XIV. *On the present amount of Westerly Magnetic Declination [Variation of the Compass] on the Coast of Great Britain, and its Annual changes. By Staff Captain* Frederick J. Evans, *R.N., F.R.S., Hydrographical Department, Admiralty, in charge of Magnetic Department*.*

Received June 15,—Read June 20, 1872.

From the rapid decrease in late years of the amount of Westerly Magnetic Declination over the whole area of the United Kingdom and the adjacent seas, the attention of the Hydrographic Department of the Admiralty has been constantly directed to this interesting physical fact as one specially affecting coast navigation and the accuracy of compass-bearings derived from the current charts.

The duties of Her Majesty's Surveying-vessels engaged on our own shores having within the last few years included districts embracing nearly the whole extent of coast-line, the opportunities thus afforded for a careful determination of the magnetic declination at widely spread and favourable localities were, under the direction of Admiral Richards, C.B., F.R.S., the Hydrographer of the Admiralty, taken advantage of, and suitable instruments furnished to the Commanding Officers from the Admiralty Compass Department.

Experience has shown that the accurate determination of the magnetic declination requires very careful manipulation and attention to instrumental details, and especially so if observed by the suspended collimator magnet, or by the reflecting apparatus devised by Dr. Lloyd and employed by the late Mr. Welsh in his Magnetic Survey of Scotland, in the years 1857–58, the account of which will be found in the Report of the British Association for the Advancement of Science for 1859.

Partly from these considerations and from the time required in the use of such delicate instruments, instead of them the well-known Admiralty Standard Compass was in general employed, supplemented occasionally with a Kater's Azimuth Compass of superior construction. Every precaution was adopted to ensure the accuracy of the several adjustments of these instruments before they left the Admiralty Compass Observatory (now established in Her Majesty's Victualling Yard at Deptford) prior to the annual resumption of the duties of the surveying-vessels, as well as in the re-examination of their errors on return from the season operations.

The most extended of the series of observations recorded in this paper were made by Staff Captain E. K. Calver in Her Majesty's Ship 'Porcupine,' assisted by Staff Commander George H. Inskip; they include Stornoway in the Hebrides, Lerwick in the

* Communicated with the sanction of the Lords Commissioners of the Admiralty.

Shetland Islands, and the N. and N.E. coasts of Scotland, the eastern coast of England from Holy Island to the North Foreland, and the N.W. and N.E. coasts of Ireland. The final results are generally the mean of two and sometimes three compasses, the individual observations having been made on several azimuths round the horizon, the true or astronomical bearings of the distant objects employed being obtained by an altitude azimuth instrument or theodolite of suitable size and telescopic power.

The observations on the west coast of Scotland were made by Captain (now Admiral) Otter with an Adie's Variation Instrument, in which three separate reversible needles were employed. The remaining declinations recorded, to which the observers names are appended, have received equal care in their determination with those above described.

With the exception of a few stations, chiefly on the west coast of Scotland, for which the true or astronomical meridian had been furnished to the Admiralty Surveyors from the Ordnance Survey Office at Southampton, the astronomical meridian to which all the magnetic bearings were referred by the several observers was generally determined in the following manner.

With an azimuth and altitude instrument or the large class of theodolite employed in the Admiralty Coast Surveys (with azimuth circles of 5 to 6 inches diameter),—the zero of which was set to some well-defined object,—the sun's exact altitude, together with the time of its centre passing the middle wire of the telescope, were noted, as also the reading of the azimuthal circle. With the exact latitude and longitude as obtained from data furnished by the Ordnance Survey Office, the sun's astronomical bearing and also that of the zero-point of the instrument, together with the terrestrial object to which it was directed, were thus derived, by two separate methods, from well-known formulæ. Azimuthal angles were then measured from the zero object to five or six well-defined landmarks, equally distributed, where possible, round the horizon; and these angles being referred to the astronomical bearing of the zero object, the astronomical bearings of the several landmarks from the instrument were thus known.

The azimuth compass was now placed in the exact position of the azimuth and altitude instrument, and its sight-vanes directed successively to the several landmarks round the horizon, and their magnetic bearings observed, the mean value of the several differences between the magnetical and astronomical bearings being taken for the magnetic declination [or variation of the compass] at the station.

The observations have been finally reduced to the 1st January, 1872. For this purpose an arbitrary value (an assumed average free from diurnal change) has been assigned for the magnetic declination at Greenwich Observatory for that date, namely 19° 40′ W. The differences between this assigned value and the recorded declination at Greenwich Observatory at the exact time * when the several observations were made on the coasts have been applied to the latter as corrections, and will be found detailed in the tabular

* The Greenwich Magnetical Observations are published to 1868, and from this source the corrections to that date have been obtained. For subsequent comparative values I am indebted to the Astronomer Royal and Mr. Glaisher, F.R.S., in charge of the Magnetic Department.

abstract as the secular change. These corrections, though not strictly accurate, as will be hereafter seen, from the unequal values of the annual changes of the magnetic declination on the several coasts of the United Kingdom, are nevertheless far within the limits of the probable errors of the observations themselves, and may therefore, I apprehend, be safely adopted as bringing the several observations forward to one common epoch, as well as clearing them from diurnal and other inequalities.

