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# PROCEDURE AT THE MAGNETIC OBSERVATORIES OF THE UNITED STATES COAST AND GEODETIC SURVEY.[1]

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In *Nature* for March 20, 1919, Dr. Charles Chree, under the title of "New Procedure at American Magnetic Observatories," reviewed the publications of the results of observations made at the United States Coast and Geodetic Survey magnetic observatories at Sitka and Honolulu for 1915 and 1916 and called attention to some changes in procedure and to the need of more information regarding certain details of the methods employed. As the questions raised must be settled before there can be that uniformity in the methods of reduction and publication which is essential to the most advantageous use of magnetic observatory results, it is well to give in some detail the considerations which led the Coast and Geodetic Survey to adopt at its five observatories the practices now in use.

Up to the end of 1914 each hourly value of declination ($D$), horizontal intensity ($H$), and vertical intensity ($Z$) in the monthly tabulations represented the momentary value of the quantity for the specified hour, *local mean time*. This was in accordance with the general practice at the time the observatories were established, a practice adopted before continuous photographic registration came into use, when eye readings were made once an hour, and when attention was paid mainly to the local features of the variations of the Earth's magnetism. This method has the disadvantages that only a very small portion of the observational data is utilized, undue weight is given to the portion which happens to occur at the arbitrarily selected time, and the results at one station cannot be compared in detail with those at another, par-

[1]Communicated by the Superintendent of the United States Coast and Geodetic Survey.

ticularly at the time of a disturbance, because the use of local mean time renders the tabulated values non-simultaneous.

The desirability of utilizing the whole or at any rate a larger part of the data was recognized in this Bureau soon after the work of reduction and publication began, and experiments were made with a polar planimeter as a means of determining the average value for a period of an hour. The time and labor involved was found to be prohibitive, however, and it was not until attention was called to the new reading scale devised at the Potsdam observatory that a change in methods became feasible. With a scale of this type it is possible to determine the average ordinate for a period of an hour without a material increase in the time and labor involved as compared with the old method.

The special term-day observations made in connection with the German Antarctic Expendition of 1902-3 and other similar international co-operative work at magnetic observatories to secure data for special investigations for the whole Earth emphasized the importance of greater uniformity in observatory methods so that the published results could be more readily used for such investigations. The subject was discussed[2] at the Berlin meeting of the Commission on Terrestrial Magnetism of the International Meteorological Committee in 1910, but no conclusions were reached, and the committee appointed to submit recommendations to the Commission at its next meeting apparently had not come to an agreement at the time of the outbreak of the war.

When the Coast and Geodetic Survey decided to use the average ordinate for an hour in deriving the hourly values, the time was opportune for changing from local mean time to standard meridian mean time, as there seemed to be no question as to the desirability of that step. At that time Potsdam, Wilhelmshaven, Munich, and Samoa were the only observatories, so far as could be told from the available publications, which had changed from local to standard meridian time in the tabulation of their results, and as the prime object of the change was to secure uniformity, it was decided to follow in effect the practice at those observatories, but make the 24 hourly values at our observatories cover the 24-hour period from $0^h$ to $24^h$ of the selected standard meridian, so that the first hourly value would be based on the average ordinate for the interval $0^h$ to $1^h$ and would correspond approximately to $0^h\ 30^m$. As the results will still be used primarily for the study of variations

[2] See *Terr. Mag.*, vol. 15, 1910, pp. 190-192.

which are a function of local mean time, it was decided to use for each observatory the nearest standard meridian in fixing the limits of the tabular day, so that the reduction to local mean time will be as small as possible.

The question will no doubt be raised whether it would not be better to secure complete uniformity by using Greenwich mean time for all observatories. In answer to this, it may be said that the greater part of the irregularities in the solar-diurnal variation occur during the daylight-hours and it might prevent a complete discussion of certain problems, such as the non-cyclic change, if the tabular day began and ended in the portion of the solar day during which the more pronounced features of the diurnal variation occur, as would be the case for an observatory differing as much as 8 hours in longitude from Greenwich. Of course, for observatories in England or Western Europe, this question would not arise.

