XX. *Observations on the Variation, and on the Dip of the magnetic Needle, made at the Apartments of the Royal Society, between the Years* 1786 *and* 1805 *inclusive. By Mr.* George Gilpin. *Communicated by* Henry Cavendish, *Esq. F.R.S.*

Read June 19, 1806.

Of the Variation Compass.

THE variation compass used in making the following observations is the same instrument used in former observations of the variation, and published by the Society in several volumes of their Transactions: and as a particular and accurate description of its construction was given by HENRY CAVENDISH, Esq. F.R.S. in the LXVIth volume, it will not be necessary to say any thing here on that subject. But these observations being the first that have been communicated since the compass was put up in the Society's apartments in Somerset Place, it may not be amiss to point out its situation in the house at the time of observation, and the method pursued to attain such allowances as were proper to be made in deducing the results here given.

1. The compass in the house, at the time of observation, was placed in the middle window, on the south side of the Society's meeting-room, upon a strong mahogany board $1\frac{1}{2}$ inch thick. Against the opposite building the dial-plate of a watch is fixed, making an angle with the true meridian of $31^\circ\ 8',8$ to the eastward, as a mark to which the telescope of

the compass was adjusted. To obtain the angle that this mark made with the true meridian, I fixed a transit-instrument on the mahogany board above mentioned, precisely in the same place where the compass had been placed, and having adjusted its telescope to the said mark, the transits of the sun and stars over a vertical circle passing through the zenith and this mark, were observed; and the angle contained between the said mark and the true meridian, was found by computation to be 31° 8′,8 as above.

2. For the purpose of ascertaining what error there might be, from a want of parallelism between the line joining the indices and the magnetism of the needle, and thereby to determine whether in the usual method of observing, the indices shew the true angle which the direction of magnetism makes with the first division or zero, a great many observations were made on both ends of the needle, and with both sides of the needle uppermost, (the cap of the needle being made to fit on readily on either face for this purpose,) *viz.* north end and south end in its upright position, and north end and south end with the needle inverted, and the mean of the four giving the angle greater by 2′, than that shewn by the north end in the upright position of the needle, (which was the end always used in these observations,) two minutes have been added to all the observations read from the instrument, as the correction for this error to angles on the east side of zero, and subtracted from angles on the west side, to obtain the true angle; which error to angles on the west side, however, only occurred, when the instrument was taken out of doors to determine the effect of the iron work of the building.

3. The variation compass being placed in the house for observation, could not be supposed to be entirely out of the influence of iron; I was therefore desirous to ascertain how far that influence might extend; for the determination of which, the following method was adopted.

Having caused to be sunk into the earth to some depth a strong post, in the wood yard of Somerset House, at a considerable distance from the influence of any iron, on which the compass might be placed, and from which station, there was a convenient mark at a proper distance to which its telescope could be adjusted; I took the compass there at those times of the day when the needle was stationary, *viz.* morning and afternoon: before the compass was carried out of doors, observations were made in the room; then it was taken out of doors to the above mentioned station for observation there; and the observations were again repeated after the compass had been restored to its situation in the room; so that had any alteration taken place in the interval, such alteration would have been detected; but during the whole series, no material difference occurred between the observations made in the house before, and after those taken in the yard.

The observations therefore made in the yard, compared with those taken in the house, both before and after those taken out of it, formed the comparison for obtaining the error, or the effect of the iron work of the room on the needle in the house, and there is reason to believe that considerable accuracy has been obtained. They are as follow.

By a mean of 20 sets, or 200 observations taken with the compass in the yard, compared with twice that number taken in the house, before and after those taken in the yard, the

variation observed in the house was found to be greater than that observed in the yard by 5′,4. The mean of nine sets of observations taken in the morning giving for the error 5′,5. And the mean of eleven taken in the afternoon giving for the error 5′,3. The variation in those tables have therefore been lessened by the above mentioned quantity 5′,4, as the error for the effect of the iron work of the room on the needle in the house.

I must not omit to mention that of these 20 sets of observations mentioned above, nine only were made with the compass in the same situation, and eleven in that of a different one; for, after nine sets had been taken, a pile of boards was put up between the compass and the mark to which it had been adjusted, which made it necessary to remove the post on which the compass had been placed, a few feet to the westward of its former situation, to clear it from the said pile of boards; and eleven sets of observations were made from this new station, with the compass adjusted to the same mark it had been adjusted to before, and the angles that this mark made with the true meridian from each of these stations, were ascertained by placing a transit-instrument precisely where the compass had been placed, and observing transits of the sun and stars, in the same manner as has been described in finding the angle of the mark that the compass was adjusted to in the house. And it is conceived that this accidental circumstance adds some weight to the accuracy with which these operations were performed, as the error from the two results of nine, and eleven, does not differ so much as 0′5 from each other.

Dipping Needle.

The dipping needle with which the observations in this communication were made, being the same instrument used in former observations of the dip, and it having also been described by Mr. CAVENDISH in the Paper before alluded to, it will not be necessary to say any thing of its construction here. Its situation in the house was in the eastern window in the meeting-room, next the door.

As the observations made with the dipping needle were not affected by any other source of error than that of the iron work of the room, in order to ascertain the quantity of error, the instrument was taken out of doors at two different times, after an interval of ten years, differently situated each time, and the observations made at both these times out of doors, compared with the observations made in the room, giving for the error 20′ more than the dip was found to be in the room, and both agreeing to one minute; that quantity has been added to all the observations made with the dipping needle in the room for its error, as affected by the iron work of the room.

Although a valuable Paper on the diurnal variation of the horizontal magnetic needle, by the late Mr. JOHN CANTON, F. R. S. was published in the first part of the LI[st] volume of the Phil. Trans. for the year 1759, containing a great number of observations made at different and irregular times of the day throughout the year; yet, it appeared to me, that if the variation were to be observed at short but stated intervals of the day for one year, the results would perhaps not only prove more satisfactory in determining the times of the needle becoming stationary, but would show its progressive and regressive motions better, than if observed at irregular intervals. To effect which, I imposed this laborious task upon myself for the space of sixteen months.

The observations contained in Table I. in sixteen pages, *viz.* from September, 1786, to December, 1787, both inclusive, are the results, made at many but stated times of the day, and so disposed, that the progress, or regress, of the variation, may be readily seen by mere inspection.

Table II. contains the mean monthly variation for the above mentioned times of the day contained in Table I.

Table III. contains, besides the mean monthly true variation, and mean monthly diurnal alteration of variation, for the sixteen above mentioned months, the mean monthly true variation, and diurnal alteration of variation for many months in the year, between the years 1786 and 1805 inclusive.

The numbers put down in Table I. are each of them a mean of five observations, and often more.

Those in Table II. depend on Table I.

As the observations from which the true variation has been given in Table III. between the years 1788 and 1805 were too numerous to be all inserted, it has been thought sufficient to

give the mean monthly true variation, and mean monthly diurnal alteration of variation only; and they were determined from a mean of the observations made at those times of the day when the variation was considered least, and greatest; which variations for each month, may generally be considered as a mean of 600 observations.

From the observations made by the late Dr. HEBERDEN and others, about the year 1775, the variation was found to increase annually nearly 10′, since that time to the present, its rate of increase has been considered as gradually diminishing,* and for the last three or four years the alteration has been so very small as to make it somewhat doubtful whether it may

* An exception to the progressive increase appears between the years 1790 and 1791, as the observations between these two years make it to decrease 2 or 3′, and subsequent observations to increase again; to what this should be attributed, I am at a loss to account, unless it arose from the alteration which took place in the iron work of the room in December, 1790; four strong iron braces having been applied to the girders in the floor of the great room of the Royal Academy, (which is over the Society's meeting-room,) in consequence of a cracking noise made from the great pressure of a number of persons in the room during the time that Sir JOSHUA REYNOLDS was delivering a lecture; these braces were applied two on each side of, and equidistant from, the compass, the nearest, about 18 feet from it. It may be proper to mention, however, that having been favoured with the variation observed both by Mr. CAVENDISH and Dr. HEBERDEN, in the above mentioned years the alteration of the variation was by the former nearly the same as in my own, but by those of the latter greater in both cases.