The results thus brought to one epoch were placed on a Mercator's Chart of the British Islands, and the lines of equal declination for each degree graphically drawn through the several values. In this delineation of the lines of equal value I was greatly assisted, both in the determination of their direction and the slight amount of necessary curvature, by numerous observations of the magnetic declination made in neighbouring countries and in the adjacent seas extending to the Arctic Ocean, which cannot be introduced in the appended Chart, but which had been used in the preparation of a Magnetic Variation Chart of the World, published by the Admiralty in 1871.

The procedure here adopted is, under the conditions of so extended an area and limited number of observations, perhaps better adapted for a truthful representation of the Isogonic lines than their calculation according to the usual method, where the differences of the values of the magnetic elements are linear functions of the differences of latitude and longitude, and accordingly straight lines.

From the records of the fixed Magnetic Observatories in this and adjacent countries, it is now certain that the annual change, *i. e.* a decrease of westerly declination, is gradually accelerating, and in some localities notably so within the last ten or fifteen years:—

At Brussels*, between 1850 and 1860, the mean annual decrease was 5′·38; between 1860 and 1868 it was 8′·17.

In Norway, at Christiania†,

between 1850 and 1855	the annual decrease	=	8′·45
1855 „ 1860	„	=	9·48
1860 „ 1865	„	=	10·52

At Paris‡,

between 1825 and 1858	„	=	5·0
1858 „ 1868·7	„	=	9·6

The annual change of the Westerly Declination at the well-known Magnetic Obser-

* See 'Notices Extraites de l'Annuaire de l'Observatoire Royal de Bruxelles' for 1869, by the Director, A. Quetelet, from which the following is extracted for the purpose of the text:—

	h		° ′	Annual change. ′ ′
1850, 12th April,	10½ A.M.,	observed W. Declination	20 25·7	53·8=5·38
1860, 4th „	1¼ P.M.	„ „	19 31·9	
1868, 1st „	Noon	„ „	18 26·5	65·4=8·17

† See 'Notices Extraites de l'Annuaire de l'Observatoire Royal de Bruxelles' for 1864, in a letter from M. Hansteen to M. A. Quetelet.

‡ See Phil. Trans. for 1870, p. 47, "Magnetic Survey of West of France," by the Rev. S. J. Perry.

vatories of Greenwich, Kew, and Stonyhurst College in recent years will be seen from the following abstract. The determinations at Greenwich have been extracted from communications of the Astronomer Royal,—those prior to 1858 from contributions to the Nautical Magazine; subsequent to that year from the Greenwich Magnetical Observations and the Annual Reports made to the Board of Visitors.

The Kew results have been obtained through the kindness of the Observatory Superintendent, SAMUEL JEFFERY, Esq.; and those from Stonyhurst College from the Meteorological and Magnetical Observations published annually.

Greenwich Observatory. Lat. 51° 28′ 38″ N. Long. $0^h\ 0^m\ 0^s$.

	Mean Westerly declination.	Difference.	Annual decrease.
	° ′	′	′
1842	23 14·5	50·2	6·27
1850	22 24·3	36·3	7·26
1855	21 48·0	33·7	6·74
1860	21 14·3	41·6	8·32
1865	20 32·7	47·7	7·95
1871	19 45·0		

Kew Observatory. Lat. 51° 28′ 6″ N. Long. 0° 18′ 47″ W.

1858	21 54·1	14·2	7·10
1860	21 39·9	40·9	8·18
1865	20 50·0	48·5	8·08
1871	20 10·5		

Stonyhurst College Observatory. Lat. 53° 50′ 40″ N. Long. 2° 28′ 8″ W.

The observations in my possession made at this Observatory do not extend further back than 1865; as the Declination is observed monthly under nearly similar conditions in each year, I have preferred adopting the comparative monthly results for 1865 and 1871, to the mean annual values for those years as appended to the Observatory Reports.

			Difference.	Annual decrease.	
		° ′	′	′	
1865 and 1871.	January	22 31·4 / 21 48·1	43·3	7·22	Mean value. ′ 7·71
	February	22 31·2 / 21 59·3	31·9	5·32	
	March	22 22·5 / 21 38·1	44·4	7·40	
	April	22 16·4 / 21 35·6	40·8	6·80	
	May	22 21·2 / 21 37·3	43·9	7·32	
	June	22 18·7 / 21 37·3	41·4	6·90	
	July	22 24·1 / 21 23·6	60·5	10·08	
	August	22 19·2 / 21 37·5	41·7	6·95	
	September	22 30·3 / 21 35·7	54·6	9·10	
	October	22 23·0 / 21 35·5	47·5	7·92	
	November	22 27·5 / 21 32·5	55·0	9·17	
	December	22 21·2 / 21 31·5	49·7	8·28	

The accordance in the values of the annual change for the interval 1865–71 at the three observatories is very satisfactory.

	′
Greenwich	7·95
Kew	8·08
Stonyhurst	7·71

From former investigations on this subject of the secular change of magnetic declination* I was induced to consider that in the area included by the shores of the United Kingdom, the change was greater on its eastern than on its western side. A comparison of the lines of equal declination, as given on the annexed Chart (Plate XLVI.) for the Epoch January 1, 1872, with those given in the Phil. Trans. of 1870 for the Epoch 1842·5, by General Sir EDWARD SABINE, late President of the RoyalSociety, confirms the opinion I had entertained, as also that in the higher parallels of latitude of this area the change is greater than in the lower,—thus incidentally confirming the larger values found at Christiania by M. HANSTEEN as compared with those observed at Brussels by M. QUETELET.

