Results of Magnetic Observations at Stations on the Coasts of the British Isles, 1907

L. W. P. Chetwynd

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X. *Results of Magnetic Observations at Stations on the Coasts of the British Isles*, 1907.

By Commander L. W. P. CHETWYND, *R.N., Superintendent of Compasses.*

Communicated by Rear-Admiral A. M. FIELD, *F.R.S.*

1. WITH a view to comparing the values of Secular Change of Declination, Horizontal Force and Dip, at various stations on the coasts of the British Isles, with the values derived from the continuous records at Kew Observatory, the Hydrographer (Rear-Admiral A. MOSTYN FIELD, F.R.S.) directed that during the year 1907 observations were to be made at certain stations, selected from those which had been occupied by Prof. RÜCKER and Dr. THORPE during their Magnetic Survey* for the epoch 1st January, 1891.

2. The observers detailed for the work were Captain M. H. SMYTH, R.N., H.M.S. "Research"; Captain W. PUDSEY-DAWSON, R.N., H.M.S. "Triton"; and Captain J. W. COMBE, R.N., H.M. Surveying Vessel "Gladiator."

(The observers' names are subsequently indicated by their initials.)

The instruments with which they were supplied were :—

	Unifilar.	Dip circle.
M. H. S.	161	186
W. P.-D.	60	188
J. W. C.	25	27

3. Careful reference, kindly verified by Dr. THORPE, was made to ensure the exact observation spot at each station being re-occupied.

4. To reduce all results to a common instrumental standard, observations were made at Kew, before the commencement of the field observations and after their completion, and the results of comparing the values obtained by each instrument with the values derived from the magnetograms were applied as corrections for instrumental differences, thus reducing the field observations to the Kew Instrumental Standard.

The corrections so applied are given in Table I.

* 'Phil. Trans.,' A, vol. 188 (1896).

TABLE I.—Corrections for Instrumental Differences.

Horizontal Force.			
Unifilar No. 161.	Unifilar No. 60.	Unifilar No. 25.	
		Magnet 25A.	Magnet 25D.
$+3\gamma$	-1γ	$+4\gamma$	$+16\gamma$

Declination.		
Unifilar No. 161.	Unifilar No. 60.	Unifilar No. 25.
$-0'\cdot4$	$-0'\cdot2$	$+1'\cdot1$

Inclination.					
Dip circle No. 186.		Dip circle No. 188.		Dip circle No. 27.	
Needle 1.	Needle 2.	Needle 1.	Needle 2.	Needle 1.	Needle 2.
$+0'\cdot91$	$+1'\cdot14$	$-0'\cdot4$	$+0'\cdot56$	$-1'\cdot51$	$-1'\cdot26$

5. To reduce the observed values to a common epoch, the field observations were compared with synchronous values derived from the Kew magnetograms, and the differences as recorded at Kew between these latter values and the mean value for 1906 and 1907 were applied as a correction to the values at the field stations to reduce them to the epoch 1st January, 1907.

The comparisons were made by the Staff of the Observatory Department of the National Physical Laboratory and the resulting differences supplied by Dr. CHREE, F.R.S.

6. A summary of the results of all the field observations is given in the following Table II. :—

TABLE II.—Summary of Results.

Place.	Date.	Declination W.		Horizontal Force.		Inclination.		Vertical force.
		Observed.	Reduced to 1st January, 1907.	Observed.	Reduced to 1st January, 1907.	Observed.	Reduced to 1st January, 1907.	Reduced to 1st January 1907.
	1907	° ′	° ′			° ′	° ′	
Harwich	8–9 May . .	15 32·3	15 31·8	0·18409	0·18419	67 5·5	67 6·9	0·43636
Great Grimsby.	13–14 „ . .	16 35·8	16 32·2	0·17627	0·17640	68 23·4	68 24·3	0·44565
Sunderland. . .	17 „ . .	17 29·2	17 29·7	0·17086	0·17093	69 14·7	69 15·3	0·45128
Stonehaven . .	21–22 „ . .	18 20·4	18 20·3	0·16345	0·16365	70 27·6	70 27·4	0·46103
Kirkwall	4–6 June. .	19 7·7	19 10·3	0·15445	0·15445	71 48·8	71 49·1	0·47027
Dublin	9–10 May . .	19 47·3	19 47·0	0·17560	0·17550	68 30·3	68 32·4	0·44645
Tanera Mor*. .	8–9 October	20 39·3	20 38·3	0·15343	0·15361	71 49·5	71 50·2	0·46822
Weymouth. . .	15–16 April. .	16 55·6	16 51·5	0·18774	0·18790	66 32·8	66 31·5	0·43266
Milford Haven.	13–16 „ . .	18 6·2	18 8·9	0·18187	0·18221	67 38·6	67 36·6	0·44229
Stranraer. . . .	12–17 June. .	19 31·3	19 34·8	0·16811	0·16844	69 43·4	69 41·7	0·45523
Letterkenny . .	19–22 July . .	20 56·4	20 59·3	0·16689	0·16713	70 0·4	69 59·4	0·45788
Loch Melfort. .	23–26 „ . .	19 47·4	19 50·9	0·16523	0·16553	70 13·5	70 11·7	0·45965

7. In the subjoined abstract of results the plan adopted by RÜCKER and THORPE in their memoirs has been followed, and in each case the data given are as follows :—

    1. The number and name of the station ;
    2. The initials of the observer ;
    3. The distinguishing numbers of the instruments used ;
    4. The date ;
    5. The latitude and longitude of the station ;
    6. Angles, magnetic bearings, or other information for fixing the position.

