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DISTRIBUTION OF THE MAGNETIC DECLINATION IN THE UNITED STATES FOR JANUARY 1, 1915

WITH ISOGONIC CHART AND SECULAR CHANGE TABLES

BY

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DISTRIBUTION OF THE MAGNETIC DECLINATION IN THE UNITED STATES FOR JANUARY 1, 1915, WITH ISOGONIC CHART AND SECULAR CHANGE TABLES.

By DANIEL L. HAZARD, *Assistant Inspector of Magnetic Work.*

INTRODUCTION.

The plan for the magnetic survey of the United States which began in 1899 was laid down in Appendix 10, Report for 1899, as follows: "To make first a general magnetic survey of the country with stations about 30 to 40 miles apart, then, as opportunities present themselves, to add stations in the magnetically disturbed areas." In regions where the distribution of magnetism is fairly regular, comparatively few additional stations will be needed, while in magnetically disturbed areas the number of stations must be governed by the character and extent of the disturbance. The plan also contemplated observations at a sufficient number of "repeat" stations to furnish the data needed to refer the results to a common epoch. This plan has been followed with only slight modifications, and the work has reached the stage where the filling in is in progress. Observations have been made at a great majority of the county seats and a number of areas of marked local disturbance have been examined in more or less detail.

It is customary to represent graphically the results of a magnetic survey by means of isomagnetic charts, maps on which lines are drawn through places where the values of a particular magnetic element are the same. In the case of the magnetic declination or variation of compass, the map showing the lines of equal magnetic declination is called an isogonic chart. In the preparation of such a chart all of the results must be reduced to a common epoch by means of the secular-change data derived from the observations at "repeat" stations.

In order that the results as represented on the isogonic chart may be used for other dates than the epoch of the chart, secular change tables must be prepared based on the results of observations at repeat stations. Under present conditions it is impossible to predict with accuracy for even a few years in advance of observation what the secular change of the magnetic declination will be, and secular-change tables must therefore be revised and extended from time to time as additional data become available.

It is now four years since Special Publication No. 9, Distribution of the Magnetic Declination in the United States for January 1, 1910,

with Isogonic Chart and Secular Change Tables, was issued, and the supply is exhausted. During that time the results of observations at more than 1,000 new stations and 200 repeat stations in the United States and adjacent part of Canada have become available. The present publication contains an isogonic chart for the epoch January 1, 1915, and secular-change tables brought up to that date by means of the observations at repeat stations to the end of June, 1915.

AVAILABLE DATA.

At the beginning of the magnetic survey of the United States in 1899 results were available for about 1,000 stations in the United States and adjacent portions of other countries. By the end of 1906 this number had increased to about 4,000, in 1911 to 4,800, and in the construction of the present chart about 5,800 land values of declination have been used. A large majority of them are the results of observations by this Bureau to the end of June, 1915. In addition use has been made of results obtained by the United States Lake Survey in the United States and Canada; by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington in the United States, Canada, Mexico, Central America, and the West Indies; by observers of the National Observatory of Mexico; by Canadian officials; by Dr. L. A. Bauer in his magnetic survey of Maryland under the auspices of the Maryland Geological Survey; by Prof. F. E. Nipher in Missouri; at the expense of the "Bache Fund" of the National Academy of Sciences; by officers of the United States Navy in Mexico; and by United States Army engineers in exploratory surveys in the southwestern part of the country. With very few exceptions the observations have been made by experienced observers with approved instruments. For the extension of the isogonic lines over the adjacent waters, use has been made of the results of observations on the vessels of this Bureau and on the *Carnegie* of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. The results of observations to the end of 1906 were collected and published in United States Magnetic Tables and Magnetic Charts for 1905. The later results by this Bureau have been published year by year, and nearly all of the results by other institutions have been published in some form. All of the results on which the 1915 isogonic chart is based will be published collectively in the near future in United States Magnetic Tables and Magnetic Charts for 1915.

The following table gives a comparison of the number of declination results in each State used in the construction of the isogonic charts of 1905, 1910, and 1915, the number of repeat stations occupied between July 1, 1911, and June 30, 1915, and the density of distribution, as shown by the average number of square miles per station.

It will be seen that the average for the whole United States is one magnetic station for each 628 square miles, but this quantity varies greatly in different States, and to a less degree in different portions of a State. East of the Mississippi there is on the average one station for each 339 square miles, whereas west of that river there is only one station for each 959 square miles.

Distribution of declination results.

State.	Declination results.			Repeat stations, 1911-1916.	Area in square miles.	Square miles per station.
	1905 chart.	1910 chart.	1915 chart.			
Alabama	40	46	88	7	51279	583
Arizona	79	84	84	2	113810	1355
Arkansas	39	51	84	5	52525	625
California	133	135	139	8	155652	1120
Colorado	62	62	76	4	103658	1364
Connecticut	33	42	45	1	4820	109
Delaware	13	14	41	2	1965	48
District of Columbia	4	4	7	1	60	9
Florida	73	76	95	8	54861	577
Georgia	71	84	172	10	58725	341
Idaho	32	32	31	0	83354	2689
Illinois	39	104	115	4	56043	487
Indiana	32	76	91	2	36045	396
Iowa	45	91	144	4	55586	386
Kansas	117	118	118	2	81774	693
Kentucky	75	99	127	4	40181	316
Louisiana	95	95	99	3	45409	459
Maine	55	72	73	2	29895	410
Maryland	153	154	154	1	9941	65
Massachusetts	50	54	62	4	8039	130
Michigan	116	161	169	1	57480	340
Minnesota	52	106	160	5	80858	505
Mississippi	42	44	88	7	46362	527
Missouri	166	192	206	8	68727	334
Montana	61	61	68	1	146201	2150
Nebraska	64	92	103	2	76808	746
Nevada	63	63	63	0	109821	1743
New Hampshire	11	19	31	0	9031	291
New Jersey	41	50	79	1	7514	95
New Mexico	71	72	72	2	122503	1701
New York	90	150	171	4	47654	279
North Carolina	119	122	133	7	48740	366
North Dakota	35	47	54	3	70183	1300
Ohio	101	104	109	2	40740	374
Oklahoma	36	56	80	6	69414	868
Oregon	75	77	85	3	95607	1125
Pennsylvania	80	88	111	7	44832	404
Rhode Island	11	11	11	0	1067	97
South Carolina	47	48	62	2	30495	492
South Dakota	33	46	65	5	76868	1184
Tennessee	56	88	112	8	41687	372
Texas	183	192	275	14	262398	954
Utah	38	38	43	3	82184	1911
Vermont	13	18	28	3	9124	326
Virginia	119	133	172	8	40262	234
Washington	92	98	113	3	66836	591
West Virginia	58	68	75	1	24022	320
Wisconsin	47	85	107	5	55256	516
Wyoming	47	47	47	0	97594	2076
Total United States	3207	3869	4737	180	2973890	628
Canada	488	618	788			
Mexico	230	230	230			
West Indies	61	67	75			
Grand total	3986	4784	5830			

Although the Canadian Government has made steady progress in the magnetic survey of that country, especially of the southern part, since its inception by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington in 1906, the number of stations is not yet sufficient to give more than an approximate location of the isogonic lines in a region where there is so much local disturbance.