An alteration took place between the observations made with the dipping needle in the same years. All the iron braces were on the north west side of the needle, and the nearest about 18 feet from it.

The allowances made to the observations of the variation, and also of the dip, for the effect of the iron work of the room, were both ascertained after the above mentioned alteration in the iron work took place, but they have, notwithstanding, been applied to the observations made before as well as since that time.

not be considered stationary, but I would not from so short a period conclude that it really is so.

From the observations of sixteen months, *viz.* from September, 1786, to December, 1787, both inclusive, the variation may be considered as generally stationary at or about 7 or 8 o'clock in the morning when it is least; and about 1 or 2 o'clock in the afternoon when it is greatest; and therefore it has been the practice in determining the true variation put down in these tables, to take a mean of the two morning, and the two afternoon observations, made at those times, for the true variation.

In March, 1787. The mean monthly diurnal alteration of variation was found to be 15′,0; in June 19′,6; in July 19′,6; in September 14′,8; and in December 7′,6. But on a mean of 12 years observations, from the year 1793 to 1805, the diurnal alteration of variation in March was only 8′,5; in June 11′,2; in July 10′,6; in September 8′,7; and in December 3′,7.

Table IV. contains the differences for 12 years, *viz.* from 1793 to 1805, between the observations of the variation made in the months of March, June, September, and December, or at the times of the vernal and autumnal equinoxes, and summer and winter solstices; by a mean of these 12 years, the variation appears to increase or go westward, from the winter solstice to the vernal equinox 0′,80; diminishes or goes eastward from the vernal equinox, to the summer solstice 1′,43; increases again from the summer solstice to the autumnal equinox 2′,43; and continues nearly the same, only decreasing 0′,14, from the said equinox to the winter solstice.

These differences at the times of the equinoxes and sol-

stices have been noticed by M. CASSINI, in his observations made at the Royal Observatory at Paris, between the years 1783 and 1788, but the effect was considerably greater in his observations, than in those mentioned above; his results however were, in my opinion, drawn from too few observations, being from only 8 days observations about the times of the equinoxes and solstices, which differ considerably among themselves; and experience teaches us, that magnetical observations made for a period so limited are not sufficient for minute purposes: I have therefore, in the results here given, taken the mean of the observations made during the whole month in which the equinoxes and solstices fall, which appear to me likely to furnish results more satisfactory; and all the foregoing observations are to be considered as the results or mean of a great many, by way of arriving at greater accuracy than could be obtained without; this, however, was found to be more necessary at some times than at others; sometimes, the needle would be extremely consistent with itself, so as to return exactly to the same point, however often it might have been drawn aside; at other times it varied 2 or 3′, sometimes 8, 10′, or even more; this uncertainty in the needle arises principally, I believe, from changes in the atmosphere, for, a change of wind, from any quarter to another, almost always produced a change in the needle from steady to unsteady, and *vice versâ*, but it was generally more unsteady with an easterly wind, than when it blew from any other quarter, and most steady when the wind was south or south-westerly. An Aurora Borealis always produced considerable agitation of the needle.

It has been mentioned in this Paper, that the annual increase

of variation was found about the year 1775 to be nearly 10′; and was considered at that time to be gradually diminishing, but it is remarkable that this rate of increase appears from the annexed Table to be nearly the same at which it has been found to move between all the different periods in the said Table, from 1580 to 1787, a period of more than 200 years, excepting between the years 1692 and 1723; the observations of Dr. HALLEY in 1692 and Mr. GRAHAM in 1723 make the annual increase 16′; to what this difference could be owing I am at a loss to account; on referring to observations made at Paris for those two years the annual increase is 14′; subsequent observations made by Mr. GRAHAM in 1748 make the annual increase between this year and 1723 only 8′,1 nearly what its rate had been found before this great difference occurred; and from the variation of Mr. GRAHAM in 1748, and the variation observed by Dr. HEBERDEN in 1773, the annual increase is 8′,4; the variation in 1773 compared with the variation observed by myself in 1787, give for the annual rate of increase 9′,3; but between 1787 and 1795, the annual increase was only 4′,7; between 1795 and 1802, 1′,2; and between 1802 and 1805, only 0′,7.

The mean rate of annual increase for the above mentioned period of 207 years, *viz.* from 1580 to 1787, is 10′.

As there appears something curious in the rate at which the variation has been moving from observations made at London, for a period of more than 200 years, the annual increase of which during that time continued nearly the same, but in a subsequent period of 18 years only, the decrease of that annual increase became so rapid, that the annual increase in the latter part of it does not amount to quite one minute,

I shall subjoin the following Table, by way of elucidating what is here mentioned.

By whom the Variation was observed.	Year.	Variation.	Annual Increase.
		° ′	′
Mr. BURROWS,* in - -	1580	11 15 E	
			+ 7,5
Mr. GUNTER - - -	1622	6 0	
			9,6
Mr. GELLIBRAND - -	1634	4 6	
			10,6
Mr. BOND† - - -	1657	0 0	
			10,2
Mr. GELLIBRAND‡ -	1665	1 22 W	
			9,7
Dr. HALLEY§ - -	1672	2 30	
			10,5
——— - -	1692	6 0	
			16,0
Mr. GRAHAM‖ - - -	1723	14 17	
			8,1
——— - -	1748	17 40	
			8,4
Dr. HEBERDEN¶ - -	1773	21 9	
			9,3
Mr. GILPIN - - -	1787	23 19	
			4,7
——— - -	1795	23 57	
			1,2
——— - - -	1802	24 6	
			0,7
——— - -	1805	24 8	

* The observations of BURROWS, GUNTER, and GELLIBRAND's, in 1634, are taken from SELLER's Practical Navigation, 1676. BURROW's observations are said to be the oldest and best in the world; longitude and latitude found by dipping needle, p. xvi. GELLIBRAND is said to be the first person who ascertained the variation of the variation, about the year 1625, Phil. Trans. No. 276—278; but if this is the date of the observations by which it was determined, the observations of GUNTER in 1622, show him to have a prior claim; BOND, in his Longitude found, p. 5 and 6, says that the variation was first found to decrease by Mr. JOHN MAIR, secondly by Mr. EDMUND GUNTER, thirdly by Mr. HENRY GELLIBRAND, and by himself in 1640.

† Longitude found, p. 3.

‡ Ibid. p. 13; and Longitude and Latitude found by Dipping Needle, p. 6.

§ Phil. Trans. No. 195, p. 565.

‖ Ibid. No. 383, p. 107; and No. 488, p. 279.

¶ Obligingly communicated by his son, the present Dr. HEBERDEN.

Table V. contains the dip of the magnetic needle from the years 1786 to 1805. For the first sixteen months, *viz.* from September, 1786, to December, 1787, both inclusive, the dip was observed as frequently as the variation, *but as there does not appear to be any diurnal alteration in the dip*, to make it at all interesting to communicate so many observations as were made, the mean therefore for each month has been thought sufficient for insertion.

To explain the foregoing Table it must be observed, that each of the numbers in the four first columns of the above Table, are each of them the mean of several means, as expressed in the line against those numbers; and as each of those means, are again the mean of five observations at least, each of the numbers in the first line, said to be the mean of nine means, is therefore a mean of forty-five observations; and so of all the rest.

The numbers in the fifth column, entitled true dip, are the means of the numbers contained in the four preceding columns in the same line with it.

The dipping needles used by NORMAN, the inventor of the dipping deedle, who observed the dip at London in the year 1576 to be* 71° 50′; and of Mr. BOND, who observed it in 1676 to be† 73° 47′; not being so much to be depended upon as the needles that have been in use for near a century past, render the progressive increase of the dip from NORMAN's time, to the time of its maximum, somewhat doubtful. But Mr. WHISTON, whose needle there is reason to believe was more to be relied upon, in the year 1720 determined the dip

* New Attractive, c. 4. † Longitude found.

to be* 75° 10′; this, when compared with many, and very accurate observations made by Mr. CAVENDISH, with several needles in the year† 1775, who found it to be 72° 30′, makes the decrease in this period of 55 years on a mean, 2′,9 *per annum.* And from a comparison of my own observations of the dip in 1805, which was 70° 21′, with the above of Mr. CAVENDISH in 1775, its annual decrease, on a mean, appears to have been 4′,3; and its progressive annual decrease on a mean in the above mentioned period of 30 years 1′,4.