For each element is given :—

    1. The date ;
    2. The Greenwich mean time of observation ;
    3. The observed value with all corrections applied (δ, H, and θ) ;
    4. The value reduced to the epoch 1st January, 1907 (δ_0, H_0, and θ_0) ;
    5. The means respectively of 3 and 4.

For convenience in reference the numbers assigned to the stations by RÜCKER and THORPE have been retained.

* See footnote, p. 236.

421.   HARWICH.   W. P.-D.   (60, 188.)   8–9 May, 1907.

Latitude 51° 56′ 36″ N., Longitude 1° 17′ 11″ E.

On reclaimed land west of the town.

	°	′	″
Martello Tower, Shotley	360	0	0
Water Tower	16	12	0
Grand Hotel (Flagstaff)	59	5	0
St. Nicholas Church Spire	93	32	0
Low Chimney, Cement Works	250	55	0
High „ „ „	260	20	0
Chimney, Ramsay Island	304	13	0

(True bearing of Chimney, Ramsay Island, N. 67° 56′ 42″ W.)

Declination.

Date.	G.M.T.	δ.	δ_0.
	h. m.	° ′	° ′
8 May	11 57 a.m.	15 33·9	15 31·7
8 „	3 34 p.m.	15 32·3	15 32·1
9 „	10 21 a.m.	15 31·3	15 32·7
9 „	2 41 p.m.	15 32·9	15 31·0
9 „	4 17 „	15 31·3	15 31·4
Means . . .		15 32·3	15 31·8

Horizontal Force.

Date.	G.M.T.	H.	H_0.
	h. m.		
8 May	10 47 a.m.	0·18398	0·18415
8 „	2 41 p.m.	0·18418	0·18415
9 „	9 24 a.m.	0·18406	0·18426
9 „	1 27 p.m.	0·18415	0·18420
Means . . .		0·18409	0·18419

Inclination.

Date.	G.M.T.	θ.	θ_0.
	h. m.	° ′	° ′
8 May	1 17 p.m.	67 5·3	67 6·7
8 „	4 49 „	67 5·2	67 6·7
9 „	11 47 a.m.	67 6·1	67 7·2
Means . . .		67 5·5	67 6·9

406.   GREAT GRIMSBY.   W. P.-D.   (60, 188.)   13–14 May, 1907.

Latitude 53° 33′ 14″ N., Longitude 0° 5′ 24″ W.

In a pasture field, almost in a line with the fence of Nunsfield Grounds and 40 feet from the brook.

A guide post on the main road is seen just to the right of a gate post.

Declination.

Date.	G.M.T.	δ.	δ_0.
	h. m.	° ′	° ′
13 May	10 59 a.m.	16 34·0	16 30·2
13 „	2 52 p.m.	16 34·1	16 29·7
13 „	4 42 „	16 36·0	16 34·0
14 „	7 52 a.m.	16 28·9	16 34·7
Means . . .		16 35·8	16 32·2

Horizontal Force.

Date.	G.M.T.	H.	H_0.
	h. m.		
13 May	10 13 a.m.	0·17613	0·17650
13 „	1 53 p.m.	0·17630	0·17637
13 „	3 54 „	0·17638	6·17634
Means . . .		0·17627	0·17640

Inclination.

Date.	G.M.T.	θ.	θ_0.
	h. m.	° ′	° ′
13 May	0 25 p.m.	68 22·7	68 24·5
14 „	9 8 a.m.	68 24·0	68 24·0
Means . . .		68 23·4	68 24·3

633.   SUNDERLAND.   W. P.-D.   (60, 188.)   17 May, 1907.

Latitude 54° 53′ 30″ N., Longitude 1° 24′ 23″ W.

In a pasture field, north of Humbledon Hill, close to a fence, and 60 yards to the northward from the main road.

Declination.

Date.	G.M.T.	δ.	δ_0.
	h. m.	° ′	° ′
17 May	9 47 a.m.	17 29·9	17 32·8
17 „	11 54 „	17 28·9	17 28·5
17 „	3 31 p.m.	17 29·9	17 28·6
17 „	5 11 „	17 28·1	17 29·0
	Means . . .	17 29·2	17 29·7

Horizontal Force.

Date.	G.M.T.	H.	H_0.
	h. m.		
17 May	8 46 a.m.	0·17074	0·17094
17 „	1 6 p.m.	0·17080	0·17090
17 „	4 30 „	0·17103	0·17094
	Means . . .	0·17086	0·17093

Inclination.

Date.	G.M.T.	θ.	θ_0.
	h. m.	° ′	° ′
17 May	11 6 a.m.	69 14·9	69 15·2
17 „	2 39 p.m.	69 14·5	69 15·4
	Means . . .	69 14·7	69 15·3

217. STONEHAVEN. W. P.-D. (60, 188.) 21–22 May, 1907.

Latitude 56° 58′ 1″ N., Longitude 2° 14′ 10″ W.

In a field, close to the fence of Farochie and north of Camp Hill.

Declination.

Date.	G.M.T.	δ.	δ₀.
	h. m.	° ′	° ′
21 May	10 37 a.m.	18 16·9	18 20·1
21 „	2 12 p.m.	18 19·2	18 18·2
21 „	4 25 „	18 20·2	18 20·0
22 „	11 7 a.m.	18 20·9	18 21·1
22 „	1 7 p.m.	18 24·9	18 21·9
Means . . .		18 20·4	18 20·3

Horizontal Force.

Date.	G.M.T.	H.	H₀.
	h. m.		
21 May	9 53 a.m.	0·16347	0·16366
21 „	1 21 p.m.	0·16341	0·16361
22 „	10 16 a.m.	0·16343	0·16366
22 „	2 2 p.m.	0·16348	0·16366
Means . . .		0·16345	0·16365

Inclination.

