XI. *Obſervations made at* Beverly, *Lat.* 42° 36′ *N. Long.* 70° 45′ *W. to determine the Variation of the magnetical Needle. By the Rev.* JOSEPH WILLARD, *Preſident of the Univerſity at* Cambridge, *V. Preſ. A. A.*

AN attention to the variation of the magnetical needle, it is well known, is of great importance at ſea, nor is it of ſmall conſequence upon the land; eſpecially in *North-America.* From the firſt ſettlement of this country, the lines between towns, and between lots of land appropriated to individuals, have been determined by the magnetical needle. If the variation always continued the ſame, no difficulty would enſue, in again tracing the lines, upon the ſame magnetical courſe; but as it alters from time to time, the lines run in any ſucceeding years muſt deviate from the firſt, and from one another, unleſs proper allowances are made for the alteration.

From the want of a ſufficient number of obſervations, and of attention to this ſubject, in thoſe who have ſurveyed the lands in this country, difficulties have ariſen at one time and another, between towns and individuals. To remedy this inconvenience for the future, this Academy, ſome time ago, recommended magnetical obſervations, to determine the variation, which it is to be hoped will be made in various parts of the country, and at proper intervals of time, and be uniformly attended to by our ſurveyors. Since this recommendation, I have endeavoured to determine the variation at *Beverly*, with as much exactneſs as I was able. With this view, I procured an azimuth compaſs, of Dr. *Gowin Knight*'s invention. It appears to be good

good of its kind, and is furniſhed with a vernier, pointing out the azimuth to 5′; but the eye may pretty eaſily determine by it to 2′, and ſometimes to 1′. To obſerve by this compaſs, I aſcertained the going of my clock to great exactneſs, and on five different days, took ſeveral magnetical azimuths, both before and after the ſun paſſed the meridian, and noted the moments, which I have put down in apparent time. For theſe times, I have calculated the true azimuths by ſpheric trigonometry, and have carried out the variation for each obſervation ſeparately. On two days, I alſo determined the variation, by taking magnetic azimuths, at correſponding altitudes of the ſun, making proper allowances for the change of declination, between the obſervations of the forenoon and afternoon. On each of the days, ſome of the obſervations differ ſeveral minutes from others; but this I cannot attribute to want of attention, as I am conſcious that I made them with all the care in my power. The differences, I ſuſpect, principally aroſe from the difficulty of determining, with entire exactneſs, when the ſhadow from the hair was on the line beneath; and when in two obſervations, the error ſhould be on different ſides, the ſum might make a number of minutes. But I have the ſatisfaction of finding the mean reſults for the ſeveral days well agreeing with each other, which is a good evidence that the reſult of the whole muſt be, at leaſt, very near the truth.

Theſe obſervations and deductions are now humbly ſubmitted to the Academy, with wiſhes that they may ſubſerve the deſigned purpoſe.

JULY

JULY 27, 1781.

Ap. times of obs.	Sun's mag. az. per obs.	Sun's true az. per cal.	Varia. of the need.
11h 34′	S 80 2′ E	S 15° 9′ E	7° 7 W.
11 36	7 0	14 2	7 2
11 50	S 1 10 W	5 57	7 7
11 58	5 55	1 15	7 10
12 4	9 28	S 2 26 W	7 2
12 20	18 45	11 45	7 0
12 26	22 15	15 10	7 5
12 28	23 30	16 17	7 13
Variation of the needle by a mean of 8 obſervations, July 27,			7 5¾

JULY 28.

11h 44	S 2° 25′ E	S 9° 19′ E	6° 54′ W.
12 4	S 9 15 W	S 2 20 W	6 55
12 6	10 35	3 30	7 5
12 8	11 45	4 40	7 5
12 22	19 45	12 46	6 59
12 26	22 5	15 2	7 3
12 30	24 15	17 16	6 59
Variation by the mean of 7 obſervations, of July 28.			7 0

JULY 30.

11 52	S 2 30 W	S 4 37 E	7 7 W.
12 2	8 15	S 1 10 W	7 5
12 6	10 28	3 28	7 0
12 18	17 28	10 19	7 9
12 26	21 55	14 47	7 8
Variation by the mean of 5 obſervations, of July 30.			7 5⅘

JULY 31.

11 29 32″	S 10 10 E	S 17 7 E	6 57 W.
11 39 32	4 35	11 37	7 2
11 43 32	2 20	9 23	7 3
11 51 32	S 2 5 W	4 51	6 56
11 55 32	4 32	2 34	7 6
11 59 32	6 40	0 16	6 56
12 1 32	7 50	0 53 W	6 57
Variation by the mean of 7 obſervations, of July 31,			6 59⅘

AUGUST 1.

11 53 52	S 3 32 W	S 3 28 E	7 0 W.
11 59 52	7 2	0 4	7 6
12 1 52	8 0	1 4 W	6 56
12 3 52	9 10	2 12	6 58
12 15 52	15 58	8 59	6 59
Variation by the mean of 5 obſervations, of Auguſt 1,			6 59⅘

Variation

Variations determined by magnetic azimuths, taken at equal altitudes of the ſun, forenoon and afternoon.

AUGUST 6.

A. M.	P. M.	Difference.	½ Diff. = Variation.
68° 28′	82° 30′	14° 2′	7° 1′ W.
65 30	79 20	13 50	6 55
63 50	77 35	13 45	6 52½
63 30	77 15	13 45	6 52½
63 0	77 0	14 0	7 0
62 30	76 32	14 2	7 1
Mean variation by the above ſix obſervations of Auguſt 6,			6 57
Equation for change of declination,			+ 4
Variation,			7 1

AUGUST 15.

67 30	81 30	14 0	7 0
67 10	81 5	13 55	6 57½
66 42	80 40	13 58	6 59
66 15	80 18	14 3	7 1½
66 2	79 55	13 53	6 56½
64 45	78 40	13 55	6 57½
64 12	78 8	13 56	6 58
63 58	77 48	13 50	6 55
63 37	77 35	13 58	6 59
63 0	77 6	14 6	7 3
61 46	75 45	13 59	6 59½
61 20	75 26	14 6	7 3
60 58	74 50	13 52	6 56
58 50	72 45	13 55	6 57½
58 30	72 25	13 55	6 57½
58 15	72 10	13 55	6 57½
57 40	71 30	13 50	6 55
57 10	70 58	13 48	6 54
56 43	70 42	13 59	6 59½
Mean variation by the above nineteen obſervations,			6 58¼
Equation for change of declination,			+ 5
Variation by nineteen obſervations of Auguſt 15,			7 3¼
Ditto ſix		6,	7 1
Ditto five		1,	6 59⅘
Ditto ſeven		July 31,	6 59⅘
Ditto five		30,	7 5⅘
Ditto ſeven		28,	7 0
Ditto eight		27,	7 5¾
Varian. by the mean of ſeven days, containing fifty-ſeven obſ.			7 2