I cannot conclude this Paper without expressing my regret, that so little avail should have been made of the numerous opportunities which have been afforded to travellers and others in the last century for making accurate observations with proper instruments, at land, on the variation in different parts of the world: such observations would probably have afforded some curious and useful facts which would have materially assisted in forming a theory much more certain than what we at present possess; the present received opinion of the cause of the diurnal alteration of variation would be confirmed or invalidated; its quantity of effect in different places, a most desirable acquisition, would be ascertained; and we should be put in possession of more valuable and correct information on the variation than can be derived from observations made with the common azimuth compass, even at land, owing to its imperfect construction. The variation thus accurately obtained at any one period, compared with the variation correctly ascertained at a subsequent period, would

* Longitude and Latitude found by Dipping Needle, p. 7—94.

† Phil. Trans. Vol. LXVI. p. 400.

give a rate of alteration of the variation which could be relied on.

The celebrated HALLEY thought the variation of so much importance, that he made two voyages for the purpose of making observations on the variation, to confirm his theory advanced in 1683, and soon after he published his variation chart. Since his time no better theory than he left has been obtained, although it must be confessed that many observations have been made at sea by voyagers; but these observations made generally to answer the purpose of the observer at the time only, are therefore seldom preserved; for unless made by authority, which rarely happens, they do not often meet the public eye; and it must be from observations made with care, and with good instruments, carefully registered, and properly arranged, that any real advantage can be derived. It is hoped therefore, that in future attention to this subject will not be thought beneath those who may have it in their power essentially to promote an undertaking so interesting to the philosopher, and so valuable and useful to the maritime world.

TABLE I.

Observations on the Variation of the magnetic Needle.

1786	7 A.M.	8 A.M.	10 A.M.	12 M.	1 P.M.	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Sep. 1	23 7	23 10	23 18	23 27	23 29	23 28	23 20	23 ...	23 ...	23 26
2	9	10	14	20	21	21	...	...	...	14
3	7	8	11	20	23	24	...	11	10	10
4	9	9	16	22	23	23	...	...	...	12
5	9	10	16	22	23	22	16	11	...	...
6	6	6	15	23	24	23	...	14	...	8
7	7	8	...	26	27	26	18	13	...	8
8	23	23	18	23	23	23	...	16	13	...
9	7	9	...	24	26	26	20	17	...	15
10	15	16	...	28	28	26	...	...	...	14
11	9	14	...	25	25	24	...	17	14	14
12	3	...	15	26	18	...	...	17	17	16
13	5	6	...	25	26	23	21	...	...	13
14	4	...	...	19	22	26	...	...	15	14
15	8	...	...	20	23	23	19	14	13	13
16	8	10	...	20	22	22	...	...	12	9
17	8	...	15	24	28	28	...	16	...	10
18	6	7	13	19	19	20	...	18	15	14
19	5	...	11	18	23	23	20	18	15	15
20	8	...	11	21	23	24	16	15	14	12
21	12	...	14	19	23	23	15	15	14	14
22	11	...	14	20	23	23	18	16	13	13
23	5	...	8	22	22	23	...	...	12	11
24	3	...	11	20	23	24	20	15	12	11
25	7	9	15	20	23	23	21	17	11	10
26	5	...	14	21	24	26	22	14	11	10
27	8	10	17	24	26	27	21	14	10	9
28	5	6	13	18	19	19	20	18	15	5
29	10	...	19	27	28	25	16	...	...	16
30	9	...	21	24	24	24	20	16	21	10

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1786	7 A.M.	8 A.M.	10 A.M.	12 M.	1 P.M.	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	11 P.M.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Oct. 1	23 7	23 9	23 13	23 21	23 23	23 ...	23 ...	23 ...	23 12	23 10	23 ...
2	14	...	17	23	26	27	20	11	10	10	11
3	11	...	18	23	27	29	22	19	16	14	13
4	9	...	15	23	23	24	18	18	14	...	...
5	9	...	14	23	25	25	21	17	14	12	12
6	9	...	14	24	24	24	21	14	14	10	11
7	8	...	11	20	23	23	19	17	15	15	15
8	9	...	15	23	23	22	17	16	16	16	16
9	8	...	14	20	23	24	20	17	...	15	15
10	10	...	15	26	26	26	20	17	...	...	14
11	10	...	12	23	25	26	23	18	16	15	15
12	7	8	13	23	25	25	20	17	15	14	14
13	8	8	15	23	27	31	29	24	19	...	...
14	10	10	13	19	21	23	21	20	19	18	17
15	10	10	11	21	23	23	21	...	18	18	...
16	8	...	13	28	31	33	...	...	17	16	16
17	10	11	14	20	22	23	19	19	18	18	...
18	...	23	20	32	30	30	20	18	16	14	13
19	17	16	20	31	34	29	21	18	17	17	...
20	15	...	23	33	34	26	25	19	17	17	...
21	14	...	15	32	28	27	21	18	15	15	...
22	10	...	16	23	23	23	19	17	16	16	...
23	10	10	19	29	29	29	21	18	17	16	...
24	10	10	12	20	24	25	23	18	16	15	...
25	8	11	15	29	35	32	31	24	15	12	11
26	11	11	15	24	24	24	21	17	...	11	...
27	10	10	14	22	25	25	18	15	13	...	...
28	16	...	21	25	25	25	17	16	15	14	14
29	10	11	14	24	25	24	20	17	16	15	...
30	14	...	17	25	30	31	26	20	16	14	...
31	10	...	14	23	25	26	19	16	14	14	14

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1786	7 A.M.	8 A.M.	10 A.M.	12 M.	1 P.M.	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	11 P.M.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Nov. 1	23 13	23 13	23 19	23 32	23 34	23 ...	23 ...	23 ...	23 ...	23 ...	23 ...
2	10	...	11	19	21	20	19	17	15	14	...
3	10	10	15	23	22	21	21	20	16	16	...
4	10	11	14	18	20	21	19	18	15	15	15
5	10	10	16	22	23	22	19	17	17	17	17
6	12	13	15	21	22	22	20	18	18	18	14
7	10	...	15	21	23	23	21	18	17	16	...
8	11	...	17	25	25	25	22	19	16	13	...
9	13	...	16	23	24	24	20	17	...	13	13
10	11	11	14	21	22	22	20	16	15	13	13
11	11	11	15	21	21	20	17	16	15	15	15
12	11	11	15	20	21	20	17	...	...	15	15
13	13	13	17	23	21	23	21	18	16	15	15
14	11	11	14	20	20	21	20	18	16	15	15
15	16	...	22	24	23	22	20	17	16	15	15
16	10	...	11	19	19	20	19	17	...	16	...
17	13	...	13	18	20	19	20	18	16	17	...
18	15	...	14	20	20	22	22	18	16	14	...
19	12	13	13	23	24	24	22	17	15	17	...
20	11	11	13	18	23	23	22	18	14	13	15
21	12	...	18	21	21	21	21	19	16	16	...
22	13	...	18	21	23	23	21	17	16	15	15
23	13	...	16	22	24	24	23	18	...	14	...
24	13	14	14	19	21	21	19	16	14	14	...
25	14	14	15	21	22	22	21	18	17	16	16
26	...	14	15	22	23	23	20	18	16	15	15
27	15	15	19	23	24	24	20	...	16	16	...
28	...	14	15	23	...	...	...	...	17	16	...
29	15	15	16	22	23	23	21	18	16	15	...
30	14	14	15	...	...	...	21	...	17	15	15