With the results for 1911, the Coast and Geodetic Survey began publishing for each month hourly values and diurnal variation tables for the five quiet days, Greenwich mean time, selected by the Executive Bureau of the Commission on Terrestrial Magnetism of the International Meteorological Committee, the form of publication agreeing with the directions contained in the circular letter sent out by the president and secretary of the Commission, supplemented by more detailed information furnished by the secretary in response to a letter of inquiry. These directions stated that, in order to reduce the additional work to a minimum, it would suffice for all practical purposes to use the value for the nearest hour of local mean time instead of the corresponding hour Greenwich mean time. The hourly means for the five selected days, uncorrected for non-cyclic change, are given on the bottom line of each monthly tabulation, the manner of deriving them being explained in the publication of the results for 1911 and 1912, but not repeated in subsequent publications. It would no doubt be an improvement to show in the table itself where the Greenwich day begins and ends and this will be introduced in future.

The directions provided that either the results should be corrected for non-cyclic change or else 25 hourly values should be given, so that allowance could be made for it. In the publication of the results for 1911 and 1912, 25 hourly values were given in the diurnal-variation tables, but in later publications, in deriving these tables, an approximate correction for non-cyclic change was applied, on the assumption that the change is uniformly distributed over the 24 hours, although the investigations of Steiner

indicate that such is not the case. The following method was employed:

The correction was based on the multiple of 24 nearest to the difference between the values for $0^h$ and $24^h$. One half of this quantity was applied to the first and twenty-fourth hourly values with opposite signs and the corrections for the intervening hours decreased uniformly so that the zero correction fell between $13^h$ and $14^h$. In this way the mean of the 24 hourly values was not affected by the application of the corrections. For example, if in the case of $D$ the value for $24^h$ was $0'.40$ greater than the one for $0^h$, a correction of $-0'.23$ was applied to the twenty-fourth hour and one of $+0'.23$ to the first hour and the corrections for the intervening hours decreased successively by $0'.02$ so that the correction for $13^h$ became $+0'.01$ and for $14^h$, $-0'.01$. In the case of $H$ and $Z$ the unit involved was $0.1\gamma$ instead of $0'.01$.

In the case of the hourly means for all days and for ten selected days, and the derived diurnal-variation tables, no correction for non-cyclic change has been applied, but an attempt has been made to eliminate the effect when selecting the ten days by avoiding days of marked non-cyclic change, such as are apt to occur immediately after a severe magnetic disturbance. Until the character of the non-cyclic change has been more definitely determined and a uniform method of correcting for it has been adopted, it is believed that the uncorrected values, rather than the more or less artificially-corrected ones, can be used to better advantage by anyone engaged on special investigations.

There is another practice in the reduction of the results of the magnetic observatories of the Coast and Geodetic Survey which is open to criticism. This is the derivation of the normal diurnal-variation tables from ten selected days rather than from all the days of a month. This practice was adopted after careful consideration, in the conviction that for a study of the systematic portion of the variations of the Earth's magnetism an effort should be made to eliminate the irregular features, particularly the severe disturbances. It was believed that the use of as many as ten days would in large measure avoid an undue effect on the mean of abnormally quiet days, and similar results of arbitrary selection, so that for a study of such questions as the seasonal change of the diurnal variation, its change during the sun-spot cycle, and a comparison of results at different observatories, a homogeneous mass of data would be provided even though the same ten days were not used at all observatories. Where only five days are used, even though the days are adopted internationally, there is the danger that abnormal conditions may be present on one or more of the slected days which might lead to erroneous conclusions. This and the question of deriving diurnal-variation tables for days of large disturbance merits the early attention of the Section of Terrestrial Magnetism and Electricity of the International Geodetic and Geophysical Union.