Date.	G.M.T.	θ.	θ₀.
	h. m.	° ′	° ′
21 May	11 52 a.m.	70 28·7	70 28·4
21 „	3 39 p.m.	70 26·4	70 26·4
Means . . .		70 27·6	70 27·4

139.   KIRKWALL.   W. P.-D.   (60, 188.)   4–6 June, 1907.

Latitude 58° 59′ 17″ N., Longitude 2° 57′ 8″ W.

Twenty feet from the road by Cromwell's Fort, 33 yards from the Coastguards' wall along the road.

Declination.

Date.	G.M.T.	δ.	δ_0.
	h. m.	° ′	° ′
4 June	11 2 a.m.	19 7·7	19 9·9
4 ,, ...	1 56 p.m.	19 8·2	19 8·4
4 ,, ...	5 7 ,,	19 6·6	19 8·6
6 ,, ...	9 9 a.m.	19 5·7	19 11·9
6 ,, ...	10 50 ,,	19 10·1	19 12·7
Means . . .		19 7·7	19 10·3

Horizontal Force.

Date.	G.M.T.	H.	H_0.
	h. m.		
4 June	10 10 a.m.	0·15430	0·15445
4 ,, ...	2 47 p.m.	0·15475	0·15462
6 ,, ...	9 53 a.m.	0·15431	0·15427
Means . . .		0·15445	0·15445

Inclination.

Date.	G.M.T.	θ.	θ_0.
	h. m.	° ′	° ′
4 June	0 11 p.m.	71 50·9	71 49·5
4 ,, ...	4 20 ,,	71 46·7	71 48·6
Means . . .		71 48·8	71 49·1

768.   DUBLIN.   M. H. S.   (161, 186.)   9–10 May, 1907.

Latitude 53° 20′ 35″ N.; Longitude 6° 15′ 21″ W.

In the grounds of Trinity College, on the eastern side of the path, 65 feet from the edge and 46·25 feet north of the north side of the small building (marked Observatory on the ordnance map), now used as a tool shed.

Note.—Captain M. H. SMYTH observes that "the observations at Trinity College, Dublin, are not very reliable, owing to the proximity of electric tramlines which surround the College grounds, and that this station cannot be looked upon as suitable for the purpose of determining magnetic elements in future."

Declination.

Date.	G.M.T.	δ.	δ_0.
	h. m.	° ′	° ′
9 May	4 31 p.m.	19 44·5	19 44·0
10 „	2 51 „	19 53·4	19 51·3
10 „	5 15 „	19 43·9	19 45·6
Means . . .		19 47·3	19 47·0

Horizontal Force.

Date.	G.M.T.	H.	H_0.
	h. m.		
9 May	4 40 p.m.	0·17557	0·17543
10 „	2 43 „	0·17562	0·17556
Means . . .		0·17560	0·17550

Inclination.

Date.	G.M.T.	θ.	θ_0.
	h. m.	° ′	° ′
9 May	1 15 p.m.	68 30·5	68 32·5
10 „	11 17 a.m.	68 30·1	68 32·3
Means . . .		68 30·3	68 32·4

226.   TANERA MOR.*   M. H. S.   (161, 186.)   8–9 October, 1907.

Latitude 58° 0′ 36″ N., Longitude 5° 24′ 9″ W.

On the steep slope immediately south of the old fish-curing establishment, with the right tangent of the wall 126 feet distant bearing N. 6° 26′ 30″ E. (true).   Corner of wall surrounding cultivated ground 63 feet distant bearing S. 86° 1′ 30″ W. (true). Fixed mark (a cairn of stones on Rudha' Ard-na-goine) bearing N. 24° 7′ 30″ E. (true), distant approximately 1022 yards.

Declination.

Date.	G.M.T.	δ.	δ_0.
	h. m.	° ′	° ′
8 October	0 35 p.m.	20 40·9	20 39·9
8 ,, ...	1 28 ,,	20 40·5	20 38·2
8 ,, ...	2 48 ,,	20 40·6	20 39·1
9 ,, ...	3 7 ,,	20 35·3	20 35·8
Means . . .		20 39·3	20 38·3

Horizontal Force.

Date.	G.M.T.	H.	H_0.
	h. m.		
8 October	4 12 p.m.	0·15362	0·15370
9 ,, ...	1 36 ,,	0·15323	0·15351
Means . . .		0·15343	0·15361

Inclination.

Date.	G.M.T.	θ.	θ_0.
	h. m.	° ′	° ′
8 October	10 26 a.m.	71 49·8	71 50·7
9 ,, ...	10 35 ,,	71 49·1	71 49·6
Means . . .		71 49·5	71 50·2

* This station being in a region of disturbance, the results should be treated with caution.

674. WEYMOUTH. M. H. S. (161, 186.) 15–16 April, 1907.

Latitude 50° 36′ 19″ N., Longitude 2° 26′ 44″ W.

To the south of the Nothe, close to high line; a brick is buried just under the surface.

True bearings from the observation spot :—

Breakwater Light House Vane	S. 43 3 40 E.
Centre of beacon on breakwater	S. 36 24 40 E.
Left tangent of Naval Torpedo Range House	S. 0 15 40 E.
Tower of Bincleave House	S. 39 19 50 W.
Flagstaff of coastguard lookout-house on Nothe . . .	N. 6 25 20 E.
Flagstaff on south bastion of Nothe Fort	N. 58 24 20 E.
Right tangent of sea wall. South side of Nothe . . .	N. 72 59 20 E.
Left tangent of breakwater outside the Fort	S. 45 37 25 E.
Left tangent of northern arm of breakwater	S. 44 36 25 E.

Declination.

