

**NO. 109A. CONTRIBUTIONS
TO TERRESTRIAL
MAGNETISM: THE VARIATION
OF THE COMPASS**

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No. 109a. Contributions to Terrestrial Magnetism: The Variation of the Compass by Various

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VARIOUS

**NO. 109A. CONTRIBUTIONS
TO TERRESTRIAL
MAGNETISM: THE VARIATION
OF THE COMPASS**

U. S. - Bureau of navig. - Hydrog. office.

[Publ.] No. 109a.



Bureau of Navigation
U. S. HYDROGRAPHIC OFFICE.

CONTRIBUTIONS TO TERRESTRIAL MAGNETISM,

THE VARIATION OF THE COMPASS.

AS OBSERVED AT FIFTY OF THE PRINCIPAL MARITIME STATIONS
FROM THE EARLIEST TIMES TO THE PRESENT, TOGETHER
WITH EQUATIONS FOR EACH STATION, FROM WHICH
VALUES MAY BE PREDICTED AND ANNUAL
RATES OF CHANGE FOUND.

Compiled by Lewis Mearns, Hydrog. Office

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1895.

PREFACE.

In this publication G. W. Littlehales, C. E., of the United States Hydrographic Office, has presented his discussion of part of the observations of the magnetic declination or variation of the compass that have been collected by him, in the Division of Chart Construction, during the last ten years. The present results relate to Aden (Arabia), Arica (Peru), Ascension Island (South Atlantic Ocean), Auckland (New Zealand), Bahia (Brazil), Batavia (Java), Bombay (India), Barbados (West Indies), Buenos Ayres (Argentine Republic), Callao (Peru), Cartagena (Colombia), Cape of Good Hope (Africa), Charlottetown (Prince Edward Island), Concepcion (Chile), Coquimbo (Chile), Curaçao (West Indies), Fayal (Azores Islands), the Galapagos Islands, Halifax (Nova Scotia), Habana (Cuba), Hongkong (China), La Guayra (Venezuela), Lagoon Head (Mexico), Magdalena Bay (Mexico), Manila (Philippine Islands), Martinique (West Indies), City of Mexico, Montevideo (Uruguay), Nagasaki (Japan), Nosy Vé (Madagascar), Panama (Colombia), Payta (Peru), Peking (China), Pernambuco (Brazil), Petropaulowski (Siberia), Puna and Guayaquil (Ecuador), Punta Arenas (Chile), Rio de Janeiro (Brazil), St. Johns (Newfoundland), San Blas (Mexico), St. Helena (South Atlantic Ocean), St. Vincent (Cape Verde Islands), San Diego (California), Sbanghai (China), Singapore (Malay Peninsula), Surabaya (Java), Sydney (Australia), Tahiti (Society Islands), Valparaiso (Chile), and Vera Cruz (Mexico).

There are also recorded in a form for discussion 1,953 observations at 920 other important maritime stations, and it is proposed to investigate these as soon as the collections of data have become sufficient.

Mr. Littlehales desires to acknowledge the assistance that has been received in the prosecution of this work from Mr. J. S. Siebert in 1888 and 1889, from Mr. C. S. Craig in 1890 and 1891, from Mr. E. G. Russell in 1892 and 1893, and from Mr. M. E. Porter in 1894 and 1895.

C. D. SIGSBEE,
Hydrographer.

UNITED STATES HYDROGRAPHIC OFFICE,
Washington, D. C., March 15, 1895.

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INTRODUCTION.

The observations that are discussed in this publication have been collected, during the period elapsed since 1885, with a view of providing for the deduction of values of the rates of secular change of the variation of the compass for use on the nautical charts of the regions in which the stations are situated. The results as presented also give values of the variation throughout the range of observation, and for the years 1895, 1900, and 1905, and provide the means for readily deducing the value of the variation for any past year not greatly beyond the range of observation, and also for predicting, within an assigned measure of precision, values for the years up to 1910, for the purpose of stating the correct direction of the magnetic meridian on the charts.