I have appended the details of this comparison of the lines of equal declination for the Epochs 1842·5 and 1872; but the following abstract brings more clearly to view the general character of the changes in the several geographical limits during the past thirty (29·5) years:—

	Annual decrease. ′
Shetland Islands and N.E. coasts of Scotland, between 60th and 56th parallels	8·24
East coast of England, 56th and 51st parallels	7·78
South coast of England, 51st and 49th parallels. [Dungeness to Scilly, with the Channel Islands.]	7·34
Greenwich Observatory	7·27
Irish Channel, between 52nd and 54th parallels	7·10
Ireland, S.W., West, and N.W. coasts, 52nd to 55th parallels	6·26
Hebrides and West coast of Scotland, 56th to 58th parallels	6·85

Included in the Stations given in this paper at which the magnetic declination has been observed within the last six years, are several at which observations had been previously made either by Mr. WELSH in his Magnetic Survey of Scotland, 1857–58 (see Report of the British Association for the Advancement of Science, 1859), and which are reduced by corresponding observations at Kew to 1st January, 1858, or by Surveying Officers of H.M. Navy (see Report of the British Association for 1861, pp. 273–278), which observations are reduced to the 1st January, 1857, by similar corresponding Kew observations.

We are thus enabled to obtain an approximate value of the amount of annual change for widely diverse localities in the United Kingdom, and to further test the recent acceleration observed at Greenwich and Kew.

* See Declination Map, British Islands, for the mean Epoch of 1st January, 1857, in Report on the Repetition of the Magnetic Survey of England (Report of the British Association for the Advancement of Science, 1861).

As the recent observations available for this purpose were made between the years 1866 and 1870, it was not desirable, on account of the large interval between those years and the Epoch adopted throughout (1872), to employ the results for that Epoch; each observation has therefore been corrected by an amount which would reduce the declination to a mean value for the month of the date actually observed; this correction has been obtained from the Greenwich Observatory Magnetical Tables for 1868, pages iv & v, by taking the differences between the mean Westerly declination in each month as deduced from the mean of the mean Hourly declination (Table III.), from the mean Monthly determination of the Westerly declination at every hour of the day, Greenwich mean solar time (Table II.)*.

* For the British Islands, with the present average amount of Annual change (eight to ten minutes), these will be found useful Tables to obtain the mean value of the magnetic declination for the month when observed at any hour of the day.

The following Table, which is deduced from Tables II. and III. alluded to in the text, has been constructed as it presents at sight the required correction, *i. e.* the amount in minutes of arc to be applied to the Westerly declination as observed within the limits of the British Islands at any hour of the day, Greenwich mean solar time, in order to obtain the mean value of the Westerly declination for the month. + sign denotes the amount in excess above the mean monthly value, and must be subtracted from the observed declination; — sign the amount in defect, and therefore to be added to the observed declination.

Greenwich mean solar time.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Greenwich mean solar time.
h	′	′	′	′	′	′	′	′	′	′	′	′	h
0	+2·0	+2·8	+4·6	+5·9	+5·0	+4·4	+4·6	+6·2	+6·8	+5·4	+3·6	+3·1	0
1	+2·8	+3·8	+6·4	+8·0	+6·0	+5·5	+6·1	+7·5	+6·6	+5·9	+4·1	+3·5	1
2	+2·4	+4·1	+6·3	+7·8	+5·4	+5·9	+6·5	+7·0	+5·9	+5·1	+3·2	+3·4	2
3	+1·6	+3·4	+4·9	+5·5	+4·4	+5·1	+5·9	+5·5	+3·7	+4·0	+2·1	+2·8	3
4	+0·8	+2·0	+3·2	+3·5	+2·9	+4·4	+4·8	+2·8	+2·2	+2·0	+1·3	+2·3	4
5	+0·6	+0·6	+0·6	+1·7	+1·8	+3·1	+3·1	+1·3	0·0	+0·6	+0·7	+1·3	5
6	+0·5	+0·1	−0·1	+0·5	+0·7	+1·9	+1·5	+0·3	−0·8	−0·2	+0·1	+0·3	6
7	−0·1	−0·3	−0·6	−0·3	−0·1	+0·3	+0·2	−0·3	−1·0	+0·1	−0·4	−0·2	7
8	−0·5	−0·6	−1·4	−0·6	−0·7	−0·6	−0·3	−0·9	−2·4	−1·7	−0·9	−1·5	8
9	−1·9	−2·3	−2·1	−1·1	−1·0	−0·2	−1·1	−1·2	−2·1	−2·3	−2·2	−2·2	9
10	−2·9	−2·9	−1·5	−1·7	−1·1	−0·8	−1·4	−2·4	−2·3	−2·5	−2·8	−2·4	10
11	−2·4	−3·3	−1·4	−1·9	−2·0	−1·4	−1·4	−2·5	−2·4	−2·4	−2·4	−2·2	11
12	−2·0	−3·1	−1·3	−2·6	−1·9	−1·8	−1·6	−2·1	−2·2	−2·6	−1·9	−2·1	12
13	−1·1	−1·9	−1·6	−2·9	−1·9	−1·4	−2·3	−1·9	−2·2	−2·2	−1·6	−1·9	13
14	−0·7	−1·4	−2·0	−3·2	−2·3	−2·1	−2·9	−1·4	−1·8	−1·9	−1·3	−1·4	14
15	−0·2	−1·2	−3·1	−3·1	−2·4	−2·1	−2·7	−2·2	−1·7	−1·1	−1·0	−1·2	15
16	−0·5	−0·9	−2·3	−2·2	−2·7	−3·0	−3·4	−2·5	−1·8	−1·5	−0·4	−1·1	16
17	+0·1	−0·2	−1·7	−2·0	−2·6	−3·7	−4·0	−3·3	−2·1	−1·0	−0·8	−1·2	17
18	+0·1	+0·3	−1·4	−2·7	−3·1	−3·9	−4·2	−3·9	−1·8	−0·9	−0·9	−0·7	18
19	0·0	+0·2	−1·5	−3·8	−3·2	−4·1	−3·8	−4·2	−2·0	−1·5	−0·6	−0·4	19
20	−0·1	−0·9	−2·7	−4·4	−3·3	−3·9	−3·4	−3·4	−2·0	−2·2	−0·9	−0·4	20
21	−0·4	−1·0	−2·7	−3·1	−1·9	−3·0	−2·4	−2·0	−1·0	−2·0	−0·5	−0·4	21
22	+0·5	+0·5	−0·7	−0·4	+0·1	−0·4	−0·6	+0·5	+1·1	+0·2	+0·7	+0·3	22
23	+1·4	+2·0	+2·2	+3·0	+2·8	+2·4	+1·6	+3·4	+4·0	+3·1	+2·8	+1·7	23
0	+2·0	+2·8	+4·6	+5·9	+5·0	+4·4	+4·6	+6·2	+6·8	+5·4	+3·6	+3·1	0