Date.	G.M.T.	δ.	δ_0.
	h. m.	° ′	° ′
15 April	2 40 p.m.	16 54·2	16 51·9
16 „	0 27 „	16 55·9	16 52·1
16 „	2 38 „	16 56·6	16 50·5
	Means . . .	16 55·6	16 51·5

Horizontal Force.

Date.	G.M.T.	H.	H_0.
	h. m.		
15 April	0 49 p.m.	0·18767	0·18788
16 „	2 50 „	0·18781	0·18792
	Means . . .	0·18774	0·18790

Inclination.

Date.	G.M.T.	θ.	θ_0.
	h. m.	° ′	° ′
15 April	4 33 p.m.	66 31·6	66 32·5
16 „	9 31 a.m.	66 34·0	66 30·5
	Means . . .	66 32·8	66 31·5

527.   MILFORD (NEW MILFORD).   J. W. C.   (25, 27.)   13–16 April, 1907.

Latitude 54° 42′ 26″ N., Longitude 4° 56′ 48″ W.

In a field belonging to Mr. Carron, situated to N.W. of an iron church now built close to the site of the previous observation spot of 1887–1892, 174 feet N.W. from the main road and 160 feet N.E. from a post near the tennis ground.

Declination.

Date.	G.M.T.	δ.	δ_0.
	h. m.	° ′	° ′
13 April.	4 14 p.m.	18 5·5	18 7·7
15 ,, ...	4 30 ,,	18 8·6	18 10·7
16 ,, ...	8 3 a.m.	18 0·4	18 7·4
16 ,, ...	9 28 ,,	18 2·2	18 6·5
16 ,, ...	4 0 p.m.	18 14·3	18 12·2
	Means . . .	18 6·2	18 8·9

Horizontal Force.

Date.	G.M.T.	H.	H_0.
	h. m.		
13 April.	1 0 p.m.	0·18212	0·18221 (Magnet 25A)
15 ,, ...	1 5 ,,	0·18187	0·18220 (,, 25D)
15 ,, ...	1 37 ,,	0·18197	0·18216 (,, 25A)
15 ,, ...	0 15 ,,	0·18177	0·18248 (,, 25D)
15 ,, ...	0 45 ,,	0·18160	0·18201 (,, 25A)
	Means . . .	0·18187	0·18221

Inclination.

Date.	G.M.T.	θ.	θ_0.
	h. m.	° ′	° ′
13 April.	3 0 p.m.	67 35·2	67 35·3
15 ,, ...	11 58 a.m.	67 42·6	67 40·4
15 ,, ...	3 29 p.m.	67 40·2	67 38·6
16 ,, ...	10 58 a.m.	67 38·9	67 34·1
16 ,, ...	2 35 p.m.	67 35·9	67 34·6
	Means . . .	67 38·6	67 36·6

220.   STRANRAER.   J. W. C.   (25, 27.)   12–17 June, 1907.

Latitude 54° 54′ 25″ N., Longitude 5° 2′ 10″ W.

In a field, 300 yards N.W. by W. of Schuchan Church.

Declination.

Date.	G.M.T.	δ.	δ_0.
	h. m.	° ′	° ′
12 June	4 48 p.m.	19 35·2	19 34·1
13 ,, ...	9 22 a.m.	19 24·3	19 32·3
13 ,, ...	3 57 p.m.	19 40·1	19 36·1
14 ,, ...	8 59 a.m.	19 25·7	19 34·2
15 ,, ...	9 30 ,,	19 24·0	19 33·0
17 ,, ...	4 20 p.m.	19 38·2	19 38·8
	Means . . .	19 31·3	19 34·8

Horizontal Force.

Date.	G.M.T.	H.	H_0.
	h. m.		
13 June	0 16 p.m.	0·16807	0·16835 (Magnet 25A)
13 ,, ...	0 52 ,,	0·16805	0·16838 (,, 25D)
14 ,, ...	11 15 a.m.	0·16801	0·16846 (,, 25D)
14 ,, ...	11 43 ,,	0·16829	0·16855 (,, 25A)
	Means . . .	0·16811	0·16844

Inclination.

Date.	G.M.T.	θ.	θ_0.
	h. m.	° ′	° ′
12 June	3 9 p.m.	69 41·9	69 41·7
13 ,, ...	11 10 a.m.	69 45·5	69 42·7
13 ,, ...	3 9 p.m.	69 42·0	69 41·2
14 ,, ...	10 2 a.m.	69 44·1	69 41·2
	Means . . .	69 43·4	69 41·7

816.   LETTERKENNY.   J. W. C.   (25, 27.)   19–22 July, 1907.

Latitude 54° 56' 55" N., Longitude 7° 43' 55" W.

In a meadow on the east side of the town, about 300 yards from the main street and 15 yards east of a lane running down to the river.

The spire of the church in the town bore N. 25° W.

Declination.

Date.	G.M.T.	δ.	δ₀.
	h. m.	° ′	° ′
19 July	4 40 p.m.	21 0·5	20 56·4
20 ,, ...	10 1 a.m.	20 54·6	20 58·9
20 ,, ...	4 30 p.m.	20 57·1	20 57·5
21 ,, ...	9 59 a.m.	20 55·0	21 2·4
21 ,, ...	4 59 p.m.	20 58·0	21 0·0
22 ,, ...	9 59 a.m.	20 53·4	21 0·5
	Means . . .	20 56·4	20 59·3

Horizontal Force.

Date.	G.M.T.	H.	H₀.
	h. m.		
19 July	2 3 p.m.	0·16680	0·16715 (Magnet 25D)
19 ,, ...	2 1 ,,	0·16701	0·16720 (,, 25A)
20 ,, ...	1 20 ,,	0·16680	0·16709 (,, 25D)
20 ,, ...	1 56 ,,	0·16696	0·16706 (,, 25A)
	Means . . .	0·16689	0·16713

Inclination.

