METEOROLOGICAL SERVICE

THE SECULAR VARIATION OF THE MAGNETIC ELEMENTS AT VALENTIA OBSERVATORY 1899–1972

By
J. McWilliams. B.Sc.

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1. Introduction

Annual means of the magnetic elements at Valentia Observatory are available in an unbroken series since 1899.

A full history of the observations, describing the instruments used, the site and the observational procedure up to and including 1953 will be found in [1].

Up to and including the year 1953 the annual means were based on one absolute observation of D, H and I made at approximately the same times on the Thursday of each week. Beginning with 1954 the annual means have been based on the mean hourly values of D, H and Z as tabulated from LaCour Variometers.

2. Instrument Comparisons

2.1. The instruments used for the weekly absolute observations were compared with similar instruments at Kew Observatory in 1924. The results of that comparison showed that:

(a) The Valentia Dover Dip Circle was giving results 0'·3 too high.

(b) The Valentia Magnetometer was giving results 7y too high for H and 0'·15 too high for D.

2.2. Circumstances prevented any subsequent comparison of the Valentia instruments with other instruments until 1953. At the beginning of that year a new set of La Cour Variometers was installed at the Observatory and was recording on an experimental basis throughout the year. Other new instruments brought into use at the same time were:

(a) The Copenhagen Quartz Magnetometer (QHM) for D and H determination.

(b) The Copenhagen Magnetometric Zero Balance (BMZ) for Z determination.

It was possible therefore with the aid of the Variometers, to compare the results obtained with the old equipment and the corresponding results with the new equipment.

The results of this comparison showed that:

(a) The Dover Dip Circle was giving values of I 2'·0 too high.

(b) The Dover Magnetometer was giving results 47y too high compared with the QHM's.

(c) The Dover Magnetometer gave Declination values 0'·2 too low compared with the QHM's.

3. Adjustment of Annual Means for 1899 - 1953.

Based on the 1953 comparisons adjustments were made to the annual means observed with the old instruments to bring them into line with the new equipment. In the absence of any information to the contrary it was assumed that the accumulated error between 1924 and 1953 was the result of a gradual drift in the instrumental "constants". Linear corrections were, therefore, applied to the earlier means to produce a homogeneous series. This is the series of means which have since 1953 been accepted.

In 1954/55, however, a comparison of the Valentia BMZ standard with

the Abinger Dye Coil showed that the BMZ was giving results which were 103y too high [2]. The BMZ constant was adjusted accordingly and for subsequent years the Valentia standard was maintained in agreement with the Abinger standard by means of annual comparisons, which continued until 1970 when they became redundant with the introduction of a Proton-Vector Magnetometer as the base line standard for Z and H at Valentia.

The adjustment to the annual means previous to 1954 was based on the assumption that the BMZ values were correct. The error subsequently found in the BMZ necessitates a re-adjustment of those earlier values to eliminate the discontinuity between the old and new regimes. This re-adjustment has now been made.

3. Adjustment of Annual Means for 1954 - 1969.

The instruments used for base line determination for H and Z during this period were subject to a gradual process of evolution and improvement. The following are the main phases:

3.1. Horizontal Force (H)

	Base Line Instrument
1954 - 1958	QHM No. 183 (supplemented by three other QHM's)
1959 - 1969	Ruska Observatory Magnetometer No. 5917.
1970 onwards	Proton Vector Magnetometer.

3.2. Vertical Force (Z)

1954 - 1966	BMZ No. 66 (supplemented by BMZ No. 112)
1967 - 1969	Total Force observed by Proton Precession Magnetometer combined with H observed with Ruska Magnetometer.
1970 onwards	Proton Vector Magnetometer.

3.3. Intercomparisons

The QHM's were kept in agreement with the Rude Skov standard by means of regular comparisons (See Annual Magnetic publications). The BMZ instruments were also kept in agreement with the Abinger Dye Coil by means of annual comparisons. With the introduction of the truly absolute Proton Vector Magnetometer in 1970 it was possible to check the accuracy of the Ruska instrument. It was found that this instrument was reading 6y too high. This was a very small reasonable discrepancy in view of the fact that the original calibration was in 1959. The 6y error has been spread linearly over the period 1960 - 1969.