					Declination West. °	Diff.	Annual change.	Mean value of annual change.
Shetland Islands and N.E. Coast of Scotland	Shetland Islands (Lerwick) ...	Welsh	1858·0	.....	25 17·5	150·5	=12·86	11·21
		Calver	1869·7	.....	22 47·0			
	Thurso.....	Otter	1857·0	.....	26 01·0	76·0	= 7·90	
		Calver	1866·6	.....	24 45·0			
	Thurso (*continued*)	Welsh	1858·0	.....	26 30·3	105·3	=12·24	
		Calver	1866·6	.....	24 45·0			
	Wick	Welsh	1858·0	.....	26 03·7	101·7	=11·83	
		Calver	1866·6	.....	24 22·0			
East Coast of England	Bridlington	Ross.....	1857·0	.....	22 43·6	106·6	=	10·35
		Calver	1867·3	.....	20 57·0			
South Coast of England.....	Plymouth	Cox	1857·0	.....	23 29·7	80·7	=	7·87
		Mayes	1867·25	.....	22 09·0			
Ireland, S.W. Coast	Berehaven	Church ...	1857·0	.....	26 42·5	34·5	= 3·63	6·58
		Moriarty ...	1866·5	.....	26 08·0			
	Valentia	Edye	1857·0	.....	27 39·0	126·5	= 9·54	
		Kerr.....	1870·25	.....	25 32·5			
Scotland, West and N.W. Coasts*	Oban (Dunolly Hill).....	Bedford ...	1857·0	.....	27 00·6	67·6	= 6·93	9·55
		Otter	1866·75	.....	25 53·0			
	Oban (Kerrera) ...	Bedford ...	1857·0	.....	26 39·0	97·0	=10·00	
		Otter	1866·7	.....	25 02·0			
	Kyle Akin	Otter	1857·0	.....	27 26·0	86·0	= 9·05	
		Otter	1866·5	.....	26 0·0			
	Loch Eribol	Otter	1857·0	.....	27 11·5	117·5	=12·24	
		Calver	1866·6	.....	25 14·0			

It will be here observed that the proportional amount of change in the several geographical districts agrees with that observed for the longer interval of 29·5 years.

* Stornoway in the Hebrides has not been included, as the stations where the observations were made at the two dates are some distance apart, and much local disturbance exists in the neighbourhood. There appears, indeed, on the western coast of Scotland generally and on many of the outlying islands, to be great difficulty in selecting a position to avoid local disturbances from basaltic and other eruptive rocks. Compass Hill at Canna is a notable example.

Coasts of Scotland.