Date.	G.M.T.	θ.	θ₀.
	h. m.	° ′	′
19 July	3 48 p.m.	70 0·3	69 59·3
20 ,, ...	11 29 a.m.	70 0·7	69 59·1
20 ,, ...	3 43 p.m.	70 0·1	69 59·7
	Means . . .	70 0·4	69 59·4

155. LOCH MELFORT. J. W. C. (25, 27.) 23–26 July, 1907.

Latitude 56° 16′ 7″ N., Longitude 5° 30′ 32″ W.

On the west side of Fearnach Bay, close to the shore.

Declination.

Date.	G.M.T.	δ.	δ₀.
	h. m.	° ′	° ′
23 July	4 50 p.m.	19 46·0	19 47·6
24 ,,	8 59 a.m.	19 48·4	19 54·5
24 ,,	9 45 ,,	19 47·7	19 52·2
24 ,,	4 14 p.m.	19 48·4	19 49·8
24 ,,	4 42 ,,	19 48·4	19 50·1
25 ,,	9 44 a.m.	19 44·1	19 51·4
25 ,,	4 44 p.m.	19 50·7	19 49·1
26 ,,	9 0 a.m.	19 45·4	19 52·6
Means . . .		19 47·4	19 50·9

Horizontal Force.

Date.	G.M.T.	H.	H₀.
	h. m.		
24 July	0 35 p.m.	0·16511	0·16543 (Magnet 25D)
24 ,,	1 9 ,,	0·16552	0·16567 (,, 25A)
25 ,,	0 56 ,,	0·16531	0·16562 (,, 25D)
25 ,,	1 29 ,,	0·16546	0·16553 (,, 25A)
26 ,,	10 2 a.m.	0·16507	0·16545 (,, 25A)
26 ,,	10 29 ,,	0·16489	0·16546 (,, 25D)
Means . . .		0·16523	0·16553

Inclination.

Date.	G.M.T.	θ.	θ₀.
	h. m.	° ′	° ′
24 July	11 6 a.m.	70 15·2	70 12·8
24 ,,	3 4 p.m.	70 13·4	70 11·6
25 ,,	10 46 a.m.	70 14·1	70 10·7
25 ,,	3 16 p.m.	70 11·1	70 11·5
Means . . .		70 13·5	70 11·7

8. Comparing the values deduced for the epoch 1st January, 1907, with the corresponding values for 1st January, 1886, or 1st January, 1891 (the epochs of Rücker and Thorpe's survey), the resulting mean annual changes at each station are as shown in columns 2, 5, 8, and 11 of Table III., in which the stations are arranged according to their latitude.

9. For comparison, in the same table are given (columns 3, 6, 9, and 12) the mean annual changes at Kew, the differences of mean annual change between Kew and the Field stations being shown in columns 4, 7, 10, and 13.

10. The resulting comparison shows that the mean annual change of Declination is generally greater at the Field stations than at Kew. The mean change at Kirkwall is $1'\cdot5$ greater than at Kew, but the results do not indicate a very marked gradual increase with increase of latitude.

11. The mean annual change of Horizontal Force appears to be less at the Field stations than at Kew, the differences being greater in the northern latitudes.

12. The mean annual change of Inclination is less at the Field stations than at Kew, the difference being greater in the northern latitudes.

13. The mean annual change of Vertical Force during the sixteen-year period 1891_0 to 1907_0 is less at the Field stations than at Kew, and, with the exceptions of Dublin and Tanera Mor, the Field station results are remarkably similar.

14. The value of the Declination at Kew for the year 1886, as originally recorded, was $18° 18'\cdot5$, derived from absolute observations only.

Compared with the value for the year 1907, derived from quiet-day magnetograms, this gives a mean annual change, during the 21 years' interval, of $5'\cdot5$.

The corresponding values at Greenwich and Stonyhurst are respectively $5'\cdot5$ and $5'\cdot6$. The mean from the results of those Field stations at which the 21 years' interval is available is $5'\cdot7$, but in the latter case the comparison is from 1886_0 to 1907_0.

15. The originally recorded value at Kew has, Dr. Chree informs me, been amended.

Previous to the year 1890 Kew had no fully corrected declination curves, but in 1892 a table of mean annual values was compiled based on the absolute observations corrected for diurnal inequality by means of statistics derived from the diurnal inequalities for short series of years; these corrections unquestionably improve the value derived from absolute observations alone, and the resulting value for the epoch 1st January, 1886, is $18° 15'\cdot3$; this latter value has been used in calculating the mean change at Kew 1886_0 to 1907_0, resulting in the value $5'\cdot2$, as given in Table III.

16. Comparing this value at Kew with corresponding values at those Field stations at which the same 21 years' interval is available, viz., Weymouth, Harwich, Dublin, Milford, Stranraer, and Kirkwall, the mean of the values at these stations is $0'\cdot5$ greater than at Kew.

17. The mean annual change at Kew during the 16-year period, 1891_0 to 1907_0, is $4'\cdot9$. Comparing this with the values at those stations at which the 16-years' interval is available, viz., Great Grimsby, Milford, Sunderland, Letterkenny, Loch Melfort, Stonehaven, and Tanera Mor, the mean of the values at the Field stations is $0'\cdot2$ greater than at Kew.

At Milford, where results are available for both the 21- and the 16-year periods, the mean for the former is $0'\cdot5$ greater than Kew, and for the 16-year period is the same as Kew.

18. These results seem to indicate that the reduction in the amount of the annual change has been greater at the Field stations than at Kew.