As mentioned in [3] the Proton - Ruska base line for Z was found to be 5·9y lower than the Dye Coil values. The Proton Vector results agreed well with the Dye Coil results and confirmed that the Proton - Ruska base used during the years 1967 - 1969 was about 5·9y too low.

The introduction of the Proton Vector magnetometer, since it is used on a special pillar about 2 metres from the BMZ or Ruska pillars, also involved a small site correction. This correction is included in the figures mentioned above. Thus to bring the data for previous years into line with the 1970 values (which being based on the Proton Vector instrument are accepted as truly absolute) the following amendments should be applied to the observed and published values:

Horizontal Force

	1961	1962	1963	1964	1965	1966	1967	1968	1969
Subtract(y)	1	1	2	3	3	4	4	5	6

Vertical Force

Add 6y to the observed values for each of the years 1967 - 1969 during which the Proton Precession (T) and Ruska (H) data were combined to give the adopted base line values for Z.

4. Conclusion

Table 1 gives the full set of annual mean values since 1899 which have been adjusted to include all the corrections referred to above and bring them into continuity with the 1970 values. It must be remembered, however, that prior to 1954, irrespective of the standard of accuracy of the instruments used, the annual means can only be approximate since they were based only on one absolute observation per week. Since 1954 the annual means, being based on the mean hourly values, should be very close to the accurate absolute value and the use of the Proton Vector Magnetometer since 1970 should ensure the maintenance of a good standard of absolute accuracy.

References

[1] Magnetic Observations at Valentia Observatory 1941 - 1953. (Published by the Irish Meteorological Service)

[2] Magnetic Observations at Valentia Observatory 1954. (Published by the Irish Meteorological Service)

[3] Magnetic Observations at Valentia Observatory 1969. (Published by the Irish Meteorological Service)

Annual Mean Values of the Magnetic Elements at Valentia Observatory

Year	D o '	H y	I o '	X y	Y y	Z y	T y
1899	-21 35·0	17739	68 33·0	16495	-6525	45149	48508
1900	-21 30·0	17765	68 29·6	16529	-6511	45084	48458
1901	-21 27·7	17801	68 26·3	16567	-6513	45048	48438
1902	-21 24·2	17833	68 23·9	16603	-6508	45037	48439
1903	-21 18·7	17833	68 22·6	16614	-6481	44987	48393
1904	-21 15·2	17840	68 20·9	16627	-6467	44941	48352
1905	-21 10·4	17848	68 19·2	16643	-6447	44895	48313
1906	-21 06·3	17867	68 16·9	16669	-6433	44856	48283
1907	-21 01·4	17870	68 17·0	16680	-6411	44867	48295
1908	-20 55·7	17870	68 16·3	16691	-6383	44840	48270
1909	-20 50·3	17877	68 15·1	16708	-6359	44813	48247
1910	-20 44·6	17892	68 13·0	16732	-6337	44771	48214
1911	-20 38·1	17889	68 12·1	16741	-6304	44729	48174
1912	-20 29·3	17898	68 10·3	16766	-6265	44684	48135
1913	-20 19·6	17892	68 09·2	16778	-6215	44628	48081
1914	-20 12·3	17895	68 07·8	16794	-6181	44583	48040
1915	-20 03·8	17869	68 07·9	16785	-6130	44522	47974
1916	-19 53·1	17869	68 06·6	16804	-6078	44473	47929
1917	-19 43·0	17855	68 06·9	16808	-6024	44449	47901
1918	-19 36·2	17843	68 06·5	16809	-5986	44405	47855
1919	-19 27·2	17840	68 06·1	16822	-5941	44382	47833
1920	-19 17·9	17837	68 05·3	16835	-5895	44345	47798
1921	-19 06·5	17844	68 03·4	16861	-5841	44292	47751
1922	-18 57·0	17844	68 02·9	16877	-5795	44273	47734
1923	-18 46·5	17846	68 01·3	16896	-5744	44219	47684
1924	-18 34·9	17847	68 00·3	16917	-5687	44184	47652
1925	-18 22·4	17841	67 59·6	16932	-5624	44143	47612
1926	-18 10·8	17825	67 59·6	16935	-5561	44104	47570
1927	-17 59·5	17826	67 58·5	16954	-5506	44066	47535
1928	-17 48·0	17813	67 58·5	16960	-5445	44033	47500
1929	-17 37·3	17807	67 58·6	16971	-5391	44022	47487
1930	-17 27·6	17798	67 58·7	16978	-5340	44004	47467
1931	-17 16·8	17798	67 57·4	16995	-5287	43956	47422
1932	-17 05·4	17791	67 57·1	17005	-5228	43928	47394
1933	-16 54·5	17792	67 56·4	17023	-5175	43904	47372
1934	-16 43·7	17791	67 55·8	17038	-5121	43880	47349
1935	-16 32·7	17782	67 55·6	17046	-5064	43850	47319