Stations.	Lat. N.	Long. W.	Date.	Greenwich mean time of observation.	Declination, West.			Observers.
					Observed.	Secular change.	Corrected.	
	° ′	° ′		h m	° ′	′	° ′	
Shetland Islands, Lerwick (near Fort Charlotte)	60 9	1 9	1869, Aug. 30	9 20 A.M.	22 46	21	22 25	Calver.
Loch Eribol, Hoan Island	58 34	4 40	1866, July 25	1 30 P.M.	25 20	50	24 30	,,
Kyle of Tongue, Rabbit Island	58 32	4 23	,, ,, 25	4 0 P.M.	24 57	49	24 8	,,
Port Skerra, East Rock	58 34	3 56	,, ,, 25	7 0 P.M.	24 28	48	23 40	,,
Thurso, Scrabster, near Quay	58 37	3 32	,, ,, 26	5 0 A.M.	24 41	44	23 57	,,
Freswick Bay, Skerra Head	58 36	3 3	,, ,, 26	9 0 A.M.	24 12	40	23 32	,,
Wick, South Head	58 26	3 4	,, ,, 26	11 35 A.M.	24 25	50	23 35	,,
Hemsdale, near Castle Wall	58 7	3 39	,, ,, 26	7 0 P.M.	24 16	47	23 29	,,
Tarbet Ness, Wilkie Haven	57 52	3 47	,, ,, 27	8 0 A.M.	24 7	42	23 25	,,
Burg Head, Coast-Guard Station	57 42	3 30	,, ,, 27	11 30 A.M.	23 53	48	23 5	,,
Knock Head	57 41	2 35	,, ,, 28	8 25 A.M.	23 56	43	23 13	,,
Fraserburgh, near Lighthouse	57 42	2 0	,, ,, 28	4 30 P.M.	23 16	48	22 28	,,
Peterhead, near South Pier	57 30	1 46	,, ,, 31	8 35 A.M.	23 0	43	22 17	,,
Aberdeen, side of River Dee	57 8	2 5	,, Aug. 1	9 0 A.M.	23 7	49	22 18	° ′ 22 19
			,, ,,	8 0 P.M.	23 6	46	22 20	,,
Montrose, near Low Lighthouse	56 42	2 27	,, ,, 3	5 10 P.M.	23 7	45	22 22	,,
River Tay, Buddon Ness	56 28	2 45	,, Sept. 4	7 45 A.M.	23 0	42	22 18	,,
Granton, Field near Pier	55 59	3 13	,, ,, 1	4 15 P.M.	23 30	48	22 42	22 42·5
			,, ,, 3	9 25 A.M.	23 28	45	22 43	,,
Edinburgh, Royal Observatory, Calton Hill	55 57	3 11	1871, October	.....	22 46*	2	22 44	
Oban, Dunolly Hill	56 25	5 27	1866, Oct. 2	Noon — 4½ P.M.	25 58†	49	25 9	Otter.
Kerrera, Ardintrave Hill	56 25	5 30	1866, Aug. 28	0 30 — 4 P.M.	25 7†	48	24 19	,,
Kyle Akin, plot W. of Inn	57 16	5 44	,, June 20	1 50 P.M.	26 6†	53	25 13	,,
Hebrides (South Uist):								
Loch Boisdale	57 9	7 18	1862, Sept.	0 30 P.M.	26 58†	77	25 41	
West Fish Island	57 9	7 18	,, ,,	10 30 A.M.	27 3†	73	25 50	25 52 ,,
West Coast Sand hill	57 9	7 22	,, ,, 11	3 30 P.M.	27 17†	73	26 4	
Stornoway, Coal Island	58 12	6 23	1869, Sept. 11	10 0 A.M.	24 56	23	24 33	Calver.

* Edinburgh Astronomical Observations, vol. xiii. plate 10.

† By Adie's Variation Instrument, mean of three needles.

Coasts of England.

Stations.	Lat. N.	Long. W. +E.	Date.	Greenwich mean time of observation.	Declination, West.			Observers.
					Observed.	Secular change.	Corrected.	
	° ′	° ′		h m	° ′	′	° ′	
Holy Island, Ross Links	55 39	1 47	1866, Sept. 6	7 35 A.M.	22 20	43	21 37	Calver.
Warkworth, Coquet R. entrance	55 20	1 34	„ „ 6	4 25 P.M.	22 2	45	21 17	„
Sunderland, Roker	54 56	1 22	1867, April 15	8 40 A.M.	21 40	38	21 2	„
Seaton Snook	54 38	1 10	„ „ 17	8 30 A.M.	21 31	39	20 52	„
Bridlington Quay, near S. pier	54 5	0 12	„ „ 19	8 45 A.M.	20 54	39	20 15	„
Spurn Point	53 35	0 7+	1866, Sept. 18	7 5 A.M.	20 46	46	20 0	
			„ „ 24	8 50 A.M.	20 45	43	20 2	19° 59′ „
			„ „ 27	5 5 P.M.	20 43	44	19 59	
			1867, May 10	10 0 A.M.	20 40	44	19 56	
Gibraltar Point	53 6	0 19+	„ „ 17	8 0 A.M.	20 16	38	19 38	
Lynn, West side of New Cut	52 45	0 23+	„ „ 25	10 45 A.M.	20 13	43	19 30	19 31 Calver.
			„ „ 27	8 0 A.M.	20 11	39	19 32	
Holkham Bay, on Sand Hill	52 58	0 49+	„ „ 29	7 30 A.M.	20 17	35	19 42	19 40·5 „
			„ „ 29	6 0 P.M.	20 19	40	19 39	
Cromer, near Lighthouse	52 55	1 19+	„ „ 30	6 0 P.M.	19 56	41	19 15	19 14·5 „
			„ „ 31	6 0 A.M.	19 51	37	19 14	
Winterton, on Sand Hill	52 43	1 42+	„ „ 31	5 0 P.M.	19 30	44	18 46	18 49·5 „
			„ June 7	8 0 A.M.	19 29	36	18 53	
Pakefield, on Cliff North of	52 27	1 44+	„ Aug. 30	8 20 A.M.	19 26	40	18 46	„
Orfordness, near High Lighthouse	52 5	1 34+	„ Sept. 20	9 45 A.M.	19 36	39	18 57	18 57 „
			„ „ 20	4 25 P.M.	19 40	43	18 57	
Harwich, Beacon Cliff	51 56	1 17+	„ „ 19	10 0 A.M.	19 39	37	19 02	19 01·5 „
			„ „ 19	5 0 P.M.	19 40	39	19 01	
Burnham, River Crouch	51 37	0 49+	„ „ 25	10 0 A.M.	19 45	42	19 03	19 02·5 „
			„ „ 25	5 45 P.M.	19 39	37	19 02	
Sheppey Island, Shellness	51 22	0 57+	„ „ 26	4 0 P.M.	19 36	41	18 55	18 56 „
			„ „ 27	9 15 A.M.	19 36	39	18 57	
North Foreland, near Obelisk	51 23	1 25+	„ „ 30	4 15 P.M.	19 19	40	18 39	18 38
			„ Oct. 2	9 0 A.M.	19 18	41	18 37	
Walmer, on beach	51 12	1 24+	1865, July 24	7 20 A.M.	19 59	52	19 07	Evans, Staff Captain, R.N.
Portsmouth, Southsea	50 47	1 5	1866, Dec. 27	3 10 P.M.	20 32	44	19 48	19 59 Mayes, Staff Commander, R.N.
	.....	.....	1867, July 20	4 25 P.M.	20 24	42	19 42	
Rat Island	50 48	1 6	1871, Sept. 9	5 0 P.M.	20 28	1	20 27	
Channel Islands. Alderney, near Windmill	49 42	2 13	1863, April 23	9 45 A.M.	21 18	66	20 12	
			„ „ 24	10 45 A.M.	21 17	71	20 06	
near E. end of Island	.....	.....	„ „ 23	11 40 A.M.	21 16	70	20 06	20 11·5 J. Richards, Staff Commander, R.N.
			„ „ 24	.....	21 9	72	19 57	
near W. end of Island	49 42	2 14	„ „ 23	10 45 A.M.	21 31	68	20 23	
			„ „ 24	12 15 A.M.	21 37	72	20 25	