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1786	8 A.M.	10 A.M.	12 M.	1 P.M.	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	11 P.M.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Dec. 1	23 15	23 16	23 23	23 23	23 23	23 20	23 17	23 15	23 15	23 ...
2	14	14	17	19	19	19	17	15	14	...
3	13	13	19	19	20	19	17	17	14	14
4	13	11	17	19	20	19	19	17	16	16
5	11	14	19	19	19	19	17	14	13	13
6	11	13	22	...	...	...	19	17	16	16
7	11	14	18	20	20	18	16	...	...	...
8	14	14	18	19	20	19	16	14	15	...
9	13	14	18	20	20	19	18	16	16	...
10	14	15	18	...	20	...	...	15	14	...
11	14	16	19	19	20	19	16	15	14	...
12	14	15	18	20	20	18	17	15	14	14
13	14	14	18	21	22	20	19	15	14	...
14	16	17	21	23	23	21	18	...	...	...
15	17	18	23	24	24	22	...	18	16	...
16	18	19	23	24	24	19	19	17	15	15
17	14	15	23	24	25	17	17	16	15	...
18	14	20	24	26	26	23	...	16	16	...
19	17	19	22	23	23	...	...	14	13	13
20	12	19	21	23	23	21	18	15	16	...
21	16	24	21	22	22	19	15	...	...	...
22	23	24	26	27	25	23	...	17	16	...
23	16	15	19	19	20	19	16	15	15	15
24	13	15	21	23	23	22	18	17	17	17
25	17	17	24	25	25	21	16	13	14	...
26	14	16	18	22	23	21	20	19	18	18
27	14	17	23	24	24	...	...	...	16	16
28	14	14	21	23	23	...	...	...	14	14
29	14	16	22	23	23	20	16	15	14	14
30	14	15	20	22	23	21	17	15	14	...
31	15	15	22	24	24	21	20	19	16	...

TABLE I.

Observations on the Variation of the magnetic Needle.

1787	7 A.M.	8 A.M.	10 A.M.	12 M.	1 P.M.	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	11 P.M.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Jan. 1	23 ...	23 15	23 19	23 23	23 24	23 24	23 21	23 16	23 ...	23 ...	23 ...
2	...	15	16	20	23	23	20	17	15	15	...
3	14	14	15	20	21	21	19	...	14	14	14
4	15	15	16	19	21	23	20	18	17	16	17
5	14	14	15	19	24	24	22	...	15	14	14
6	...	12	13	20	22	29	29	...	14	14	14
7	...	14	15	22	26	24	...	19	...	...	...
8	14	14	16	21	24	24	21	...	17	15	16
9	15	15	18	21	23	23	19	19	13	13	14
10	...	16	22	23	24	22	20	17	17	16	...
11	...	17	21	23	23	22	20	19	...	...	...
12	...	19	20	20	25	28	23	...	...	16	...
13	14	14	16	20	22	22	21	18	15	11	...
14	...	14	20	28	28	28	25	19	14	13	14
15	...	15	21	23	23	23	20	17	14	14	...
16	...	13	16	23	23	22	19	14	14	13	...
17	...	14	15	24	25	27	23	20	16	15	...
18	...	13	14	21	25	25	20	16	...	...	...
19	...	15	16	22	24	24	22	17	15	15	...
20	...	14	15	24	24	24	21	17	14	15	...
21	...	14	16	21	23	23	20	20	18	16	...
22	...	15	16	21	23	24	21	16	14	14	...
23	...	14	21	25	29	26	24	18	16	13	...
24	...	13	18	23	25	26	24	19	18	14	...
25	...	14	19	22	27	30	28	26	...	...	...
26	14	14	22	27	28	29	22	22	21	21	...
27	...	14	16	24	24	24	20	15	10	9	...
28	...	10	16	21	24	24	23	18	15	14	14
29	13	14	16	24	24	24	23	23	20	18	17
30	14	14	15	22	24	25	24	21	18	15	15
31	13	14	15	24	24	24	23	18	15	13	14

TABLE I.

Observations on the Variation of the magnetic Needle.

1787	7 A.M.	8 A.M.	10 A.M.	12 M.	1 P.M	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	11 P.M.	12 P.M.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Feb. 1	23 13	23 12	23 15	23 21	23 23	23 23	23 21	23 20	23 ...	23 17	23 ...	23 17
2	16	16	17	20	20	20	21	19	19	18	...	...
3	16	16	21	22	24	25	31	27	19	14	14	...
4	16	16	19	25	26	26	23	18	16	16	...	...
5	16	16	17	22	25	25	24	18	16	14	14	...
6	14	14	16	23	23	24	23	21	16	10	...	...
7	...	16	18	27	26	24	24	17	16	10	...	9
8	...	17	16	21	25	25	20	16	...	14	...	...
9	14	13	15	23	23	23	23	21	17	16	...	16
10	17	17	18	22	25	25	22	17	15	11	11	13
11	13	14	15	23	27	26	21	15	11	10	10	...
12	15	16	14	23	22	23	21	19	18	16	16	...
13	13	12	16	25	25	23	20	16	13	12	12	...
14	11	11	14	22	23	23	20	...	...	...	...	...
15	13	15	17	24	31	30	28	20	...	10	...	...
16	...	16	17	24	25	25	23	21	18	17	...	...
17	...	28	28	28	28	28	20	18	...	17	...	...
18	...	16	17	22	24	24	24	19	16	16	16	...
19	9	9	9	20	22	22	21	18	16	15	...	...
20	...	12	12	25	27	28	29	20	15	10	...	...
21	...	21	23	26	26	26	25	...	16	13	...	12
22	12	11	19	21	24	23	23	16	...	...	...	...
23	15	15	21	...	...	31	29	...	11	10	10	...
24	14	14	17	23	26	29	25	18	14	13	13	...
25	13	13	15	28	29	30	29	25	...	23	...	...
26	23	23	23	24	24	23	...	19	16	12	12	...
27	12	12	17	24	25	26	24	18	14	12	...	...
28	14	13	14	21	22	22	...	15	9	14	...	13

TABLE I.

Observations on the Variation of the magnetic Needle.

1787	7 A.M.	8 A.M.	10 A.M.	12 M.	1 P.M.	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	11 P.M.	12 P.M.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Mar. 1	23 13	23 13	23 17	3 25	23 27	23 28	23 22	23 18	23 ...	23 11	23 ...	23 ...
2	11	11	15	23	24	24	20	...	...	...	12	12
3	19	19	16	26	27	26	24	23	13	11	11	...
4	12	12	15	29	28	29	26	20	15	15	15	...
5	11	12	14	19	25	26	23	16	17	17	...	...
6	10	11	16	26	26	26	21	22	5	12	...	...
7	14	13	15	26	26	26	25	23	19	7	8	...
8	12	13	12	25	26	26	..	...	...	...	...	...
9	13	12	14	28	29	29	...	21	19	18	...	...
10	15	15	16	26	27	27	20	18	18	18	...	...
11	12	13	14	...	26	27	...	...	17	16	...	...
12	12	11	14	24	28	28	24	20	11	13	...	...
13	17	17	18	31	31	31	21	14	12	12	13	...
14	12	12	20	26	26	26	18	18	18	18	19	...
15	19	19	22	28	28	27	19	18	...	...	...	...
16	12	12	15	25	26	26	19	18	18	16	...	19
17	13	15	19	26	27	26	22	17	19	18	18	...
18	8	8	11	31	33	33	22	20	16	...	...	...
19	9	8	11	26	28	28	21	16	14	15	...	14
20	9	9	12	31	30	32	23	17	14	13	...	13
21	28	28	31	29	29	29	27	33	10	10	...	11
22	12	11	16	31	33	33	26	20	19	19	18	...
23	12	13	14	26	28	27	22	19	17	19	18	...
24	13	13	14	28	28	26	22	19	18	18	17	...
25	11	11	13	25	26	28	21	17	18	19	17	...
26	12	12	12	25	27	28	23	19	19	19	19	...
27	15	14	14	28	28	27	22	19	18	17	17	...
28	13	13	12	27	26	26	22	17	18	18	...	...
29	8	8	13	26	32	33	25	14	...	16	16	...
30	11	10	14	25	28	29	23	19	17	16	17	...
31	8	8	13	23	27	26	24	18	15	17	16	...

TABLE I.

Observations on the Variation of the magnetic Needle.