Annual Means of the Magnetic Elements at Valentia Observatory

Year	D ° '	H γ	I ° '	X γ	Y γ	Z γ	T γ
1936	-16 21·6	17777	67 55·7	17057	-5007	43842	47309
1937	-16 11·7	17777	67 55·9	17072	-4958	43849	47315
1938	-16 02·7	17782	67 56·3	17089	-4915	43876	47342
1939	-15 54·1	17793	67 56·1	17112	-4875	43896	47365
1940	-15 45·6	17798	67 56·1	17129	-4834	43908	47378
1941	-15 36·8	17808	67 55·2	17151	-4793	43900	47374
1942	-15 28·0	17831	67 53·6	17185	-4755	43898	47381
1943	-15 19·8	17837	67 53·6	17202	-4716	43913	47397
1944	-15 11·6	17861	67 52·1	17237	-4681	43917	47410
1945	-15 03·6	17867	67 51·1	17253	-4642	43895	47392
1946	-14 54·2	17857	67 52·3	17256	-4593	43914	47406
1947	-14 45·1	17876	67 52·3	17287	-4552	43961	47456
1948	-14 37·2	17883	67 52·1	17304	-4514	43971	47468
1949	-14 30·1	17911	67 50·9	17340	-4485	43996	47502
1950	-14 23·9	17952	67 49·8	17388	-4464	44056	47573
1951	-14 16·5	17983	67 48·3	17428	-4434	44077	47604
1952	-14 10·3	18020	67 45·7	17472	-4412	44072	47614
1953	-14 03·6	18061	67 44·3	17520	-4388	44121	47675
1954	-13 55·9	18109	67 41·8	17576	-4360	44147	47717
1955	-13 48·5	18137	67 39·9	17613	-4329	44146	47727
1956	-13 41·6	18158	67 39·0	17642	-4298	44165	47752
1957	-13 35·1	18192	67 37·1	17683	-4273	44178	47777
1958	-13 29·0	18226	67 35·4	17724	-4250	44197	47808
1959	-13 22·9	18252	67 34·1	17756	-4224	44215	47831
1960	-13 16·4	18279	67 32·7	17791	-4197	44229	47857
1961	-13 10·3	18318	67 30·5	17836	-4174	44242	47884
1962	-13 04·1	18359	67 27·9	17884	-4151	44245	47903
1963	-12 57·6	18391	67 26·0	17923	-4125	44253	47922
1964	-12 51·6	18428	67 23·7	17966	-4102	44260	47943
1965	-12 46·1	18466	67 21·4	18009	-4081	44268	47965
1966	-12 40·8	18495	67 19·8	18044	-4060	44277	47985
1967	-12 35·7	18526	67 18·3	18080	-4040	44298	48016
1968	-12 30·7	18564	67 16·3	18123	-4022	44316	48047
1969	-12 25·8	18605	67 14·1	18169	-4005	44337	48082
1970	-12 20·6	18651	67 11·8	18220	-3987	44361	48122
1971	-12 14·8	18697	67 09·3	18271	-3966	44379	48157
1972	-12 08·2	18735	67 07·4	18316	-3939	44400	48191