To each series of observations there has been adapted a periodic function of the form $v = A + B_1 \sin \frac{360^\circ}{m} t + B_2 \cos \frac{360^\circ}{m} t$, in which v represents the variation, m the period of the cycle, t the time in years and fractions of a year reckoned from the epoch 1850, and A , B_1 and B_2 constants that are determined from the observations by the method of least squares. In this manner the rate of movement of the compass needle is found for any epoch within the range of observation, the times when the needle is stationary are computed, and the values of the declination are predicted for current use for ten or fifteen years beyond the limits of the period of observation.

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THE VARIATION OF THE COMPASS.

Lat. 12° 47' N.

ADEN.

Long. 44° 59' E.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
1612.....	13.16	{ 13.88, Middleton, 1612..... 12.96, Downton, 1612.....	{ Hansteen's Magnetism der Erde, Christiania, 1818.
1674.....	15.00	.....	Do.
1723.....	13.77	{ 13.83, Matthews, 1723..... 13.70, Matthews, 1723.....	{ Do.
1811.....	8.50	.....	Bequerel's <i>Traité du Magnétisme</i> .
1825.....	8.70	Owen.....	Do.
1834.....	5.03	Haines.....	Phil. Trans. Royal Society, Part I, 1875.
1849.....	4.38	{ 4.38, Keller, 1849..... 4.48, Keller, 1849.....	{ <i>Annales Hydrographiques</i> , 1851.
1857.....	4.25	Moyce.....	Phil. Trans. Royal Society, Part I, 1875.
1887.....	3.93	Lieut. W. P. Bay, U. S. N. .	Hydrographic Office Publication, No. 109, Contributions to Terrestrial Magnetism.

Year.	Observed.	Computed.	O-C.	$\overline{O-C^2}$.	
1612.....	13.17	12.90	+0.24	0.0576	} Probable error of a single observed value = ±.43'. Period = 440 years.
1674.....	15.00	15.40	-0.40	0.1600	
1723.....	13.77	14.80	-0.63	0.2809	
1811.....	8.50	7.97	+0.53	0.2809	
1825.....	8.70	8.68	+1.82	3.0124	
1834.....	5.03	6.17	-1.14	1.2996	
1849.....	4.38	5.31	-0.93	0.8649	
1857.....	4.25	4.71	-0.46	0.2116	
1887.....	3.93	3.53	-0.40	0.1600	
				8.6179	

Empirical equation for determining the variation for any year: $v = 9.20 - 4.24 \sin \frac{9}{11} (t - 1850) - 4.09 \cos \frac{9}{11} (t - 1850)$.

Lat. 18° 28' S.

ARICA, PERU.

Long. 70° 20' W.

Year.	Variation of com- pass.	Authority.	
		Observer.	Where recorded.
1713.....	— 8.00	.....	Browster's Treatise on Mag., Edinb., 1834.
1821.....	—10.42	B. Hall.....	Bequaere's Traité du Magnétisme.
1827.....	—10.75	.....	Sabine's Collection, Phil. Trans. Royal Society, 1877.
1835.....	—11.00	.....
1858.....	—10.88	.....	Annales Hydrographiques, 2d series, 1884. Annales Hydrographiques, 2d vol., 1893.
1883.....	—10.00	Ensign Favreau, Jr. N.....	
1893.....	— 9.87	Lieut. Motten, Fr. N.....	

Year.	Observed.	Computed.	O-C.	O-C ² .
1713.....	— 8.00	— 8.026	+0.026	0.0009
1821.....	—10.42	—10.581	+0.161	0.0258
1827.....	—10.75	—10.692	—0.062	0.0038
1835.....	—11.00	—10.793	—0.211	0.0441
1858.....	—10.88	—10.738	—0.142	0.0199
1883.....	—10.00	—10.072	+0.072	0.0049
1893.....	— 9.87	— 9.808	—0.068	0.0038
				0.1028

Probable error of single observation = ± 0.07.
Period = 240 years.

Empirical equation for finding the variation for any year: $v = -9.4 + 0.223 \sin 1.5 (t - 1850) - 14.81 \cos 1.5 (t - 1850)$.