1787	6 A.M.	7 A.M.	8 A.M.	10 A.M.	12 M.	1 P.M.	2 P.M.	4 P.M	6 P.M.	8 P.M.	10 P.M.	11 P.M.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Apr. 1	23 ...	23 12	23 12	23 16	23 24	23 26	23 28	23 26	23 21	23 19	23 19	23 18
2	...	7	7	20	32	35	37	36	...	...	...	...
3	...	15	10	18	23	24	24	22	15	17	16	...
4	...	9	10	15	24	25	25	22	16	11	16	17
5	...	10	10	15	25	26	26	22	19	18	18	18
6	...	14	14	16	23	30	30	23	18	13	15	13
7	...	9	9	12	23	28	29	24	19	13	12	13
8	...	10	10	12	23	29	30	24	19	15	15	15
9	...	8	8	15	26	30	31	29	22	18	17	17
10	8	7	8	14	23	27	28	26	20	16	16	16
11	8	7	8	12	21	28	29	24	18	15	15	16
12	...	7	7	10	17	27	28	23	16	12	11	12
13	...	11	11	13	19	26	27	23	17	16	17	16
14	...	8	8	13	21	23	28	19	15	14	14	14
15	9	8	8	13	23	30	29	19	16	14	13	13
16	18	18	18	21	29	30	...	...	16	16	17	...
17	...	8	8	13	23	26	27	21	15	15	15	...
18	...	7	8	12	24	26	26	23	20	15	15	15
19	9	8	10	13	23	26	25	19	20	...	...	...
20	6	10	6	11	22	28	29	21	18	17	17	17
21	12	11	11	13	23	26	27	26	25	19	18	18
22	...	15	15	15	20	21	24	24	17	17	17	17
23	7	8	6	13	23	24	24	20	15	16	17	16
24	11	13	11	15	25	28	26	25	17	17	16	16
25	...	9	9	10	27	26	26	17	17	18	17	18
26	...	8	9	11	24	27	26	21	20	...	...	...
27	...	11	10	19	30	32	32	17	18	18	17	...
28	9	10	12	12	23	23	23	17	15	15	13	14
29	...	7	6	9	21	25	25	21	17	15	...	...
30	...	13	13	15	25	28	27	20	15	14	15	14

TABLE I.

Observations on the Variation of the magnetic Needle.

1787	6 A.M.	7 A.M.	8 A.M.	10 A.M.	12 M.	1 P.M.	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	11 P.M.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
May 1	23 8	23 8	23 8	23 16	23 23	23 26	23 26	23 22	23 16	23 16	23 15	23 16
2	8	8	8	15	25	25	25	21	20	19	18	17
3	11	11	11	14	23	27	26	21	15	...	...	...
4	6	5	6	13	28	29	29	23	17	16	16	16
5	7	8	7	11	25	26	26	21	17	15	15	16
6	9	7	7	17	28	27	28	25	18	17	18	17
7	9	8	8	13	25	28	28	21	19	19	9	14
8	7	8	7	17	25	26	26	22	17	13	15	14
9	...	...	...	18	30	30	30	26	20	19	19	20
10	2	4	3	23	32	30	27	18	18	...	17	26
11	6	6	6	11	24	23	24	20	17	17	16	17
12	9	8	8	11	23	24	24	20	17	16	17	17
13	6	5	5	11	24	25	25	...	...	15	14	13
14	11	10	6	10	38	38	31	27	26	18	17	17
15	13	11	11	13	25	26	26	16	19	18	17	19
16	8	8	9	14	22	25	25	23	24	23	26	24
17	10	11	10	13	17	21	21	17	17	...	...	...
18	8	9	9	13	28	29	29	24	15	15	15	15
19	4	3	3	9	22	25	25	24	16	14	16	...
20	9	7	7	11	23	25	25	19	19	19	19	18
21	10	10	11	14	28	30	27	26	23	22	22	21
22	10	11	10	13	26	27	27	21	15	14	16	15
23	10	9	9	14	24	26	26	21	15	16	16	17
24	6	6	6	12	24	25	25	16	16	16	...	...
25	7	7	7	16	25	26	27	21	15	17	16	16
26	5	5	7	14	24	25	25	19	17	17	17	17
27	7	7	8	14	23	26	26	...	...	17	17	17
28	6	5	5	10	23	25	25	20	17	17	17	17
29	8	8	10	13	24	26	26	19	19	19	18	19
30	5	6	6	14	26	27	27	19	16	16	16	17
31	4	5	4	11	24	26	27	19	16	18	15	17

TABLE I.

Observations on the Variation of the magnetic Needle.

1787	6 A.M	7 A.M.	8 A.M.	10 A.M.	12 M.	1 P. M.	2 P. M.	4 P. M.	6 P. M.	8 P. M.	10 P. M.	11 P. M.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
June 1	23 8	23 7	23 7	23 11	23 26	23 28	23 28	23 22	23 17	23 16	23 18	23 17
2	6	6	6	17	24	25	25	20	19	17	18	17
3	6	6	6	18	28	28	27	24	20	18	19	18
4	6	5	7	13	24	26	25	21	19	16	15	16
5	6	6	5	16	29	28	29	22	19	17	16	17
6	7	6	8	17	29	30	30	24	19	19	16	15
7	5	5	5	13	25	30	30	27	22	17	...	16
8	7	8	8	19	28	28	28	27	20	16	15	16
9	18	17	19	21	26	26	26	19	17	17	17	17
10	16	15	16	20	24	26	26	22	19	18	19	19
11	6	7	6	16	28	27	27	20	19	19	18	19
12	6	6	6	15	28	29	29	26	19	19	19	19
13	6	5	6	13	25	27	27	23	20	19	19	19
14	6	6	7	14	26	30	31	24	20	16	...	16
15	3	5	5	10	28	31	32	25	20	20	20	20
16	6	5	6	15	28	31	33	26	17	17	16	18
17	8	8	10	11	28	31	30	25	18	19	16	17
18	9	8	10	16	29	31	31	26	18	18	18	17
19	6	5	5	13	26	27	27	24	17	17	18	17
20	14	13	14	21	31	32	32	24	19	17	16	18
21	8	9	8	18	26	29	29	24	19	19	...	18
22	11	11	10	18	29	29	29	24	19	18	19	18
23	8	8	10	18	26	26	26	20	19	19	19	19
24	6	6	6	16	23	28	29	22	19	19	19	19
25	19	19	19	19	28	28	29	21	19	18	18	18
26	8	7	7	15	23	23	23	18	18	19	18	18
27	9	11	9	14	28	30	29	18	18	18	18	18
28	10	9	11	19	26	28	26	19	16	17	...	...
29	9	9	13	18	26	26	25	20	18	17	19	18
30	10	8	10	17	24	26	26	21	18	20	18	18

TABLE I.

Observations on the Variation of the magnetic Needle.

1787	6 A.M	7 A.M.	8 A.M.	10 A.M.	12 M.	1 P. M.	2 P. M.	4 P. M.	6 P. M.	8 P. M.	10 P. M.	11 P. M.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
July 1	23 9	23 9	23 11	23 18	23 26	23 26	23 25	23 19	23 16	23 17	23 16	23 16
2	9	10	9	15	29	29	28	22	17	16	17	17
3	5	5	7	12	27	27	27	22	17	17	16	17
4	8	7	11	17	28	30	29	22	19	16	16	17
5	8	7	8	11	28	30	30	21	17	17	18	17
6	7	7	8	22	25	27	27	21	19	20	18	19
7	8	6	7	16	27	28	28	22	18	18	18	18
8	6	7	8	15	25	27	27	21	18	18	18	19
9	7	8	7	15	25	27	27	22	20	20	20	20
10	5	5	5	15	24	24	24	23	20	20	20	20
11	7	7	8	17	26	27	27	26	23	19	19	19
12	5	5	7	14	30	33	33	23	21	20	19	19
13	10	10	10	17	30	30	30	24	19	19	19	20
14	10	10	11	19	28	29	30	23	20	17	18	18
15	11	11	13	20	28	29	29	22	20	18	21	18
16	10	11	13	18	25	29	27	24	23	23	23	23
17	8	6	8	21	30	35	36	26	18	19	20	19
18	9	9	11	14	25	29	29	26	19	...	18	19
19	9	8	11	19	25	29	29	25	20	19	20	20
20	9	9	10	20	28	29	29	25	20	21	20	20
21	7	8	8	20	29	30	30	25	19	18	20	19
22	8	10	8	19	29	30	30	24	20	18	22	19
23	15	17	16	16	28	30	30	26	23	22	23	22
24	8	8	8	16	28	31	33	27	21	21	22	21
25	13	16	14	18	28	31	33	20	20	20	20	20
26	14	14	14	15	26	30	31	24	21	21	22	21
27	14	14	15	22	...	...	...	...	...	...	20	20
28	14	15	14	26	30	30	31	23	19	19	21	20
29	16	16	16	21	31	32	31	20	18	18	19	19
30	13	12	13	23	30	30	32	26	19	18	19	18
31	12	11	12	22	29	30	30	...	...	...	...	...