REDUCTION TO EPOCH.

The secular change of declination up to 1905 was discussed so thoroughly in 1906 that it has been decided to accept as correct the reduction to January 1, 1905, of observations made prior to January 1, 1907, as published in United States Magnetic Tables and Magnetic Charts for 1905. After the new secular-change tables had been prepared in the manner explained below, the total change of declination between 1905 and 1915 was derived for each region given in the tables, and these values were plotted on a small-sized map of the United States. Lines of equal change were drawn, and it was then easy to scale off the change between 1905 and 1915 for each of the results given in the 1905 tables.

For each region given in the secular-change tables the average annual change between 1910 and 1915 was derived and these average values were plotted on a small-sized map of the United States. Lines of equal annual change were then drawn to conform approximately to the plotted values. The reduction to 1915 of observations made subsequent to 1906 was performed with the aid of this map. These lines of equal annual change are shown in blue on the isogonic chart. While they are more nearly applicable to the middle of the interval—i. e., 1912.5—they are approximately correct for 1915 and are the best values at present available for subsequent years.

A great majority of the results utilized have been obtained since 1899, when the systematic magnetic survey of the United States was begun, and very few refer to an earlier date than 1870, so that the uncertainty in the reduction to epoch is small.

CONSTRUCTION OF THE ISOGONIC CHART.

The isogonic chart has been constructed by the graphical method, as in the past. The reduced values of declination were plotted on a large-sized map of the United States and the lines of equal magnetic declination were drawn free-hand to conform to the plotted values. As the number of stations in a given area becomes greater this process usually becomes more difficult, and in greatly disturbed areas the sinuosities of the isogonic lines are an indication of disturbance rather than an accurate representation of the distribution of declination. On the present chart it was found impossible in many places

to represent the large local disturbances by continuous lines and the plan was adopted of representing a disturbed area of limited extent by a small closed curve, and of entering on the chart the isolated abnormal values which differ by more than a degree from the normal value for the locality. These values are given in degrees and tenths, the decimal point indicating the location of the station.

LINES OF EQUAL ANNUAL CHANGE.

The lines of equal annual change, shown in blue on the isogonic chart, were derived in the manner explained above. For the eastern part of the country their distribution has not changed materially since 1910. At the Porto Rico magnetic observatory west declination has been increasing more than 10′ a year since 1912 and a recent discussion of the secular change of declination in the West Indies in connection with the construction of an isogonic chart of that region indicates that the annual change is two or three minutes greater than that in the Barbados. On the Pacific coast there has been a decided change in the location of the lines of equal annual change, corresponding to a general decrease in the rate of change.

The north end of the compass needle is moving to the westward at all places east of the line of no annual change, and to the eastward at all places west of that line.

(*a*) In the part of the United States east of the agonic line (line of no declination), west declination is increasing at an annual rate of from 2′ to 6′.

(*b*) In the region between the agonic line and the line of no annual change, east declination is decreasing at an annual rate of from 0 to 2′.

(*c*) In the region west of the line of no annual change, east declination is increasing at an annual rate of from 0 to 4′.

SECULAR CHANGE TABLES.

On the succeeding pages will be found tables showing the secular change of the magnetic declination for one or more places in each State from 1750 or the date of the earliest observations to 1915. They are based on similar tables which accompanied the isogonic chart for 1910, in Special Publication No. 9, with only such modifications as were needed to extend them to 1915 and represent more closely the secular motion since 1900 as developed by a rediscussion of the secular change since 1875.

A graphical method was employed in constructing the tables. The results at all the repeat stations in a given region were combined to obtain a curve representing as nearly as possible the average secular change for the region. While it is probable that the secular change

of declination is affected somewhat by local conditions—e. g., by the presence of local disturbance—our observational data are not as yet sufficiently extensive or detailed to permit more than an approximate representation of the average conditions, and these appear to vary with comparative uniformity in passing across the country. Before finally adopting the secular change curve for a particular region, therefore, a comparison was made with the curves for adjoining regions as a basis for a final smoothing out. From these curves values at 10-year intervals to 1900 and 5-year intervals after that date were scaled and tabulated, showing the change of declination from each date to 1915. From these tables other similar ones were obtained by interpolation for the greater number of smaller areas for which it was desired to publish secular change tables. From these tables, in turn, others were prepared, showing the change of declination at some place near the center of each area, at which recent observations had been made.

From this it will be seen that while a table gives directly the declination at different times for but one place in a specified region, it represents with almost the same accuracy the change in declination at any place in the limited area to which the table refers. For a place lying near the border of the specified region a somewhat better result may be obtained by interpolating between the tables for that region and the adjoining one, as explained in example (2) given below.

USE OF THE SECULAR CHANGE TABLES.

Whenever a surveyor is called upon to redetermine the boundary lines of a tract of land run out by compass at some previous date and can find in the vicinity a well-defined line known to have been established with the same compass at about the same time as the lines of the tract in question, he can not do better than determine the amount of change in the compass bearing of that well-defined line and use it to obtain the present bearings of the boundary lines to be reestablished. In this way he will eliminate possible errors in the two compasses used. Only in the absence of such definite information is the use of the following tables recommended.

In using these tables the surveyor must bear in mind the uncertainties incident to the use of the compass and should not be surprised if, for example, the change in declination since the early part of the nineteenth century, as given by the tables, differs by half a degree or even more from the value indicated by his own retracing of old lines. Even at the present time some compasses are in error by as much as a quarter of a degree, owing to imperfect construction or lack of proper care, and 100 years ago the state of affairs was still worse. The tables are intended to give the actual change in the magnetic declination, eliminating as far as possible the errors of

individual instruments, but they are only approximate and the earlier portions are less reliable on account of the inferior character and limited amount of the data on which they are based.