Coasts of England (continued).

	Stations.	Lat. N.	Long. W.	Date.	Greenwich mean time of observation.	Declination, West. Observed.	Secular change.	Corrected.		Observers.
		° ′	° ′		h m	° ′	′	° ′	° ′	
Channel Islands.	Jersey, near Roselle Mill	49 14	2 3	1863, April 16	9 45 A.M.	21 23	70	20 13	20 16	J. Richards, Staff Commander, R.N.
	Boulez Guard-house	49 15	2 6	„ „ 16	0 20 P.M.	21 34	75	20 19		
	Guernsey, Castle Cornet	49 27	2 32	„ „ 11	10 50 A.M.	21 38	72	20 26	20 24	„
	Doyle column	49 26	2 32	„ „ 11	0 35 P.M.	21 36	76	20 20		
	Icart Barrack	49 25	2 34	„ „ 13	3 10 P.M.	21 37	71	20 26		
	Plymouth, Devonport	50 22	4 10	1866, Nov. 27	3 30 P.M.	22 18	43	21 35	21 28·5	Mayes.
	near Keyham Dockyard	50 23	4 11	1867, June 28	8 15 A.M.	21 58	36	21 22		
	Scilly Isles, Menewethan	49 57	6 15	1863, July 8	P.M.	23 14	71	22 3	22 01	G. Williams, Captain, R.N.
	Great Ganilly	.....	.....	„ Nov. 9	2 P.M.	23 14	65	22 9		
	St. Martin, at daymark	49 58	6 16	„ Aug. 27	P.M.	23 18	70	22 8		
	St. Mary, Newfoundland Point	49 55	6 17	„ Sept. 18	P.M.	23 56	70	22 46		
	Peninnis Point	49 54	6 18	„ Nov. 12	Noon.	23 17	65	22 12		
	Round	49 59	6 19	„ July 7	P.M.	23 6	72	21 54		
				„ Aug. 21	3 P.M.	23 9	71	21 58		
	St. Helens	49 58	6 19	„ „ 20	P.M.	22 45	68	21 37		
				„ Nov. 7	P.M.	22 49	64	21 45		
	Gugh	49 54	6 20	„ July 10	P.M.	23 15	68	22 7		
	St. Agnes, Horse Point	49 53	6 20	„ Sept. 17	11 30 A.M.	22 38	68	21 30		
	Oliver's Castle	49 58	6 21	„ Oct. 2	P.M.	22 55	67	21 48	22 03·6	Williams (*continued*).
	Samson	49 56	6 21	„ July 10	Noon.	23 26	72	22 14		
	Bryer, Watch Hill	49 57	6 21	„ Aug. 24	P.M.	23 22	69	22 13		
	Shipman Head	49 58	6 22	„ Sept. 29	P.M.	23 11	68	22 3		
	Annet	49 54	6 22	„ Aug. 14	P.M.	23 7	69	21 58		
				„ Sept. 11	P.M.	23 8	70	21 58		
	Meledgan	49 52	6 22	„ Oct. 22	3 30 P.M.	23 24	66	22 18		
	Minicarlo	49 56	6 23	„ Nov. 13	11 A.M.	22 52	64	21 48		
	Gorregan	49 52	6 23	„ Oct. 17	3 15 P.M.	23 6	63	22 3		
	Rosevear	49 52	6 24	„ „ 17	11 A.M.	23 21	65	22 16		
	Crebawethan	49 53	6 25	„ „ 17	1 P.M.	23 13	72	22 1		
	Milford Haven:									
	near Llanstadwell Church	51 42	4 58	1866, Dec. 20	1 30 P.M.	22 57	44	22 13	21 57	E. J. Bedford, Captain, R.N.
	Mount Pleasant	51 41	4 57	„ „ 19	Noon.	22 26	45	21 41		„
	Neyland	51 42	4 55	1871, Oct. 24	Noon.	22 8	11	21 57		J. Richards.
	Holyhead	53 19	4 37	„ Aug. 10	3 45 P.M.	22 58	7	22 51		„
	Fleetwood, Low Lighthouse	53 56	3 1	„ „ 11	4 0 P.M.	22 8	7	22 01		„
	Walney Island, Lighthouse	54 3	3 10	„ May 23	8 45 A.M.	22 20	3	22 17		„
	Stonyhurst Magnetic Observatory	53 51	2 28	1872 (1° 49′ difference from Greenwich)*				21 29		
	Kew Magnetic Observatory	51 28	0 19	1872 (0° 25′ difference from Greenwich)†				20 05		