TABLE I.

Observations on the Variation of the magnetic Needle.

1787	6 A.M.	7 A.M.	8 A.M.	10 A.M.	12 M.	1 P.M.	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	11 P.M.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Aug. 1	23 8	23 9	23 13	23 19	23 38	23 39	23 39	23 36	23 23	23 18	23 17	23 17
2	7	8	17	21	31	31	31	24	19	19	18	19
3	9	8	13	18	28	34	35	24	19	18	19	17
4	11	13	12	18	31	31	31	23	19	19	21	19
5	13	12	11	15	28	33	32	26	...	...	19	20
6	11	10	12	17	26	31	33	27	21	21	21	20
7	10	11	10	16	26	30	33	28	21	20	20	21
8	9	9	10	17	30	32	32	29	21	21	19	21
9	11	13	12	17	30	31	30	25	19	19	19	20
10	13	12	14	22	31	33	34	29	18	16	19	16
11	10	14	11	20	32	32	32	26	15	15	15	17
12	15	13	14	20	28	31	30	25	19	19	19	19
13	8	11	10	17	29	30	30	24	19	19	19	19
14	10	10	10	20	30	31	31	23	19	18	17	16
15	10	10	9	19	38	38	35	29	20	19	19	20
16	13	14	12	21	33	35	33	29	19	19	19	19
17	8	7	9	18	29	30	30	25	20	19	18	18
18	7	7	8	21	28	29	29	28	21	19	17	19
19	8	8	9	20	31	...	...	...	...	...	19	19
20	21	21	20	29	35	34	31	27	19	19	21	20
21	21	20	21	29	34	33	32	24	19	21	19	20
22	13	13	14	17	27	29	29	25	20	18	19	19
23	13	12	13	17	29	30	30	24	19	17	18	18
24	11	11	13	17	29	30	29	23	21	19	21	22
25	21	20	21	25	31	31	31	22	19	19	20	19
26	12	14	13	18	28	30	30	...	18	19	19	18
27	14	14	15	21	29	29	29	21	17	18	18	18
28	12	12	13	18	29	30	30	25	21	19	21	...
29	14	14	14	21	30	31	32	25	18	18	18	18
30	12	11	12	19	29	31	31	22	19	18	19	17
31	13	12	13	23	33	31	31	23	19	18	18	20

TABLE I.

Observations on the Variation of the magnetic Needle.

1787	6 A.M.	7 A.M.	8 A.M.	10 A.M.	12 M.	1 P.M.	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	11 P.M.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Sep. 1	23 13	23 14	23 14	23 23	23 33	23 34	23 35	23 26	23 20	23 21	23 20	23 20
2	13	13	14	21	31	32	32	...	21	20	20	20
3	14	14	14	22	33	33	32	26	21	20	21	19
4	13	13	15	19	29	31	31	25	19	21	20	20
5	14	13	14	18	29	30	30	26	21	17	19	19
6	14	14	15	21	29	31	31	28	21	19	19	21
7	19	19	20	26	33	35	34	31	21	16	17	17
8	15	16	15	21	28	30	29	24	18	17	17	17
9	15	16	16	21	30	30	29	...	20	18	19	19
10	14	14	14	22	30	30	30	23	19	18	18	18
11	13	14	14	21	29	29	29	22	19	20	19	18
12	12	11	14	18	30	30	29	23	18	18	19	19
13	13	15	14	18	29	30	30	22	19	19	19	19
14	14	15	15	21	30	30	30	25	20	19	18	20
15	15	14	14	20	32	33	33	26	19	19	20	19
16	13	13	15	21	36	35	36	23	18	19	19	18
17	16	14	20	18	28	36	36	...	23	19	20	20
18	19	20	15	23	35	31	33	26	22	21	21	20
19	16	16	16	21	27	29	29	...	...	20	19	20
20	16	18	14	23	27	29	28	23	21	19	20	20
21	16	16	14	21	28	30	28	24	21	20	18	19
22	17	17	13	22	29	28	28	23	21	20	19	20
23	16	16	14	21	28	29	29	21	18	18	18	18
24	18	17	15	22	29	31	31	26	20	20	21	19
25	18	19	14	26	31	32	29	25	21	20	20	21
26	17	17	13	21	28	27	27	21	17	16	16	16
27	16	16	14	20	29	30	30	26	22	18	20	19
28	15	14	19	18	26	28	27	22	19	19	19	19
29	13	13	17	20	27	28	28	26	22	21	21	21
30	14	13	17	16	31	30	31	29	23	21	21	22

TABLE I.

Observations on the Variation of the magnetic Needle.

1787	7 A.M	8 A.M.	10 A.M.	12 M.	1 P.M.	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	11 P.M.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Oct. 1	23 17	23 17	23 23	23 32	23 32	23 32	23 29	23 21	23 21	23 21	23 ...
2	19	19	19	30	30	30	26	21	20	20	...
3	18	18	24	30	33	33	23	21	21	21	21
4	14	14	21	30	33	33	26	21	21	12	...
5	18	17	25	31	35	34	31	17	13	14	13
6	15	15	19	29	31	31	27	21	19	19	20
7	15	15	...	30	31	31	27	22	21	21	...
8	15	15	22	30	30	30	26	20	20	20	...
9	14	14	19	29	31	32	27	21	20	21	...
10	15	16	21	33	34	34	30	21	21	21	...
11	19	17	26	33	34	33	...	25	21	19	...
12	16	17	23	30	31	30	26	23	22	23	...
13	18	16	18	29	29	29	...	...	...	...	...
14	21	21	27	31	32	32	...	22	20	20	...
15	16	15	19	28	31	31	28	21	22	20	...
16	16	16	18	27	28	28	27	24	24	22	...
17	15	18	16	26	26	26	26	23	24	21	...
18	17	17	17	28	26	31	27	21	20	20	...
19	17	16	21	26	28	28	27	24	22	22	...
20	17	17	18	29	29	29	26	19	20	19	...
21	16	16	18	29	30	30	...	22	19	21	...
22	18	17	18	31	33	32	...	...	20	20	...
23	17	16	19	30	30	29	23	21	19	20	...
24	18	19	20	33	33	31	33	23	21	17	...
25	23	18	23	37	38	37	34	23	23	22	...
26	21	22	26	35	37	35	28	22	24	25	...
27	26	28	27	35	35	33	28	22	21	22	...
28	19	18	24	34	35	33	...	...	21	20	21
29	18	18	21	34	35	35	24	21	22	21	...
30	18	18	23	35	35	35	28	22	22	21	22
31	16	15	19	32	34	34	29	29	...	...	...

TABLE I.

Observations on the Variation of the magnetic Needle.