19. This is corroborated by a comparison (p. 244) of the Declination-change curves for Kew and Stonyhurst (fig. 1).

20. *Comparison of Mean Annual Change of Declination at Kew, Greenwich, and Stonyhurst.*

To compare the annual change at Kew, Greenwich, and Stonyhurst, the mean of five successive yearly differences of Declination is assigned as the mean annual change for the mid-year of the 5-year period.

Thus the mean of the yearly differences from $1886._5$ to $1891._5$ is assigned as the mean annual change for the year 1889. The mean annual value representing the value for the middle of the year, the quinquennial mean change is allotted to 1st January of the middle year.

21. Curves of which these quinquennial mean values are the ordinates have been drawn, as shown in fig. 1.

22. The comparison of these curves indicates that between the years 1886 and 1894 (embracing the period of RÜCKER and THORPE'S survey) the value of the secular change at Stonyhurst was considerably in excess of that at Kew—this being in agreement with the results found by RÜCKER and THORPE that the value was greater in the North-west than at Kew.

Since the year 1894 the values at Stonyhurst and Kew are in closer agreement and that at Stonyhurst slightly less than at Kew.

23. Figs. 2, 3, and 4 show respectively the curves of annual change of Declination, Horizontal Force, and Inclination at Kew derived from quinquennial means.

24. The Declination-change curve, fig. 2, indicates that the annual change which was decreasing in amount from the epoch 1893 to 1904 is now increasing in amount, and that the mean value at the present epoch (1 January, 1907) is $4'\cdot8$.

25. Assuming the mean difference between Kew and the rest of the British Isles, derived from observations at 16 years' interval, to be as given (see paragraph 17), the mean value of the change for the United Kingdom is $5'$.

26. The Horizontal Force-change curve, fig. 3, indicates that the amount of annual

increase has, since the year 1898, been diminishing, that this annual increase is at present very small, and may shortly become an annual decrease. Thus, if ΔH represent the difference of the values of Horizontal Force for successive years, ΔH has been positive, but has since the year 1898 diminished in numerical value.

ΔH is at present very small and may shortly change from being $+$ to being $-$.

27. The Inclination-change curve, fig. 4, indicates that the amount of the annual decrease has been, and still is, diminishing, and that its present value is $-1'$. Thus, if $\Delta\theta$ represents the difference of the values of Inclination for successive years, $\Delta\theta$ has been, and still is, negative, but has diminished in numerical value until it is now $1'$.
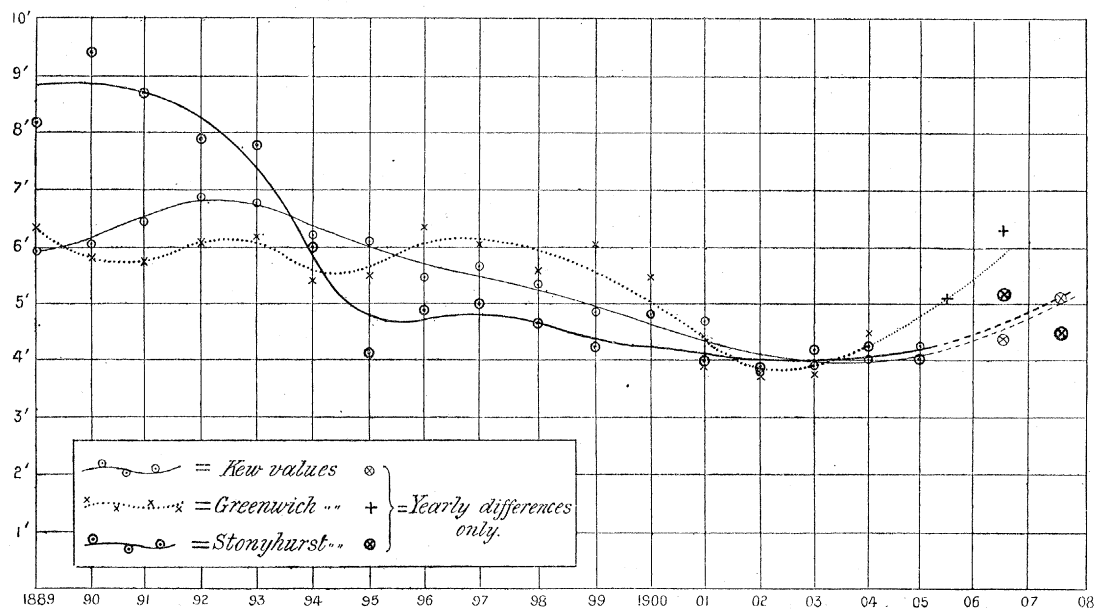