* Mean of 7 years' comparison. † Mean of 14 years' comparison.

Coasts of Ireland.

Stations.	Lat. N.	Long. W.	Date.	Greenwich mean time of observation.	Declination, West.			Observers.
					Observed.	Secular change.	Corrected.	
	° ′	° ′		h m	° ′	′	° ′	
Belfast, near Abercorn Basin	54 36	5 55	1869, July 16	9 55 A.M.	24 15	22	23 53	Calver.
Kingston, Harbour, North pier	53 18	6 7	1871, Aug. 8	3 30 P.M.	23 31	4	23 27	J. Richards.
Arklow, Ovoca River (entrance)	52 47	6 9	,, ,, 5	4 10 P.M.	23 38	8	23 30	,,
Cahore Point	52 34	6 12	,, July 26	3 40 P.M.	23 21	5	23 16	,,
Wexford, South Bay, Carnsore cliff ...	52 15	6 20	,, ,, 31	6 50 A.M.	23 17	+8	23 25	,,
Berehaven :								
Dinish Island, highest part	51 39	9 51	1866, July 9	6 35 P.M.	26 09	50	25 19	° ′ 25 16
Bere Island, Palmer Point	51 39	9 47	,, ,, 11	5 50 A.M.	25 59	46	25 13	Moriarty, Staff Captain, R.N.
Valentia, Meteorological Observatory.	51 55	10 18	1868, Oct. 23–27	A.M. & P.M.	25 52	31	25 21	25 13·5 Rev. T. Kerr.
			1871, Sept. 18–30	,,	25 13	7	25 6	
Galway, on Green near Dock.....	53 16	9 3	1869, May 26	10 15 A.M.	25 18	25	24 53	24 56 Calver.
			,, June 9	4 0 P.M.	25 28	29	24 59	
Killibegs, Rough Point	54 38	8 26	,, ,, 23	10 20 A.M.	25 42	26	25 16	25 17 ,,
			,, ,, 26	7 20 P.M.	25 41	23	25 18	

Annual change of Westerly Declination on coasts of United Kingdom between the Epochs 1842·5 and 1872 [29·5 years], obtained by comparison with Sir Edward Sabine's Declination Map in Philosophical Transactions for 1870.

			°	Diff. °	Annual decrease. ′	Mean value.
Shetland Islands and N.E. Coasts of Scotland, between 60th and 56th parallels.	Lerwick	1842·5	27·20	4·45	= 9·06	8·24
		1872·0	22·75			
	Wick	1842·5	27·40	3·90	= 7·93	
		1872·0	23·50			
	Peterhead	1842·5	26·35	4·00	= 8·14	
		1872·0	22·35			
	St. Abbs	1842·5	25·85	3·85	= 7·83	
		1872·0	22·00			
East Coast of England, between 56th and 51st parallels.	Holy Island.....	1842·5	25·50	3·85	= 7·83	7·78
		1872·0	21·65			
	Flamboro' Head ...	1842·5	24·20	3·80	= 7·73	
		1872·0	20·40			
	Cromer	1842·5	23·10	3·80	= 7·73	
		1872·0	19·30			
	North Foreland ...	1842·5	22·65	3·80	= 7·73	
		1872·0	18·85			

Annual change of Westerly Declination (continued).