The figures on any line refer to the 1st day of January of the year given in the first column. A value for any other date must be obtained by interpolation from the tabular quantities. In this operation it is convenient to express the month and day as a fraction of the year, as follows:

Month and day expressed as a fraction of a year.

Jan. 19 to Feb. 24=0.1	July 21 to Aug. 25=0.6
Feb. 25 to Apr. 1=0.2	Aug. 26 to Oct. 1=0.7
Apr. 2 to May 8=0.3	Oct. 2 to Nov. 7=0.8
May 9 to June 13=0.4	Nov. 8 to Dec. 13=0.9
June 14 to July 20=0.5	Dec. 14 to Dec. 31=1.0

The use of the tables may best be explained by a few examples.

(1) What was the change in declination in eastern Alabama between June 1, 1795, and August 10, 1915?

In the table for Ashland, eastern Alabama, the values for 1790 and 1800 are 5° 28′ E. and 5° 49′ E., respectively, showing an average annual increase of 2′.1. Hence the value for June 1, 1795, would be 5° 28′ E. + (2′.1×5.4)=5° 39′ E. The table gives for 1915 the value 2° 58′ E. with an annual increase of 0′.4. Hence the value for August 10, 1915, would be 2° 58′ E. Therefore the north end of the compass needle pointed 2° 41′ more to the east on June 1, 1790, than it did on August 10, 1915.

(2) The magnetic declination at New Castle, Pa., on November 15, 1902, was 2° 55′ W. What was it at the same place in January, 1810?

New Castle lies near the boundary between western Pennsylvania and eastern Ohio. From the table for western Pennsylvania are derived the values 0° 38′ E. for January, 1810, and 4° 05′ W. for November, 1902, showing a change of 4° 43′ in the interval. The corresponding values for eastern Ohio are 2° 16′ E. and 2° 06′ W., showing a change of 4° 22′. The mean of these two values, 4° 43′ and 4° 22′, applies to New Castle. Hence the needle pointed 4° 33′ more to the east at New Castle in January, 1810, than it did in November, 1902, and the declination at the earlier date was 1° 38′ E.

(3) A four-sided piece of land at Santa Barbara, Cal., was surveyed in February, 1831, and the bearings recorded as follows: N. 20° 15′ W., N. 75° 30′ E., S. 18° 45′ E., and S. 78° 00′ W. What bearings should be used in order to retrace the lines in March, 1912?

From the table for California south, Mojave, the value for February, 1831, is 13° 26′ E. and for March, 1912, 15° 56′ E., showing an increase of 2° 30′ in the interval. The desired bearings are, therefore, N. 22° 45′ W., N. 73° 00′ E., S. 21° 15′ E., and S. 75° 30′ W.

Secular Change of the Magnetic Declination in the United States.

Region.	Alabama, east.	Alabama, west.	Arizona, east.	Arizona, west.	Arkansas, east.	Arkansas, west.	California, southeast.	California, south.
Place	Ashland	Tuscaloosa	Holbrook	Prescott	Augusta	Danville	Bagdad	Mojave
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Latitude	33 16	33 12	34 55	34 34	35 17	35 05	34 35	35 03
Longitude	85 51	87 33	110 10	112 30	91 22	93 25	115 53	118 10
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	3 18 E							
1760	3 54							
1770	4 30	5 31 E						
1780	5 01	6 02						10 38 E
1790	5 28	6 29						11 12
1800	5 49	6 51			7 19 E			11 46
1810	6 03	7 08			7 41			12 21
1820	6 09	7 16			7 54			12 53
1830	6 06	7 16			8 01	9 20 E	13 06 E	13 23
1840	5 55	7 09			7 58	9 20	13 32	13 50
1850	5 37	6 55	13 32 E	13 19 E	7 47	9 12	13 52	14 11
1860	5 12	6 34	13 43	13 33	7 28	8 58	14 07	14 27
1870	4 44	6 07	13 46	13 40	7 06	8 39	14 16	14 38
1880	4 06	5 31	13 39	13 40	6 30	8 09	14 26	14 54
1890	3 25	4 49	13 24	13 35	5 53	7 34	14 24	14 54
1900	2 58	4 24	13 29	13 42	5 28	7 12	14 33	15 04
1905	2 55	4 23	13 41	14 01	5 28	7 12	14 52	15 24
1910	2 55	4 26	14 04	14 25	5 34	7 21	15 17	15 49
1915	2 58 E	4 31 E	14 21 E	14 42 E	5 42 E	7 32 E	15 34 E	16 06 E
Annual change in 1915	0′.4 incr.	1′.0 incr.	3′.4 incr.	3′.4 incr.	1′.6 incr.	2′.2 incr.	3′.4 incr.	3′.4 incr.

Region.	California, middle.	California, north.	Colorado, east.	Colorado, west.	Connecticut.	Delaware.	District of Columbia.	Florida, south.
Place	Modesto	Redding	Pueblo	Ouray	Hartford	Dover	Washington	Miami
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Latitude	37 38	40 36	38 14	38 01	41 45	39 09	38 55	25 46
Longitude	120 59	122 24	104 38	107 41	72 40	75 31	77 02	80 11
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750					5 45 W	3 23 W	1 41 W	4 25 E
1760					5 16	2 46	1 02	4 55
1770					4 55	2 16	0 28	5 20
1780	12 21 E	14 07 E			4 43	1 52	0 01 W	5 40
1790	12 47	14 35			4 41	1 37	0 19 E	5 51
1800	13 16	15 04			4 49	1 33	0 28	5 55
1810	13 45	15 34			5 06	1 37	0 28	5 51
1820	14 14	16 04			5 32	1 52	0 19 E	5 40
1830	14 41	16 33			6 05	2 16	0 01 W	5 20
1840	15 06	17 01			6 45	2 46	0 28	4 55
1850	15 29	17 26	13 45 E	15 03 E	7 29	3 23	1 02	4 25
1860	15 49	17 47	13 48	15 11	8 07	4 03	1 41	3 53
1870	16 04	18 06	13 44	15 12	8 41	4 41	2 21	3 18
1880	16 08	18 15	13 29	15 00	9 22	5 20	3 00	2 43
1890	16 12	18 20	12 58	14 36	9 47	5 51	3 36	2 13
1900	16 34	18 40	12 51	14 35	10 21	6 29	4 11	1 44
1905	16 54	19 00	13 02	14 48	10 41	6 48	4 29	1 36
1910	17 16	19 22	13 17	15 06	11 09	7 13	4 51	1 31
1915	17 32 E	19 37 E	13 32 E	15 21 E	11 38 W	7 37 W	5 13 W	1 31 E
Annual change in 1915	3′.2 incr.	3′.0 incr.	3′.0 incr.	3′.0 incr.	5′.8 incr.	4′.7 incr.	4′.4 incr.	0.0

Secular Change of the Magnetic Declination in the United States—Continued.