1787	7 A.M.	8 A.M.	10 A.M.	12 M.	1 P.M.	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	11 P.M.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Nov. 1	23 21	23 20	23 21	23 30	23 30	23 28	23 27	23 22	23 18	23 20	23 ...
2	17	20	20	28	31	28	26	22	20	22	23
3	20	20	21	27	37	35	31	22	23	22	...
4	18	18	...	35	36	35	28	21	22	22	21
5	17	18	21	35	35	35	32	24	21	18	...
6	18	18	19	35	35	33	30	22	21	20	20
7	17	17	19	30	33	33	26	20	22	20	21
8	17	17	19	30	33	33	26	20	22	20	21
9	17	18	20	30	33	33	31	31	...	22	...
10	18	17	19	31	33	33	31	28	22	22	23
11	20	20	21	31	34	35	32	...	20	22	22
12	18	20	19	28	31	32	28	21	22	21	...
13	18	19	19	28	29	30	28	22	21	21	22
14	18	18	20	28	29	29	25	22	21	22	22
15	20	19	20	28	28	28	27	25	...	23	23
16	19	19	20	27	26	28	26	19	17	20	20
17	20	19	20	26	28	27	25	21	20	21	20
18	19	19	20	29	29	29	...	25	24	...	...
19	22	23	23	31	32	31	31	26	22	22	21
20	23	22	23	31	33	32	29	22	21	21	22
21	21	23	23	28	29	29	26	22	21	22	23
22	21	20	21	31	29	30	29	23	...	22	22
23	21	21	21	29	28	29	26	22	23	22	...
24	22	20	21	30	31	30	26	22	22	20	21
25	22	22	22	30	30	30	...	...	22	21	...
26	20	21	21	30	29	31	26	22	23	...	...
27	21	22	21	28	30	29	26	23	23	22	...
28	19	21	20	26	27	27	26	23	22	23	...
29	21	20	21	31	31	29	25	23	22	22	...
30	22	21	23	31	34	33	28	22	21	22	...

TABLE I.

Observations on the Variation of the magnetic Needle.

1787	7 A.M.	8 A.M.	10 A.M.	12 M.	1 P.M.	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	11 P.M.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Dec. 1	23 21	23 21	23 20	23 29	23 31	23 30	23 28	23 22	23 23	23 22	23 22
2	20	21	21	31	31	31	27	23	22	21	22
3	21	20	21	30	31	29	26	22	22	23	...
4	21	22	22	30	31	31	...	...	22	21	...
5	18	20	21	28	31	26	26	22	21	23	...
6	22	22	23	29	29	30	28	24	23	21	...
7	21	21	22	28	30	29	26	23	23	22	22
8	20	21	21	26	28	29	29	26	22	22	...
9	22	20	21	26	31	30	26	26	21	22	...
10	21	21	21	29	29	29	25	23	21	22	21
11	18	21	22	28	29	31	28	21	23	21	...
12	20	20	21	33	33	33	31	24	24	19	...
13	...	21	21	28	30	30	27	25	...	22	...
14	21	21	26	30	31	33	...	...	...	22	...
15	20	22	22	30	31	30	27	21	23	20	...
16	...	22	29	31	28	31	...	25	22	22	...
17	...	22	23	31	33	33	...	23	22	23	21
18	...	21	20	28	29	29	28	23	24	22	...
19	...	19	22	29	28	27	25	23	22	23	...
20	...	21	24	28	30	29	26	24	24	24	...
21	...	23	26	29	29	29	25	22	22	22	...
22	...	21	21	24	26	24	22	25	20	19	...
23	...	19	21	24	24	24	...	20	20	19	...
24	...	20	20	29	30	29	24	24	22	22	...
25	...	22	20	28	28	28	26	22	20	21	...
26	...	22	22	29	33	29	26	22	23	22	...
27	...	21	21	24	26	26	23	21	21	21	...
28	...	21	21	25	25	26	24	23	20	21	...
29	...	20	20	23	22	25	25	20	20	21	...
30	...	21	21	...	25	30	29	...	...	...	...
31	...	21	20	29	26	28	25	22	22	...	...

TABLE II.

Mean monthly Variation of the magnetic Needle.

1786	6 A.M.	7 A.M.	8 A.M.	10 A.M.	12 M.	1 P.M.	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	11 P.M.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Sept.	23	23 7,9	23 10,1	23 14,5	23 22,2	23 23,7	23 23,9	23 19,0	23 15,3	23 13,5	23 12,4	23 ....
Oct.	. . .	10,4	11,3	15,2	24,4	26,1	26,1	21,1	17,7	15,6	14,5	13,8
Nov.	. . .	12,2	12,5	15,3	21,6	22,5	22,0	20,3	17,6	15,9	15,1	14,7
Dec.	. . .	. . .	14,5	16,1	20,6	22,0	22,2	20,0	17,4	15,8	15,0	15,0
1787												
Jan.	. . .	14,0	14,2	17,1	22,3	24,1	24,5	21,8	18,4	15,6	14,5	14,8
Feb.	. . .	14,2	15,1	17,1	23,3	24,8	25,1	23,6	18,8	15,3	15,8	12,8
Mar.	. . .	12,8	12,8	15,3	26,5	27,7	27,8	18,4	19,0	15,9	15,5	15,7
April	9,7	9,9	9,7	13,9	23,6	27,0	27,4	22,6	17,8	15,7	15,7	15,6
May	7,6	7,5	7,4	13,5	25,2	26,6	26,2	21,0	17,7	17,1	16,8	17,0
June	8,4	8,2	8,8	16,0	26,6	28,1	28,1	22,6	18,7	17,9	17,8	17,7
July	9,5	9,6	10,3	17,8	27,6	29,3	29,4	23,2	19,4	18,9	19,3	19,1
Aug.	11,9	12,0	12,8	19,7	30,3	31,7	31,5	25,6	19,3	18,7	18,9	18,8
Sept.	15,0	15,1	15,3	20,2	29,8	30,7	30,5	24,7	20,1	19,1	19,2	19,2
Oct.	. . .	17,5	17,3	21,1	30,8	31,9	31,6	27,4	21,9	20,8	20,2	19,6
Nov.	. . .	19,4	19,7	20,6	29,7	31,1	30,2	27,7	22,7	21,4	21,3	21,4
Dec.	. . .	20,4	21,0	21,8	28,2	29,0	29,0	26,2	22,9	21,9	21,6	. . .

TABLE III.

Mean monthly true Variation, and mean monthly diurnal Alteration of Variation of the magnetic Needle.

	True Variation.	Diurnal Alteration of Variation.	True Variation.	Diurnal Alteration of Variation.	True Variation.	Diurnal Alteration of Variation.	True Variation.	Diurnal Alteration of Variation.	True Variation.	Diurnal Alteration of Variation.	True Variation.	Diurnal Alteration of Variation.
	January.		February.		March.		April.		May.		June.	
	° ′	′	° ′	′	° ′	′	° ′	′	° ′	′	° ′	′
1786	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
1787	23 19,2	10,2	23 19,8	10,4	23 20,3	15,0	23 18,5	17,4	23 17,0	18,9	23 18,3	19,6
1788	23 25,6	8,7	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	23 28,9	18,8
1789	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	23 34,2	17,1
1790	23 38,9	8,4	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
1791	23 35,6	6,8	. . .	. . .	. . .	. . .	23 36,0	15,0	. . .	. . .	. . .	. . .
1792	23 41,1	5,4	. . .	. . .	. . .	. . .	. . .	. . .	23 41,9	11,5	. . .	. . .
1793	23 46,9	4,3	23 48,3	4,6	23 48,8	8,5	23 46,2	11,7	23 47,3	10,4	23 48,5	12,6
1794	23 54,2	4,5	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
1795	. . .	. . .	. . .	. . .	23 57,5	9,8	. . .	. . .	. . .	. . .	23 57,1	9,4
1796	. . .	. . .	. . .	. . .	24 1,1	7,0	. . .	. . .	. . .	. . .	23 58,7	9,8
1797	. . .	. . .	. . .	. . .	24 1,5	7,4	. . .	. . .	. . .	. . .	24 0,2	11,6
1798	. . .	. . .	. . .	. . .	24 0,6	7,2	. . .	. . .	. . .	. . .	23 59,4	11,2
1799	. . .	. . .	. . .	. . .	24 1,1	7,5	. . .	. . .	. . .	. . .	24 0,6	10,8
1800	. . .	. . .	. . .	. . .	24 3,6	6,9	. . .	. . .	. . .	. . .	24 1,8	10,9
1801	. . .	. . .	. . .	. . .	24 5,2	8,8	. . .	. . .	. . .	. . .	24 2,8	10,8
1802	. . .	. . .	. . .	. . .	24 6,9	9,5	. . .	. . .	. . .	. . .	24 5,3	10,7
1803	. . .	. . .	. . .	. . .	24 8,0	11,8	. . .	. . .	. . .	. . .	24 7,0	12,6
1804	. . .	. . .	. . .	. . .	24 9,4	10,0	. . .	. . .	. . .	. . .	24 6,0	11,3
1805	. . .	. . .	. . .	. . .	24 8,7	8,1	. . .	. . .	. . .	. . .	24 7,8	12,5

TABLE III.