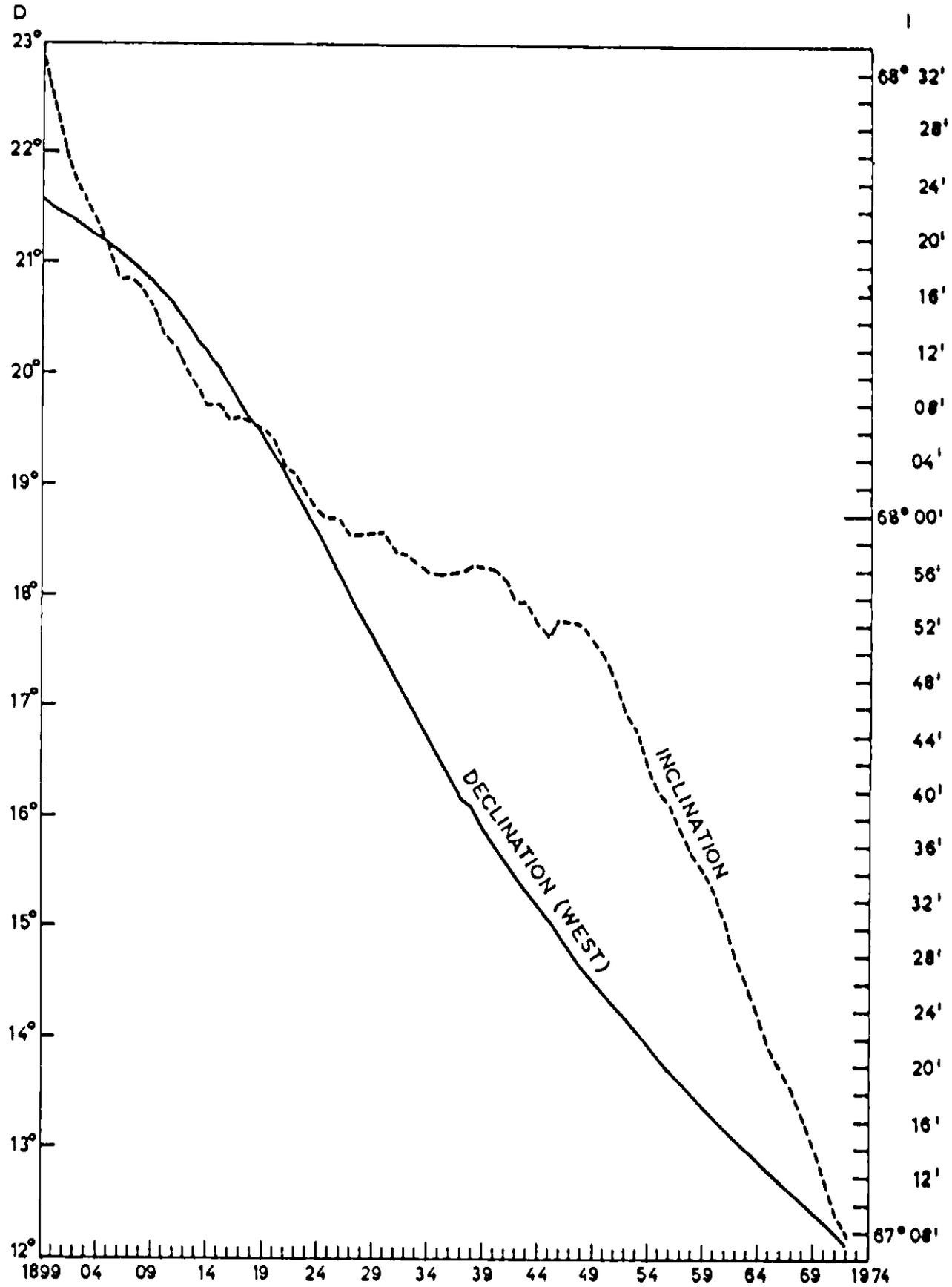

Fig. 1. Annual mean values of declination (D) and inclination (I), 1899 - 1972.

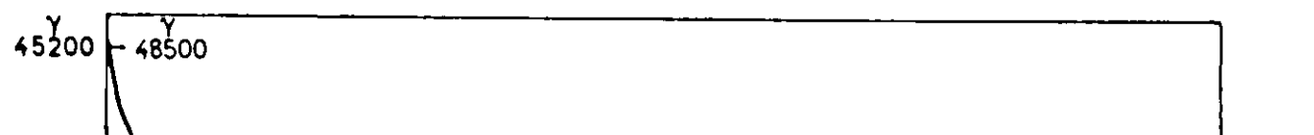

Fig. 2. Annual mean values of horizontal force (H), vertical force (Z) and total force (T) 1899 - 1972.