Region.	Florida, middle.	Florida, northeast.	Florida, northwest.	Georgia, east.	Georgia, west.	Idaho, southeast.	Idaho, southwest.	Idaho north.
Place	Bartow	Jacksonville	Tallahassee	Millen	Americus	Pocatello	Boise	Pierce
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	°
Latitude	27 53	30 20	30 26	32 48	32 05	42 52	43 37	46 29
Longitude	81 51	81 39	84 18	82 00	84 13	112 26	116 12	115 48
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	3 29 E	2 26 E	3 04 E	2 20 E	3 17 E	.....	.....	.....
1760	4 03	3 03	3 41	2 57	3 54	.....	.....	.....
1770	4 33	3 39	4 16	3 32	4 29	.....	.....	.....
1780	4 59	4 11	4 48	4 03	5 01	.....	.....	.....
1790	5 17	4 86	5 14	4 27	5 27	.....	.....	.....
1800	5 29	4 54	5 34	4 43	5 46	.....	.....	.....
1810	5 31	5 03	5 46	4 51	5 56	.....	.....	.....
1820	5 25	5 03	5 50	4 49	5 58	.....	.....	.....
1830	5 11	4 54	5 45	4 39	5 52	.....	.....	.....
1840	4 49	4 36	5 32	4 20	5 36	.....	.....	20 13 E
1850	4 22	4 11	5 12	3 53	5 13	17 42 E	18 00 E	20 39
1860	3 50	3 39	4 45	3 21	4 44	17 56	18 30	20 59
1870	3 15	3 03	4 13	2 44	4 09	18 02	18 45	21 12
1880	2 37	2 24	3 34	2 06	3 30	17 56	18 45	21 09
1890	2 05	1 49	2 57	1 28	2 52	17 45	18 39	21 09
1900	1 35	1 18	2 29	0 56	2 23	17 53	18 51	21 23
1905	1 28	1 12	2 25	0 46	2 16	18 09	19 08	21 38
1910	1 22	1 05	2 22	0 40	2 13	18 28	19 31	21 58
1915	1 19 E	0 59 E	2 20 E	0 35 E	2 12 E	18 42 E	19 45 E	22 11 E
Annual change in 1915	0′.4 decr.	1′.0 decr.	0′.0	1′.0 decr.	0′.2 decr.	2′.8 incr.	2′.8 incr.	2′.6 incr.

Region.	Illinois, east.	Illinois, west.	Indiana.	Iowa, east.	Iowa, west.	Kansas, east.	Kansas, west.	Kentucky, east.
Place	Kankakee	Rushville	Indianapolis	Walker	Sac City	Emporia	Ness City	Manchester
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Latitude	41 07	40 08	39 48	42 17	42 25	38 25	38 28	37 10
Longitude	87 50	90 34	86 12	91 46	95 00	96 12	99 54	83 46
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	.....	.....	.....	.....	.....	.....	.....	.....
1760	.....	.....	.....	.....	.....	.....	.....	.....
1770	.....	.....	.....	.....	.....	.....	.....	.....
1780	.....	.....	.....	.....	.....	.....	.....	.....
1790	.....	.....	.....	.....	.....	.....	.....	.....
1800	6 16 E	7 13 E	4 44 E	.....	.....	.....	.....	3 23 E
1810	6 36	7 40	4 59	.....	.....	.....	.....	3 38
1820	6 46	8 00	5 04	8 54 E	10 26 E	.....	.....	3 34
1830	6 46	8 05	4 59	9 05	10 42	.....	.....	3 26
1840	6 36	8 03	4 44	9 06	10 49	.....	.....	3 09
1850	6 16	7 49	4 21	8 56	10 45	11 32 E	12 23 E	2 46
1860	5 49	7 27	3 50	8 37	10 32	11 26	12 22	2 15
1870	5 21	7 02	3 20	8 10	10 10	11 13	12 11	1 38
1880	4 45	6 24	2 45	7 30	9 34	10 48	11 53	0 57
1890	4 04	5 42	2 05	6 45	8 51	10 12	11 20	0 15 E
1900	3 29	5 11	1 28	6 14	8 25	9 54	11 09	0 17 W
1905	3 22	5 08	1 18	6 12	8 27	9 57	11 15	0 26
1910	3 16	5 08	1 08	6 13	8 33	10 06	11 26	0 34
1915	3 11 E	5 08 E	1 00 E	6 14 E	8 39 E	10 15 E	11 38 E	0 41 W
Annual change in 1915	0′.8 decr.	0′.0	1′.4 decr.	0′.2 incr.	1′.2 incr.	2′.0 incr.	2′.4 incr.	1′.6 incr.

Secular Change of the Magnetic Declination in the United States—Continued.