Fig. 1. Curves of mean annual decrease of Declination at Kew, Greenwich, and Stonyhurst (derived from quinquennial means).
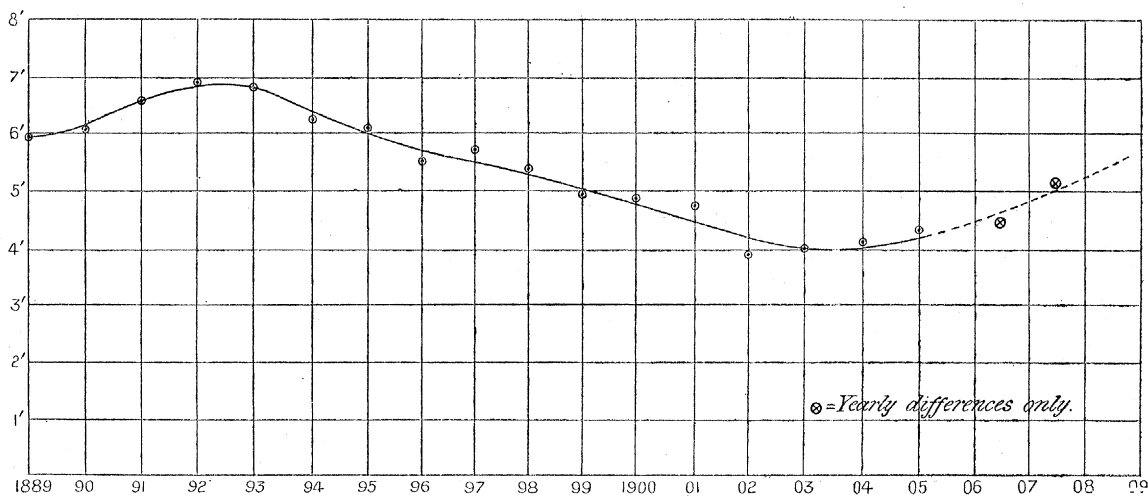

Fig. 2. Curve of mean annual decrease of Declination at Kew (derived from quinquennial means).
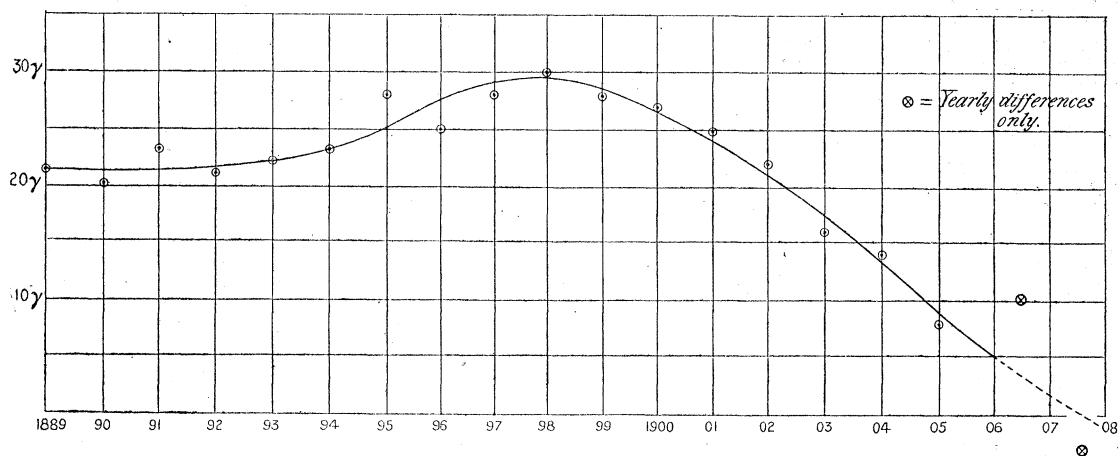
Fig. 3.   Curve of mean annual increase of Horizontal Force at Kew
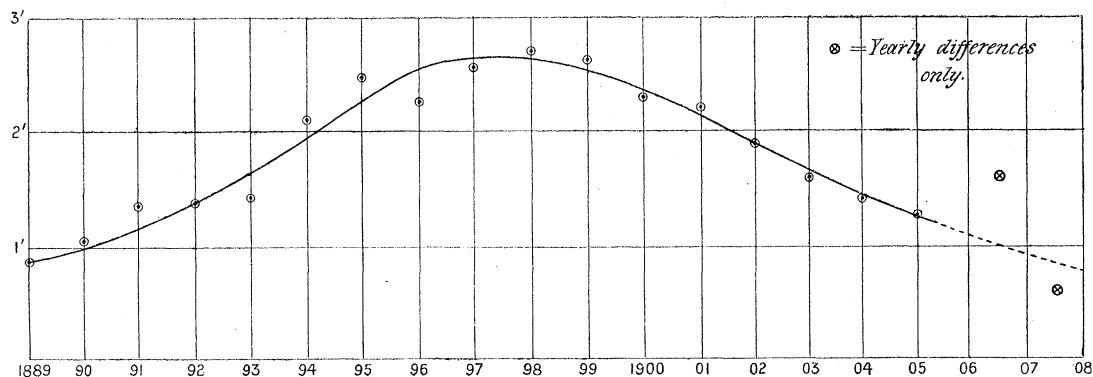(derived from quinquennial means).

Fig. 4.   Curve of mean annual decrease of Inclination at Kew
(derived from quinquennial means).

Comparison of Declination Values Observed at Sea with those on Shore.

To compare the values of Declination at sea with those observed on shore, H.M. ships "Research" (Captain M. H. SMYTH, R.N.) and "Triton" (Captain W. PUDSEY-DAWSON, R.N.) were instructed to obtain the values of the Declination by "swinging ship" in deep water in the vicinity of the shore stations.

The vessels were swung turning to starboard and to port and a mean of the results accepted as the value of the Declination.

These results have not been corrected for diurnal variation, but allowance has been made for secular change to reduce them to epoch 1st January, 1907.

An allowance in each case has been made for the difference of position from shore station, such allowance having been derived from a consideration of the values shown by the mean lines of equal Declination on the Admiralty charts of equal Declination.

The results, which cannot be considered to a closer degree of accuracy than $\pm 10'$, are given in Table IV.

The comparison with the values deduced from observations at the nearest shore station is given in Table V.

The main feature which this comparison brings out is that the sea values on the East Coast come out generally greater, and on the West Coast generally less, than the corresponding value deduced from observations on shore.

The differences appear to be slightly greater in the Northern latitudes.

It is intended to investigate further the source of this difference. Meantime, for navigational purposes, the values as found at sea have been accepted, and they are, in so far as the English Channel is concerned, corroborated by results from other vessels.