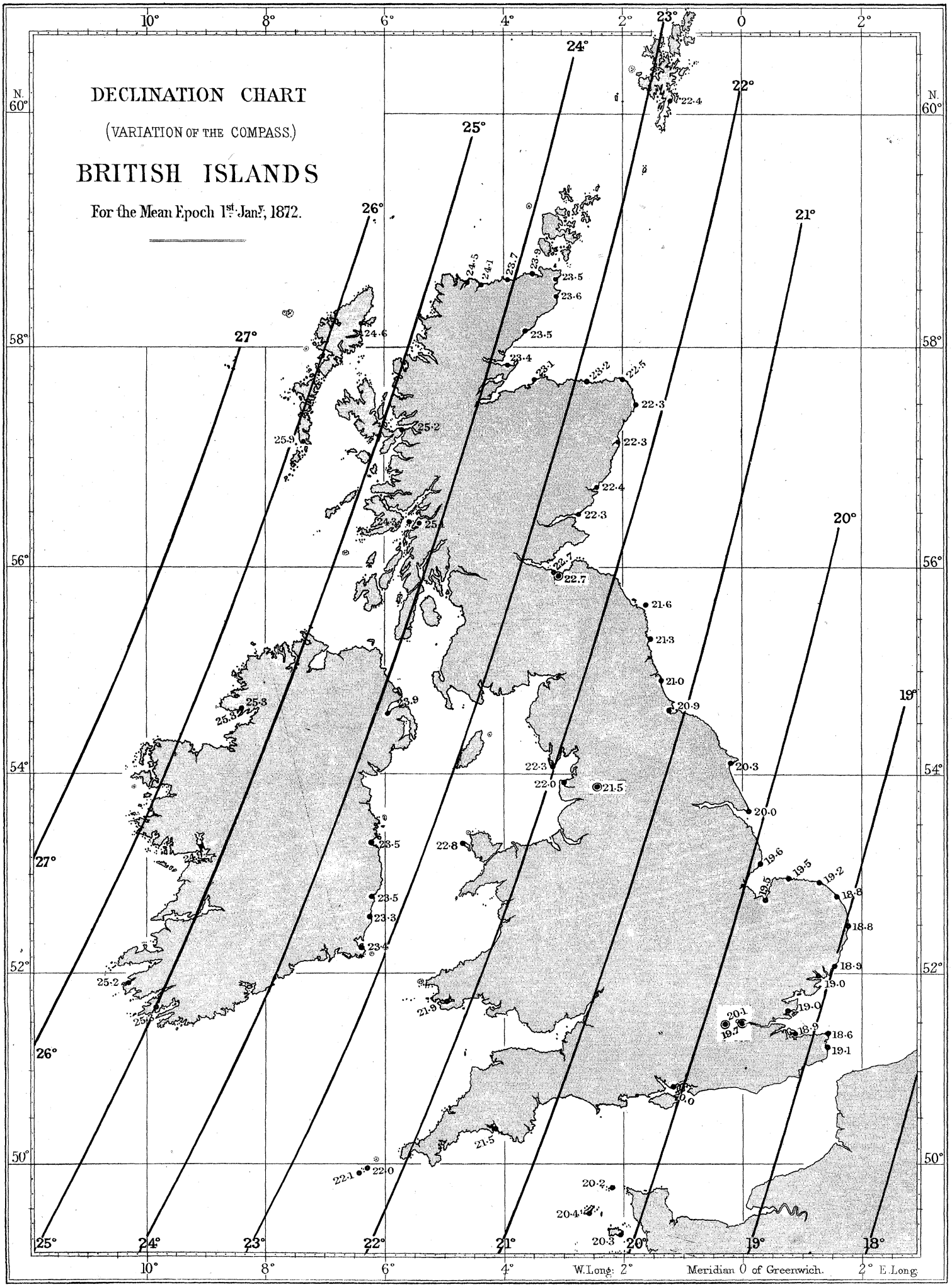
			°	Diff. °	Annual decrease. ′	Mean value.
South Coast of England, from Dungeness to Scilly, including Channel Islands, between 51st and 49th parallels.	Dungeness	1842·5	22·75	3·75	= 7·63	7·34
		1872·0	19·00			
	Portsmouth	1842·5	23·70	3·65	= 7·43	
		1872·0	20·05			
	Guernsey	1842·5	24·00	3·60	= 7·33	
		1872·0	20·40			
	Plymouth	1842·5	24·95	3·55	= 7·22	
		1872·0	21·40			
	Scilly Islands	1842·5	25·80	3·50	= 7·12	
		1872·0	22·30			
Irish Channel, between 52nd and 54th parallels.	Milford	1842·5	25·75	3·50	= 7·12	7·10
		1872·0	22·25			
	Wexford	1842·5	26·65	3·40	= 6·91	
		1872·0	23·25			
	Dublin	1842·5	27·00	3·45	= 7·02	
		1872·0	23·55			
	Holyhead	1842·5	26·20	3·55	= 7·22	
		1872·0	22·65			
	Calf of Man	1842·5	26·55	3·55	= 7·22	
		1872·0	23·00			
	Cantyre (Mull)	1842·5	27·50	3·50	= 7·12	
		1872·0	24·00			
Ireland, S.W., West, and N.W. Coasts: 52nd to 55th parallel.	Martin Head	1842·5	28·30	3·25	= 6·61	6·26
		1872·0	25·05			
	Sligo	1842·5	28·35	3·05	= 6·20	
		1872·0	25·30			
	Galway	1842·5	28·25	3·00	= 6·10	
		1872·0	25·25			
	Valentia	1842·5	28·30	2·95	= 6·00	
		1872·0	25·35			
	Cork	1842·5	27·50	3·15	= 6·40	
		1872·0	24·35			
Hebrides and West Coast of Scotland: 56th to 58th parallel.	West Coast of Islay	1842·5	28·00	3·40	= 6·91	6·85
		1872·0	24·60			
	Kyle Akin	1842·5	28·25	3·50	= 7·12	
		1872·0	24·75			
	West Coast, Outer Hebrides	1842·5	29·40	3·20	= 6·51	
		1872·0	26·20			

DECLINATION CHART

(VARIATION OF THE COMPASS.)

BRITISH ISLANDS

For the Mean Epoch 1st Jany, 1872.



Malby & Sons, Lith.