Region.	Kentucky, middle.	Kentucky, west.	Louisiana.	Maine, northeast.	Maine, middle.	Maine, southwest.	Maryland.	Massachusetts, east.
Place	Louisville	Princeton	Winfield	Eastport	Bangor	Portland	Baltimore	Boston
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Latitude	38 14	37 07	31 57	44 55	44 48	43 39	39 18	42 20
Longitude	85 42	87 53	92 36	67 00	68 48	70 17	76 35	71 01
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	.....	.....	.....	12 22 W	10 45 W	8 50 W	3 05 W	7 46 W
1760	.....	.....	.....	12 10	10 29	8 31	2 26	7 19
1770	.....	.....	.....	12 10	10 27	8 26	1 52	7 00
1780	.....	.....	.....	12 22	10 33	8 26	1 25	6 50
1790	.....	.....	.....	12 43	10 46	8 31	1 05	6 50
1800	4 36 E	6 29 E	8 16 E	13 15	11 11	8 50	0 56	7 01
1810	4 50	6 47	8 37	13 55	11 45	9 18	0 56	7 20
1820	4 55	6 56	8 53	14 40	12 26	9 54	1 05	7 47
1830	4 51	6 56	9 01	15 29	13 10	10 34	1 25	8 22
1840	4 38	6 47	9 00	16 19	13 55	11 13	1 52	9 04
1850	4 18	6 29	8 52	17 15	14 43	11 54	2 26	9 48
1860	3 48	6 01	8 36	18 00	15 26	12 34	3 05	10 28
1870	3 14	5 31	8 12	18 30	15 56	13 04	3 45	11 01
1880	2 32	4 47	7 38	18 50	16 23	13 38	4 24	11 30
1890	1 54	4 13	7 07	19 00	16 42	14 06	5 00	11 58
1900	1 27	3 51	6 45	19 16	17 03	14 32	5 35	12 33
1905	1 20	3 47	6 50	19 31	17 19	14 49	5 53	12 52
1910	1 15	3 44	7 00	20 01	17 49	15 19	6 15	13 22
1915	1 12 E	3 45 E	7 12 E	20 31 W	18 19 W	15 49 W	6 38 W	13 52 W
Annual change in 1915	0′.6 decr.	0′.2 incr.	2′.4 incr.	6′.0 incr.	6′.0 incr.	6′.0 incr.	4′.5 incr.	6′.0 incr.

Region.	Massachusetts, west.	Michigan, north.	Michigan, southeast.	Michigan, southwest.	Minnesota, southeast.	Minnesota, southwest.	Minnesota, northeast.	Minnesota, northwest.
Place	Pittsfield	Marquette	Lapeer	Grand Haven	St. Paul	Marshall	Hibbing	Bagley
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Latitude	42 26	46 33	43 03	43 04	44 58	44 24	47 27	47 32
Longitude	73 16	87 22	83 20	86 12	93 06	95 51	92 56	95 23
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	6 22 W	.....	.....	.....	.....	.....	.....	.....
1760	5 53	.....	.....	.....	.....	.....	.....	.....
1770	5 32	.....	.....	.....	.....	.....	.....	.....
1780	5 20	.....	.....	.....	.....	.....	.....	.....
1790	5 18	.....	.....	.....	.....	.....	.....	.....
1800	5 26	.....	.....	.....	.....	.....	.....	.....
1810	5 43	.....	.....	.....	.....	.....	.....	.....
1820	6 09	6 45 E	2 35 E	5 04 E	11 35 E	.....	10 31 E	.....
1830	6 42	6 45	2 26	5 01	11 48	.....	10 44	13 01 E
1840	7 22	6 31	2 06	4 45	11 52	11 44 E	10 46	13 08
1850	8 06	6 05	1 38	4 21	11 42	11 39	10 37	13 04
1860	8 44	5 28	1 02	3 49	11 24	11 26	10 16	12 48
1870	9 18	4 41	0 18 E	3 09	10 56	11 03	9 41	12 20
1880	9 59	3 50	0 29 W	2 22	10 19	10 32	8 59	11 43
1890	10 26	3 03	1 13	1 36	9 30	9 48	8 14	10 58
1900	10 59	2 26	1 46	1 03	8 55	9 16	7 39	10 27
1905	11 17	2 12	2 00	0 51	8 51	9 20	7 39	10 30
1910	11 46	2 04	2 15	0 40	8 50	9 24	7 41	10 36
1915	12 15 W	1 53 E	2 30 W	0 29 E	8 50 E	9 28 E	7 39 E	10 38 E
Annual change in 1915	5′.8 incr.	2′.2 decr.	3′.0 incr.	2′.2 decr.	0′.2 incr.	0′.8 incr.	0′.4 decr.	0′.4 incr.

Secular Change of the Magnetic Declination in the United States—Continued.

Region.	Mississippi, east.	Mississippi, west.	Missouri, east.	Missouri, west.	Montana, east.	Montana, middle.	Montana, west.	Nebraska, east.
Place	Meridian	Vicksburg	Hermann	Sedalia	Miles City	Lewistown	Ovando	Albion
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Latitude	32 23	32 21	38 42	38 43	46 24	47 04	47 02	41 41
Longitude	88 44	90 53	91 26	93 14	105 53	109 26	113 08	97 59
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	.....	.....	.....	.....	.....	.....	.....	.....
1760	.....	.....	.....	.....	.....	.....	.....	.....
1770	.....	.....	.....	.....	.....	.....	.....	.....
1780	.....	.....	.....	.....	.....	.....	.....	.....
1790	.....	.....	.....	.....	.....	.....	.....	.....
1800	6 57 E	7 50 E	.....	.....	.....	.....	.....	.....
1810	7 16	8 11	.....	.....	.....	.....	.....	.....
1820	7 26	8 23	9 09 E	9 51 E	.....	.....	.....	12 26 E
1830	7 29	8 28	9 16	9 57	.....	.....	.....	12 44
1840	7 24	8 25	9 15	9 57	.....	19 29 E	20 21 E	12 54
1850	7 12	8 15	9 03	9 51	17 38 E	19 50	20 46	12 54
1860	6 54	7 59	8 43	9 36	17 46	20 04	21 05	12 46
1870	6 30	7 35	8 19	9 16	17 42	20 08	21 15	12 29
1880	5 56	7 04	7 40	8 41	17 25	19 56	21 06	11 59
1890	5 13	6 22	7 01	8 01	16 56	19 35	20 56	11 22
1900	4 51	6 00	6 31	7 37	16 52	19 38	21 07	11 01
1905	4 50	6 02	6 30	7 39	17 04	19 51	21 21	11 06
1910	4 54	6 08	6 31	7 45	17 18	20 07	21 39	11 15
1915	5 01 E	6 16 E	6 34 E	7 51 E	17 30 E	20 20 E	21 52 E	11 25 E
Annual change in 1915	1′.3 incr.	1′.7 incr.	0′.8 incr.	1′.3 incr.	2′.4 incr.	2′.6 incr.	2′.6 incr.	2′.0 incr.

