLE XXIII.—Harmonic Constants for Mean Monthly Surface Temperatures.
Ostende to Tilbury Dock.

Longitude.	Latitude.		A ₀ .	A ₁ .	Mean Maximum.	Mean Minimum.	e ₁ .	Approximate date of Minimum.	A ₂ .	e ₂ .
° ,	°	'					° ,			° ,
1907.										
1 E.	51	30 N.	10·27	6·30	16·57	3·97	64 8	Feb. 10	·29	69 41
1 30 E.	51	30 N.	10·13	5·90	16·03	4·23	51 33	" 23	·32	33 26
2 E.	51	24 N.	10·34	5·81	16·15	4·53	44 31	Mar. 20	·46	24 21
2 30 E.	51	20 N.	10·51	6·29	16·80	4·22	51 40	Feb. 22	·56	33 42
2 50 E.	51	16 N.	10·35	6·78	17·13	3·57	62 52	" 11	·49	64 19

TABLE XXIV.—Harmonic Constants for Mean Monthly Surface Temperatures.
Copenhagen to Pentland Firth.

Longitude.	Latitude.		A ₀ .	A ₁ .	Mean Maximum.	Mean Minimum.	e ₁ .	Approximate date of Minimum.	A ₂ .	e ₂ .
°	°	'					° ,			° ,
1907.										
8 E.	57	52 N.	9·13	4·90	14·03	4·23	45 45	Feb. 28	1·71	—18 26
7 E.	57	58 N.	8·68	4·54	13·22	4·14	46 26	" 28	1·78	—25 59
6 E.	58	3 N.	8·25	4·58	12·83	3·67	54 31	" 19	·95	—36 2
5 E.	58	8 N.	8·19	4·33	12·52	3·86	50 4	" 24	·89	—45 12
4 E.	58	12 N.	8·20	3·88	12·08	4·32	45 31	" 28	·68	—70 14
3 E.	58	17 N.	8·36	3·49	11·85	4·87	45 7	Mar. 1	·66	—79 58
2 E.	58	21 N.	8·47	3·26	11·73	5·21	43 8	" 3	·69	88 21
1 E.	58	25 N.	8·42	3·04	11·46	5·38	39 24	" 7	·80	85 12
0	58	28 N.	8·50	2·72	11·22	5·78	40 14	" 6	·56	80 12
1 W.	58	32 N.	8·68	2·44	11·12	6·24	43 31	" 2	·33	—80 12
2 W.	58	36 N.	8·75	2·29	11·04	6·46	42 12	" 4	·15	—32 13

The values obtained for the mean annual temperature (A₀) during 1906 and 1907 have been charted, and the corresponding isotherms drawn.