Mean monthly true Variation, and mean monthly diurnal Alteration of Variation of the magnetic Needle.

	True Variation.	Diurnal Alteration of Variation.	True Variation.	Diurnal Alteration of Variation.	True Variation.	Diurnal Alteration of Variation.	True Variation.	Diurnal Alteration of Variation.	True Variation.	Diurnal Alteration of Variation.	True Variation.	Diurnal Alteration of Variation.
	July.		August.		September.		October.		November.		December.	
	° ′	′	° ′	′	° ′	′	° ′	′	° ′	′	° ′	′
1786	. . .	. . .	. . .	. . .	23 16,4	14,8	23 18,4	15,3	23 17,3	9,9	23 18,3	7,6
1787	23 19,6	19,6	23 21,9	19,4	23 22,8	15,5	23 24,5	14,3	23 25,0	11,1	23 25,8	8,3
1788	23 29,8	16,4	. . .	. . .	. . .	. . .	23 32,1	14,6	. . .	. . .	. . .	. . .
1789	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	23 41,2	5,4
1790	23 39,0	15,4	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
1791	23 36,7	15,2	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
1792	. . .	. . .	23 43,6	12,7	23 43,9	11,1	23 45,6	8,9	23 45,9	3,7	23 45,2	3,1
1793	23 50,5	12,5	23 48,6	12,1	23 52,6	9,8	23 52,3	7,0	23 51,9	3,8	23 52,3	3,8
1794	23 54,4	11,2	23 57,2	9,8	23 58,1	8,4	. . .	. . .	. . .	. . .	. . .	. . .
1795	23 57,1	8,4	. . .	. . .	24 0,4	7,6	. . .	. . .	. . .	. . .	23 59,4	3,6
1796	23 59,2	10,1	. . .	. . .	24 0,1	8,3	. . .	. . .	. . .	. . .	24 1,3	4,9
1797	24 0,3	10,1	. . .	. . .	24 1,4	7,6	. . .	. . .	. . .	. . .	24 1,3	5,0
1798	24 0,0	10,0	. . .	. . .	24 1,4	9,4	. . .	. . .	. . .	. . .	24 1,4	2,7
1799	24 1,8	10,4	. . .	. . .	24 2,9	7,8	. . .	. . .	. . .	. . .	24 2,3	3,4
1800	24 3,0	9,2	. . .	. . .	24 3,6	7,7	. . .	. . .	. . .	. . .	24 3,3	3,1
1801	24 4,1	10,3	. . .	. . .	24 3,8	10,1	. . .	. . .	. . .	. . .	24 5,4	2,5
1802	24 6,0	12,3	. . .	. . .	24 8,7	8,9	. . .	. . .	. . .	. . .	24 6,8	3,8
1803	24 7,9	13,1	. . .	. . .	24 10,5	9,5	. . .	. . .	. . .	. . .	24 10,7	3,0
1804	24 8,4	10,4	. . .	. . .	24 8,9	9,3	. . .	. . .	. . .	. . .	24 9,0	3,7
1805	24 7,8	10,4	. . .	. . .	24 10,0	9,3	. . .	. . .	. . .	. . .	24 9,4	4,6

TABLE IV.

Differences between the Observations of the Variation of the magnetic Needle at the Times of the Equinoxes and those at the Solstices.

Years.	March.	June.	September.	December.
1793	+ 3′,6	− 0′,3	+ 4′,1	− 0′,3
1795	. . . .	− 0,4	+ 3,3	− 1,0
1796	+ 1,7	− 2,4	+ 1,4	+ 1,2
1797	+ 0,2	− 1,3	+ 1,2	− 0,1
1798	− 0,7	− 1,2	+ 2,0	0,0
1799	− 0,3	− 0,5	+ 2,3	− 0,6
1800	+ 1,3	− 1,8	+ 1,8	− 0,3
1801	+ 1,9	− 2,4	+ 1,0	+ 1,6
1802	+ 1,5	− 1,6	+ 3,4	− 1,9
1803	+ 1,2	− 1,0	+ 3,5	+ 0,2
1804	− 1,3	− 3,4	+ 2,9	+ 0,1
1805	− 0,3	− 0,9	+ 2,2	− 0,6
Mean	+0′,80	−1′,43	+2′,43	−0′,14

TABLE V.

Dip of the magnetic Needle.

	Face East.	Face West.	Poles reversed. Face East.	Face West.	True Dip.	
	° ′	° ′	° ′	° ′	° ′	
1786						
September	72 28,7	72 1,4	71 57,3	72 5,1	72 8,1	Mean of 9 means.
October	72 29,9	71 59,0	72 0,4	72 1,2	72 7,6	—— 7 ——
November	72 7,6	72 17,6	72 2,4	71 46,7	72 3,6	—— 6 ——
December	72 10,6	72 2,2	72 2,2	71 58,4	72 3,4	—— 6 ——
1787						
January	72 11,4	72 1,8	72 1,0	71 56,0	72 2,5	—— 11 ——
February	72 19,4	72 10,8	72 1,5	71 55,8	72 6,9	—— 12 ——
March -	72 19,1	72 11,9	72 0,5	71 52,2	72 5,9	—— 14 ——
April -	72 24,4	72 9,5	72 0,5	71 52,2	72 6,6	—— 14 ——
May -	72 24,4	72 9,6	72 4,2	71 52,9	72 7,8	—— 15 ——
June -	72 22,6	72 7,9	72 4,2	71 52,9	72 6,8	—— 15 ——
July -	72 22,6	72 7,9	71 59,9	71 55,1	72 6,4	—— 15 ——
August	72 22,3	72 6,7	71 59,3	71 55,2	72 5,9	—— 15 ——
September	72 22,3	72 6,7	72 2,9	71 51,0	72 5,7	—— 15 ——
October	72 23,1	72 2,5	72 2,9	71 51,0	72 4,9	—— 15 ——
November	72 23,1	72 2,5	72 2,7	71 50,3	72 4,7	—— 15 ——
December	72 22,8	72 2,0	72 2,7	71 50,3	72 4,4	—— 15 ——
1788						
January	72 22,8	72 2,0	72 2,6	71 48,8	72 4,0	—— 15 ——
1789						
January	72 16,0	72 0,0	71 51,9	71 31,1	71 54,8	—— 4 ——
December	72 17,5	71 59,4	71 38,9	71 42,8	71 54,6	—— 4 ——
1790						
January	72 16,9	71 57,7	71 40,2	71 40,2	71 53,7	—— 7 ——
1791						
January	71 43,9	71 36,1	71 37,2	71 17,5	71 23,7	—— 4 ——
1795						
October	71 12,8	71 9,5	71 13,9	71 9,4	71 11,4	—— 14 ——
1797						
October	71 4,9	71 10,9	70 56,3	70 44,7	70 59,2	—— 30 ——
1798						
April -	71 4,7	71 14,5	71 2,3	70 19,8	70 55,4	—— 16 ——
October	70 55,6	71 14,5	71 7,7	70 22,2	70 55,0	—— 16 ——
1799						
October	70 56,0	71 13,5	71 11,5	70 7,9	70 52,2	—— 16 ——
1801						
April -	70 47,4	71 5,6	70 52,4	69 38,2	70 35,6	—— 16 ——
1803						
October	70 30,9	71 9,9	70 40,5	69 46,7	70 32,0	—— 16 ——
1805						
August -	70 25,2	70 55,7	70 26,9	69 36,3	70 21,0	—— 16 ——