The original records of the observations here discussed, as well as charts showing the exact positions of the shore stations, are retained in the Compass Branch of the Hydrographic Department of the Admiralty.

TABLE III.—Comparison of Secular Change.

Station.	1. Interval in years.	2. D. Mean annual decrease. At station.	3. At Kew.	4. Difference from Kew.	5. H. Mean annual increase. At station.	6. At Kew.	7. Difference from Kew.	8. θ. Mean annual decrease. At station.	9. At Kew.	10. Difference from Kew.	11. V. Mean annual decrease, 1891 to 1907. At station.	12. At Kew.	13. Difference from Kew.
		′	′	′	γ	γ	γ	′	′	′	γ	γ	γ
Weymouth	21	5·5	5·2	+0·3	22	21	+1	1·9	1·7	+0·2	21	22	−1
Harwich	21	5·1	5·2	−0·1	19	21	−2	1·5	1·7	−0·2	13	22	−9
Dublin	21	5·4	5·2	+0·2	22	21	+1	2·0	1·7	+0·3	32	22	+10
Great Grimsby	16	5·4	4·9	+0·5	19	21	−2	1·5	2·0	−0·5	10	22	−12
Milford {	21	5·7	5·2	+0·5	20	21	−1	1·5	1·7	−0·2	14	22	−8
{	16	4·9	4·9	0·0	19	21	−2	1·7	2·0	−0·3			
Sunderland	16	4·4	4·9	−0·5	16	21	−5	1·4	2·0	−0·6	13	22	−9
Stranraer	21	5·8	5·2	+0·6	19	21	−2	1·5	1·7	−0·2	14	22	−8
Letterkenny	16	5·3	4·9	+0·4	19	21	−2	1·4	2·0	−0·6	13	22	−9
Loch Melfort	16	5·3	4·9	+0·4	20	21	−1	1·7	2·0	−0·3	14	22	−8
Stonehaven	16	5·3	4·9	+0·4	15	21	−6	1·3	2·0	−0·7	13	22	−9
Tanera Mor*	16	5·2	4·9	+0·3	17	21	−4	1·0	2·0	−1·0	−6	22	−28
Kirkwall	21	6·6	5·2	+1·4	16	21	−5	1·1	1·7	−0·6	11	22	−11

* See footnote, p. 236.

TABLE IV.—Declination Results from Swinging Ship at Sea.

Date.	Latitude.	Longitude.	Greenwich mean time of observations.	Declination.	Observer.
1907	° ′	* ° ′	h. m.	° ′	
10 May	51 55 N.	1 48 E.	5 53 p.m.	15 33 W.	W. P.-D.
16 ,, ...	54 40	1 10 W.	5 16 a.m.	16 39	,,
26 ,, ...	57 0	1 50	5 39 p.m.	18 45	,,
9 September	58 50	2 40	4 58 ,,	19 23	,,
19 April	50 29	2 32	7 42 a.m.	16 35	M. H. S.
22 ,, ...	50 27	2 28	6 10 p.m.	16 40	,,
1 May	51 41	5 10	6 42 a.m.	17 47	,,
13 ,, ...	53 21	5 51	7 10 ,,	19 7	,,
13 ,, ...	53 26	5 18	5 32 p.m.	18 34	,,
15 ,, ...	55 30	7 35	6 24 ,,	20 53	,,
17 ,, ...	56 10	6 0	6 40 a.m.	20 39	,,
14 October	57 57	5 23	—	19 21	,,
17 ,, ...	57 57	5 23	—	19 9	,,

TABLE V.—Comparison of Declination Values Observed at Sea with those from Observations made on Shore.

Date.	Latitude, longitude.	Declination reduced to epoch 1st January, 1907.	Shore station referred to.	Deduced corresponding value at shore station.	Value at shore station from observations on shore.	Difference from shore value.	Observer.
1907	° ′	° ′		° ′	° ′	° ′	
10 May	51 55 N. 1 48 E.	15 35 W.	Harwich	15 52	15 32	+ 0 20	W. P.-D.
16 ,, ...	54 50 N. 1 10 W.	16 41	Sunderland	16 50	17 30	− 0 40	,,
26 ,, ...	57 0 N. 1 50 W.	18 47	Stonehaven	19 5	18 20	+ 0 45	,,
9 September .	58 50 N. 2 40 W.	19 28	Kirkwall	19 28	19 10	+ 0 18	,,
19 April . . .	50 29 N. 2 32 W.	16 37	Weymouth	16 37	16 51	− 0 14	M. H. S.
22 ,, . . .	50 27 N. 2 28 W.	16 42	,,	16 42	16 51	− 0 9	,,
1 May . . .	51 41 N. 5 10 W.	17 49	Milford	17 43	18 9	− 0 26	,,
13 ,, . . .	53 21 N. 5 51 W.	19 9	Dublin	19 21	19 47	− 0 26	,,
13 ,, . . .	53 26 N. 5 18 W.	18 36	,,	19 3	19 47	− 0 44	,,
15 ,, . . .	54 0 N. 3 36 W.	18 3	Stranraer	19 3	19 35	− 0 32	,,
16 ,, . . .	55 30 N. 7 35 W.	20 55	Letterkenny	20 50	20 59	− 0 9	,,
17 ,, . . .	56 10 N. 6 0 W.	20 41	Loch Melfort	20 27	19 51	+ 0 36	,,
14 October . .	57 57 N. 5 23 W.	19 26	Tanera Mor*	19 31	20 38	− 1 7	,,
17 ,, . .	57 57 N. 5 23 W.	19 13	,,	19 19	20 38	− 1 19	,,

* See footnote p. 236.