Region.	Nebraska, middle.	Nebraska, west.	Nevada, east.	Nevada, west.	New Hampshire.	New Jersey.	New Mexico, east.	New Mexico, west.
Place	Valentine	Alliance	Elko	Hawthorne	Hanover	Trenton	Santa Rosa	Laguna
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Latitude	42 52	42 06	40 51	38 32	43 43	40 15	34 56	35 03
Longitude	100 34	102 51	115 46	118 38	72 17	74 48	104 41	107 24
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	.....	.....	.....	.....	8 00 W	4 43 W	.....	.....
1760	.....	.....	.....	.....	7 26	4 04	.....	.....
1770	.....	.....	.....	.....	7 01	3 31	.....	.....
1780	.....	.....	.....	.....	6 45	3 06	.....	.....
1790	.....	.....	.....	.....	6 40	2 50	.....	.....
1800	.....	.....	.....	.....	6 47	2 45	.....	.....
1810	.....	.....	.....	.....	7 04	2 50	.....	.....
1820	.....	.....	.....	.....	7 30	3 06	.....	.....
1830	.....	.....	.....	.....	8 09	3 31	.....	.....
1840	.....	.....	.....	.....	8 54	4 04	.....	.....
1850	14 08 E	15 26 E	17 20 E	16 15 E	9 44	4 43	12 43 E	13 26 E
1860	14 04	15 26	17 36	16 36	10 29	5 22	12 47	13 33
1870	13 51	15 17	17 41	16 51	11 06	6 01	12 43	13 34
1880	13 22	14 49	17 44	16 59	11 36	6 41	12 25	13 22
1890	12 48	14 19	17 38	17 01	11 59	7 11	12 00	13 02
1900	12 33	14 09	17 49	17 16	12 34	7 46	11 54	13 02
1905	12 40	14 17	18 04	17 32	12 44	8 07	12 10	13 15
1910	12 50	14 30	18 27	17 57	13 14	8 33	12 29	13 36
1915	13 02 E	14 43 E	18 43 E	18 13 E	13 44 W	8 59 W	12 45 E	13 53 E
Annual change in 1915	2′.4 incr.	2′.6 incr.	3′.2 incr.	3′.2 incr.	6′.0 incr.	5′.2 incr.	3′.2 incr.	3′.4 incr.

Secular Change of the Magnetic Declination in the United States—Continued.

Region.	New York, east.	New York, middle.	New York, west.	North Carolina, east.	North Carolina, middle.	North Carolina, west.	North Dakota, east.	North Dakota, middle.
Place	Albany	Elmira	Buffalo	Newbern	Greensboro	Asheville	Jamestown	Bismarck
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Latitude	42 40	42 07	42 54	35 07	36 04	35 35	46 53	46 48
Longitude	73 45	76 50	78 54	77 03	79 49	82 32	98 42	100 47
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	7 41 W	4 40 W	.....	0 18 W	1 14 E	.....	.....	.....
1760	6 59	3 57	.....	0 18 E	1 50	.....	.....	.....
1770	6 23	3 18	.....	0 50	2 24	.....	.....	.....
1780	5 56	2 46	1 52 W	1 17	2 53	.....	.....	.....
1790	5 40	2 24	1 24	1 35	3 14	.....	.....	.....
1800	5 34	2 13	1 08	1 44	3 26	4 06 E	.....	.....
1810	5 40	2 13	1 01	1 44	3 29	4 12	.....	.....
1820	5 56	2 24	1 08	1 35	3 23	4 09	.....	.....
1830	6 23	2 46	1 24	1 16	3 07	3 57	14 02 E	.....
1840	6 59	3 18	1 52	0 50	2 43	3 35	14 12	.....
1850	7 45	3 57	2 26	0 17 E	2 12	3 07	14 12	16 23 E
1860	8 31	4 46	3 10	0 19 W	1 38	2 35	14 02	16 18
1870	9 10	5 23	3 49	1 00	1 00	1 57	13 44	16 04
1880	9 57	6 16	4 40	1 40	0 20 E	1 17	13 15	15 38
1890	10 18	6 57	5 22	2 16	0 17 W	0 41	12 32	14 58
1900	10 56	7 32	5 57	2 52	0 51	0 09 E	12 09	14 40
1905	11 11	7 50	6 11	3 08	1 04	0 02 W	12 17	14 50
1910	11 37	8 12	6 32	3 25	1 19	0 13	12 25	15 00
1915	12 05 W	8 37 W	6 53 W	3 42 W	1 34 W	0 23 W	12 32 E	15 09 E
Annual change in 1915	5′.6 incr.	5′.0 incr.	4′.4 incr.	3′.4 incr.	3′.0 incr.	1′.8 incr.	1′.4 incr.	1′.8 incr.

Region.	North Dakota, west.	Ohio, east.	Ohio, west.	Oklahoma, east.	Oklahoma, west.	Oregon, east.	Oregon, west.	Pennsylvania, east.
Place	Dickinson	Canton	Urbana	Okmulgee	Enid	Sumpter	Detroit	Wilkes-Barre
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Latitude	46 53	40 49	40 06	35 38	36 25	44 45	44 43	41 13
Longitude	102 46	81 24	83 44	95 56	97 54	118 13	122 08	75 54
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	.....	.....	.....	.....	.....	.....	.....	4 43 W
1760	.....	.....	.....	.....	.....	.....	.....	3 59
1770	.....	.....	.....	.....	.....	.....	.....	3 19
1780	.....	.....	.....	.....	.....	.....	.....	2 46
1790	.....	.....	.....	.....	.....	.....	.....	2 26
1800	.....	2 07 E	4 11 E	.....	.....	.....	16 05 E	2 17
1810	.....	2 16	4 23	.....	.....	.....	16 43	2 18
1820	.....	2 14	4 24	.....	.....	.....	17 22	2 31
1830	.....	2 02	4 16	.....	.....	.....	18 01	2 53
1840	.....	1 41	3 58	.....	.....	.....	18 38	3 24
1850	17 40 E	1 12	3 32	10 13 E	11 14 E	19 15 E	19 12	4 02
1860	17 40	0.36 E	2 59	10 04	11 11	19 40	19 41	4 42
1870	17 30	0 00	2 25	9 49	10 59	19 58	20 06	5 21
1880	17 07	0 41 W	1 47	9 31	10 36	20 09	20 20	6 02
1890	16 30	1 20	1 08	9 05	10 09	20 11	20 30	6 36
1900	16 18	1 57	0 31	8 40	9 49	20 26	20 50	7 13
1905	16 30	2 13	0 18	8 43	9 55	20 44	21 09	7 33
1910	16 42	2 30	0 05 E	8 53	10 08	21 07	21 33	7 58
1915	16 53 E	2 47 W	0 08 W	9 03 E	10 21 E	21 21 E	21 47 E	8 22 W
Annual change in 1915	2′.2 incr.	3′.3 incr.	2′.5 incr.	2′.6 incr.	2′.8 incr.	2′.8 incr.	2′.8 incr.	4′.8 incr.