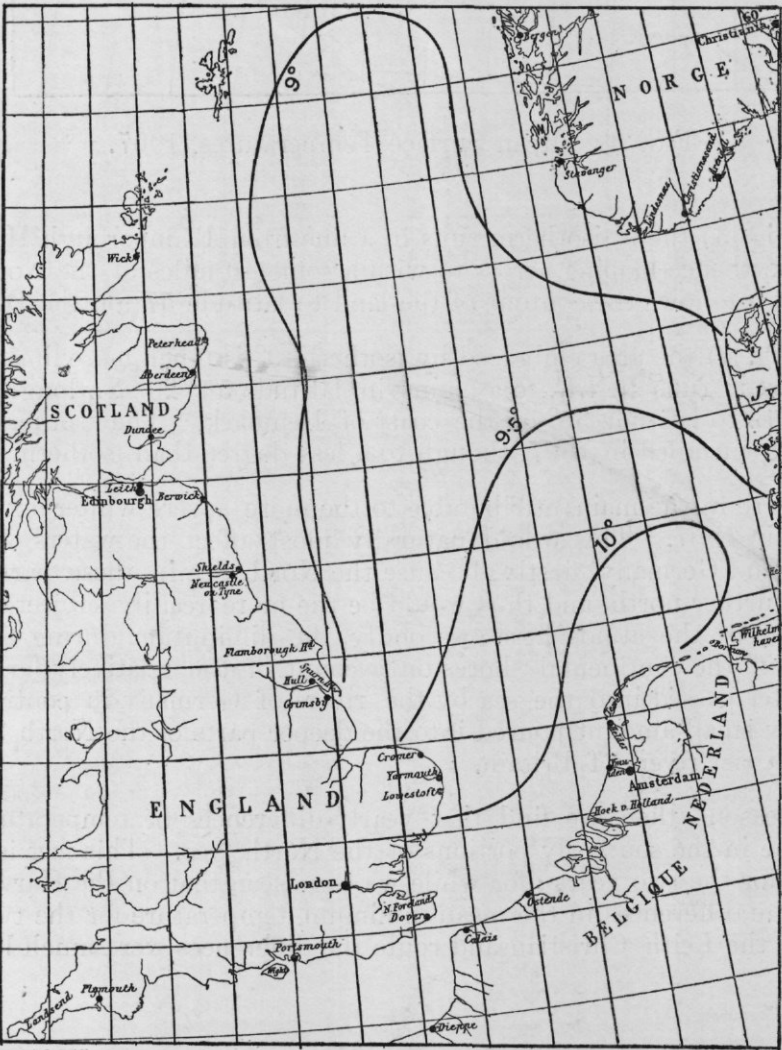


FIG. 3. Mean Surface Temperatures, 1906.

A glance at these two maps shows that during 1907 the mean surface temperature over the whole North Sea area was much lower than it was in the preceding year.

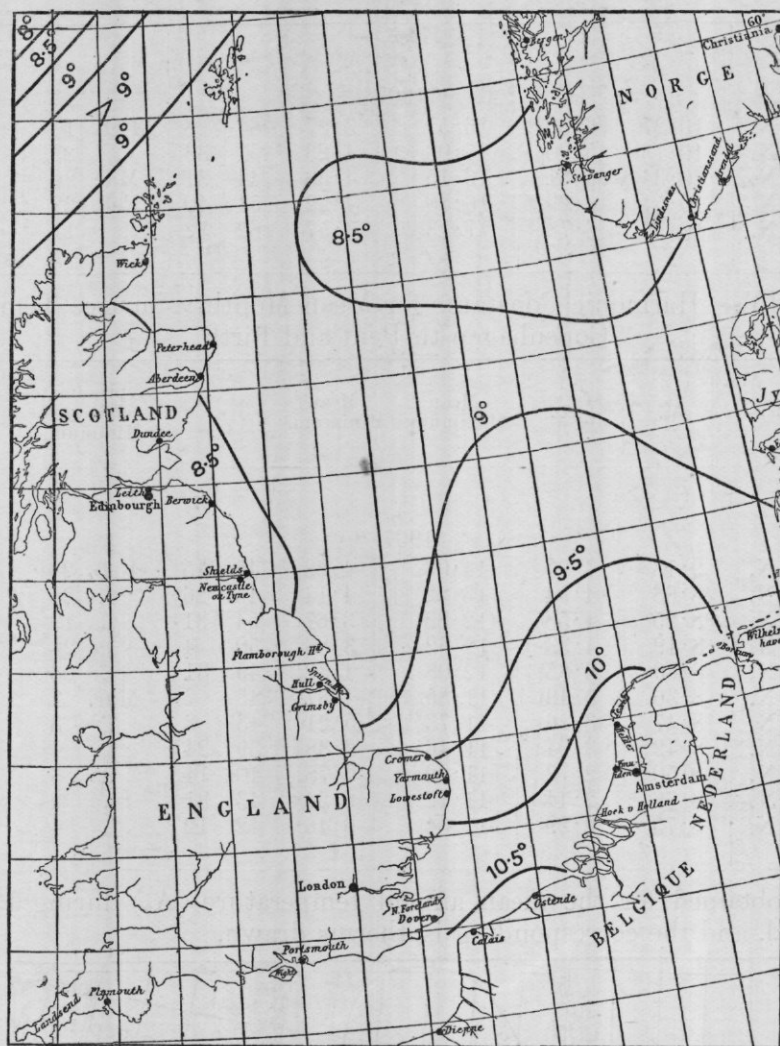


FIG. 4. Mean Surface Temperatures, 1907.

In 1906 (Fig. 3) the 9° isotherm runs in a line from Flamborough Head almost due north to Lerwick, thence looping across to within some 40 miles of the Norwegian Coast, from which point it follows the contour of the land to latitude 57° on the Danish seaboard.

In 1907 (Fig. 4) the area embraced by isotherm 9° is much more limited. From the Lincolnshire coast it runs N.N.E. to a point in latitude $56^{\circ} 20' N.$, longitude $4^{\circ} E.$, and thence nearly S.E. to latitude 55° on the coast of Denmark. The isotherms of 9.5° and 10° are also much curtailed in 1907, though to a less degree than isotherm 9° .