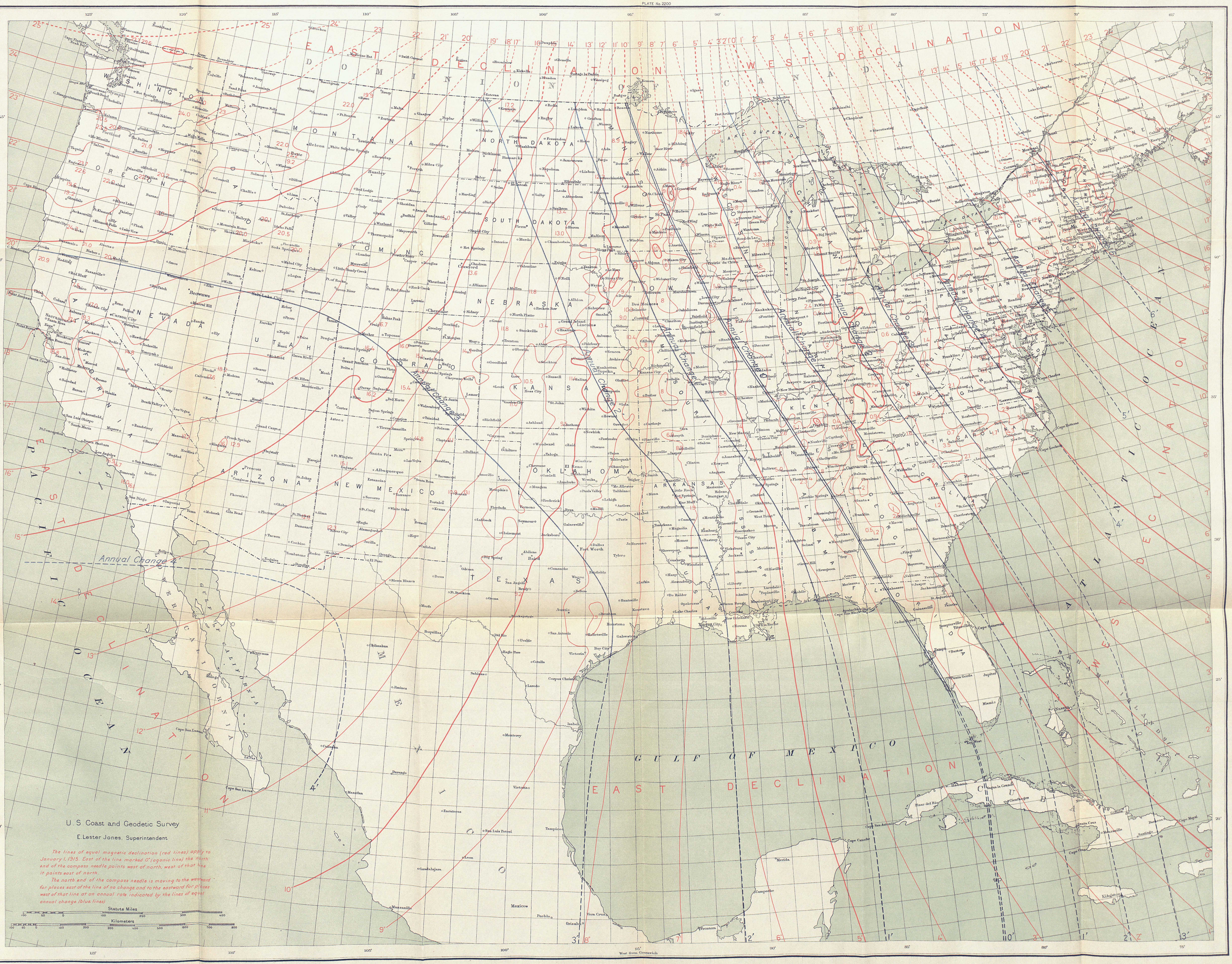
Secular Change of the Magnetic Declination in the United States—Continued.

Region.	Pennsylvania, middle.	Pennsylvania, west.	Rhode Island.	South Carolina, east.	South Carolina, west.	South Dakota, east.	South Dakota, middle.	South Dakota, west.
Place	Lockhaven	Indiana	Newport	Marion	Aiken	Huron	Murdo	Rapid City
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Latitude	41 09	40 39	41 30	34 11	33 34	44 21	43 54	44 05
Longitude	77 26	79 12	71 20	79 24	81 44	98 10	100 43	103 12
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	.....	.....	7 04 W	1 09 E	2 19 E	.....	.....	.....
1760	.....	.....	6 37	1 46	2 56	.....	.....	.....
1770	.....	.....	6 18	2 19	3 31	.....	.....	.....
1780	2 03 W	0 07 W	6 08	2 47	4 01	.....	.....	.....
1790	1 40	0 17 E	6 08	3 08	4 24	.....	.....	.....
1800	1 26	0 32	6 19	3 19	4 39	.....	.....	.....
1810	1 23	0 38	6 38	3 24	4 45	.....	.....	.....
1820	1 32	0 32	7 05	3 16	4 42	.....	.....	.....
1830	1 52	0 16 E	7 40	3 02	4 30	.....	.....	.....
1840	2 22	0 09 W	8 22	2 39	4 09	13 11 E	.....	.....
1850	2 59	0 42	9 06	2 08	3 42	13 11	15 00 E	16 26 E
1860	3 39	1 20	9 46	1 34	3 08	13 02	14 55	16 26
1870	4 19	1 59	10 19	0 55	2 31	12 45	14 42	16 16
1880	4 59	2 39	10 50	0 17 E	1 53	12 20	14 17	15 50
1890	5 39	3 18	11 17	0 22 W	1 16	11 40	13 40	15 17
1900	6 17	3 55	11 52	0 58	0 42	11 13	13 21	15 07
1905	6 36	4 13	12 11	1 12	0 32	11 23	13 31	15 15
1910	6 59	4 33	12 40	1 24	0 22	11 32	13 41	15 26
1915	7 22 W	4 53 W	13 10 W	1 36 W	0 14 E	11 41 E	13 51 E	15 38 E
Annual change in 1915	4′.4 incr.	4′.0 incr.	6′.0 incr.	2′.4 incr.	1′.6 decr.	1′.5 incr.	2′.0 incr.	2′.5 incr.

Region.	Tennessee, east.	Tennessee, middle.	Tennessee, west.	Texas, east.	Texas, middle.	Texas, west.	Texas, northwest.	Utah.
Place	Knoxville	Shelbyville	Huntingdon	Houston	San Antonio	Pecos	Floydada	Manti
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Latitude	35 56	35 30	36 00	29 47	29 29	31 26	33 59	39 16
Longitude	83 57	86 29	88 23	95 21	98 32	103 33	101 15	111 40
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	.....	.....	.....	.....	.....	.....	.....	.....
1760	.....	.....	.....	.....	.....	.....	.....	.....
1770	.....	.....	.....	.....	.....	.....	.....	.....
1780	.....	.....	.....	.....	.....	.....	.....	.....
1790	.....	.....	.....	.....	.....	.....	.....	.....
1800	3 40 E	6 12 E	7 01 E	.....	.....	.....	.....	.....
1810	3 49	6 26	7 18	.....	.....	.....	.....	.....
1820	3 48	6 30	7 26	8 59 E	.....	.....	.....	.....
1830	3 38	6 26	7 20	9 14	9 33 E	10 43 E	.....	.....
1840	3 19	6 14	7 18	9 23	9 45	10 57	.....	.....
1850	2 54	5 54	7 01	9 23	9 50	11 05	11 15 E	16 27 E
1860	2 21	5 28	6 37	9 16	9 45	11 04	11 17	16 40
1870	1 45	4 55	6 07	8 54	9 33	10 57	11 10	16 45
1880	1 05	4 18	5 31	8 23	9 13	10 45	10 55	16 40
1890	0 30 E	3 42	4 55	7 52	8 43	10 21	10 24	16 25
1900	0 01 W	3 12	4 26	7 41	8 40	10 15	10 16	16 30
1905	0 10	3 05	4 22	7 51	8 54	10 27	10 27	16 44
1910	0 19	3 00	4 20	8 06	9 11	10 45	10 43	17 05
1915	0 25 W	2 58 E	4 22 E	8 21 E	9 28 E	11 03 E	10 58 E	17 21 E
Annual change in 1915	1′.2 incr.	0′ 4 decr.	0′.4 incr.	3′.0 incr.	3′.2 incr.	3′.4 incr.	3′.0 incr.	3′.2 incr.

Secular Change of the Magnetic Declination in the United States—Continued.

Region.	Vermont.	Virginia, east.	Virginia, middle.	Virginia, west.	Washington, east.	Washington, west.	West Virginia.
Place	Rutland	Richmond	Lynchburg	Wytheville	Wilson Creek	Seattle	Sutton
	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Latitude	43 37	37 33	37 24	36 57	47 26	47 33	38 39
Longitude	72 58	77 28	79 08	81 04	119 00	122 15	80 43
	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1750	7 34 W	1 13 W	.....	.....	.....	.....	.....
1760	7 00	0 37	0 06 W	.....	.....	.....	.....
1770	6 35	0 05 W	0 28 E	.....	.....	.....	.....
1780	6 19	0 20 E	0 57	.....	.....	17 11 E	.....
1790	6 14	0 38	1 19	.....	.....	17 44	1 29 E
1800	6 21	0 47	1 32	2 48 E	.....	18 19	1 44
1810	6 38	0 47	1 37	2 55	.....	18 56	1 51
1820	7 04	0 38	1 32	2 52	.....	19 33	1 48
1830	7 39	0 20 E	1 19	2 43	.....	20 08	1 36
1840	8 20	0 05 W	0 57	2 24	.....	20 41	1 15
1850	9 04	0 36	0 31 E	1 59	21 15 E	21 11	0 47
1860	9 50	1 12	0 04 W	1 26	21 36	21 37	0 12 E
1870	10 30	1 51	0 43	0 48	21 51	21 58	0 26 W
1880	11 10	2 29	1 23	0 08 E	21 55	22 11	1 07
1890	11 33	3 06	2 00	0 32 W	22 05	22 24	1 45
1900	12 08	3 40	2 34	1 05	22 21	22 46	2 21
1905	12 18	3 55	2 50	1 18	22 37	23 06	2 37
1910	12 48	4 13	3 07	1 30	22 59	23 32	2 54
1915	13 18 W	4 33 W	3 24 W	1 42 W	23 12 E	23 45 E	3 11 W
Annual change in 1915	6′.0 incr.	4′.0 incr.	3′.4 incr.	2′.4 incr.	2′.6 incr.	2′.6 incr.	3′.2 incr.

Region.	Wisconsin, east.	Wisconsin, west.	Wyoming, east.	Wyoming, west.
Place	Shawamo	Stanley	Douglas	Green River
	° ′	° ′	° ′	° ′
Latitude	44 47	44 57	42 44	41 32
Longitude	88 37	90 56	105 22	109 28
	° ′	° ′	° ′	° ′
1750	.....	.....	.....	.....
1760	.....	.....	.....	.....
1770	.....	.....	.....	.....
1780	.....	.....	.....	.....
1790	.....	.....	.....	.....
1800	.....	.....	.....	.....
1810	.....	.....	.....	.....
1820	7 24 E	8 54 E	.....	.....
1830	7 27	9 03	.....	.....
1840	7 18	9 00	.....	.....
1850	6 58	8 46	15 50 E	16 46 E
1860	6 29	8 22	15 58	16 59
1870	5 52	7 50	15 58	17 03
1880	5 03	7 06	15 48	16 51
1890	4 19	6 20	15 18	16 31
1900	3 44	5 45	15 14	16 37
1905	3 34	5 37	15 26	16 50
1910	3 27	5 34	15 42	17 09
1915	3 20 E	5 31 E	15 55 E	17 23 E
Annual change in 1915	1′.4 decr.	0′.6 decr.	2′.6 incr.	2′.8 incr.

LINES OF EQUAL MAGNETIC DECLINATION AND OF EQUAL ANNUAL CHANGE IN THE UNITED STATES FOR 1915