These facts are in the main attributable to the more severe winter experienced over western Europe in 1907. This would naturally most affect the waters off the coasts of the Netherlands and Germany, firstly, because the North Sea in these parts is shallower than is the case further north, and thus would be the more readily subject to fluctuations in the temperature of the atmosphere; secondly, the diminution during 1907 would be more noticeable off the continental shores on account of the relatively larger proportion of cold fresh water passed into the sea by the rivers of Germany in contradistinction to the comparatively small amount poured into the deeper parts of the North Sea by the less voluminous east coast rivers of Britain.

For these reasons, then, we find that yearly differences of temperature are greater and more extreme in the southerly portions of the North Sea. This fact is borne out by the observations for the two years; for while we have seen that on the Harwich-Hamburg route we had large differences in the mean minimum temperature for the two years under consideration, on the Leith-Christiansand route the differences were much less.

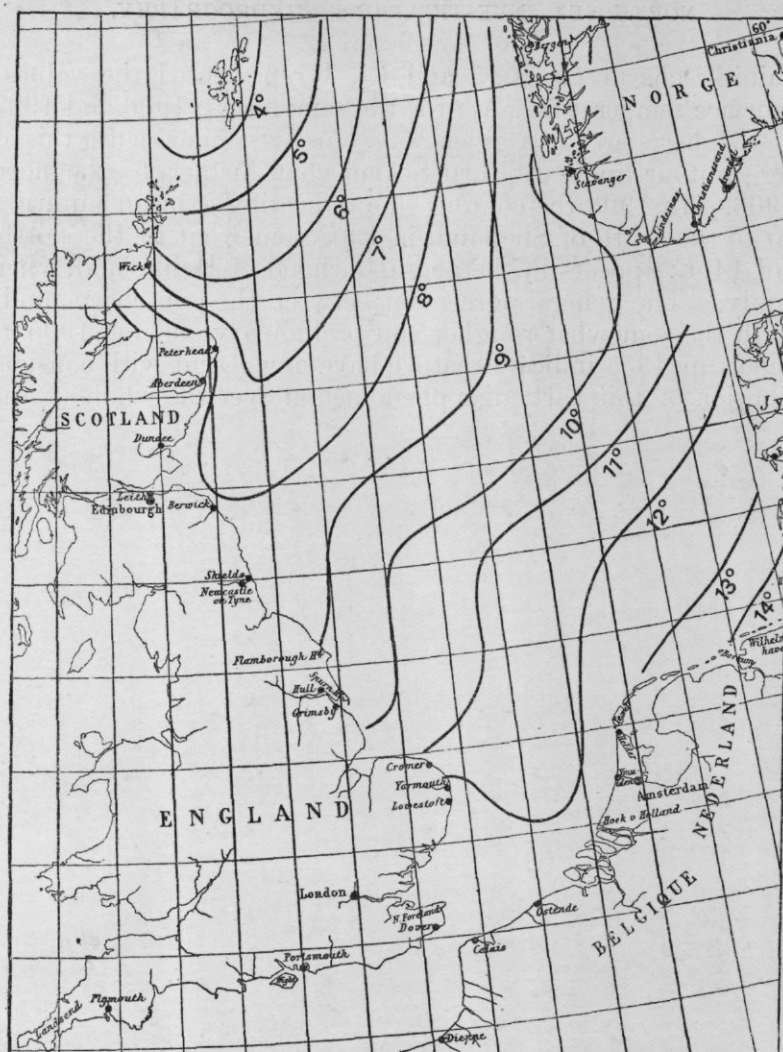


FIG. 5. Mean Range of Surface Temperature, 1906.



FIG. 6. Mean Range of Surface Temperature, 1907.

In the remaining charts (Figs. 5 and 6), I represented the values for the mean annual range of surface temperature (A_1) for the same years, 1906 and 1907. It will be seen that these two charts are, in a given way, closely similar, with this difference, that the corresponding contour lines are thrust somewhat further to the north in 1907 as compared with 1906. In 1906 the contour line indicating a mean annual range of 4° C. appears somewhat to the south of Shetland, in 1907 somewhat to the north thereof; and in 1906 a range of 14° C. appears in the neighbourhood of Heligoland, where the chart for 1907 shows 13° only. The general agreement between the two charts, and their general correspondence with the somewhat rougher and preliminary one for 1905 (already given in our Second Report, p. 195) indicate that we have now learnt with considerable accuracy the normal distribution of this particular phenomenon over the whole of the North Sea.
