Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Relation between Solar Activity and Atmospheric Electricity.

DR. CHREE in his reply (NATURE, September 8, p. 361) to my communication on solar activity and atmospheric electricity (NATURE, August 11, p. 203) first makes reference to the status of the question as to the effect of sun-spot activity on the secular change of the earth's magnetism. Those who have investigated this question have reached apparently contrary conclusions according to the phenomenon examined, the data used, and the method employed by the individual investigator. It would require too much space to enter into detail as to the reasons for the discordant results. Let it suffice here to state that Dr. Chree and I have investigated different phenomena. Thus Dr. Chree, on the basis of the Kew data alone, concluded, contrary to Leyst, that the secular change of the *magnetic declination* did not vary markedly, if at all, with sun-spottedness.

Such a restricted investigation could, of course, not be accepted as settling the broad question as to whether any appreciable change in the *direction of magnetisation* of the earth may be related to solar activity changes during a sun-spot cycle. I, on the other hand, confined my investigation solely to the question whether there was an appreciable change in the earth's *intensity of magnetisation* which might be associated with change in solar activity during the sun-spot cycle. Instead of relying upon the data from one station alone, I used the intensity data from eight stations distributed around the globe, namely: Kew, Potsdam, Pola, Bombay (Colaba and Alibag), Honolulu, Sitka, Cheltenham (Maryland), and Porto Rico. Regarding the various questions which must be considered in investigations of this character, the interested reader may be referred to my paper on the subject,[1] at the conclusion of which the intention was stated of making a still more comprehensive examination, as soon as additional data were available.

With regard to the difference in the method or formula used by Dr. Chree and myself when investigating a possible relationship between solar activity and atmospheric electricity, let me state briefly the assumptions involved. Dr. Chree in his paper[2] adopts a formula which assumes that there is strict synchronism between the phenomena of sun-spottedness and atmospheric electricity, and that for the same sun-spot number, during the first and second halves of the cycle, for example, the atmospheric-electric element investigated should have precisely the same value. In my formula (NATURE, August 11, p. 203) I introduced a term, provisionally called a time- or cycle-term, which was intended to take into account, approximately, a possible a-cyclic effect in atmospheric electricity during a sun-spot cycle such that the atmospheric-electric element considered, barring other disturbing causes, would not have precisely the same value for the same sun-spottedness. With the aid of this additional assumption, which does not appear unreasonable in view of similar effects in other geophysical and cosmical phenomena, an improved mathematical representation was obtained and higher values of the correlation coefficient were derived than those which Dr. Chree had found. No futile attempt was made to get an *exact* representation by unduly multiplying the number of unknowns to be determined by the method of least squares. The desire was merely to obtain, in accordance with the best practice, a sufficiently satisfactory representation of the observed facts with the *fewest* possible unknowns; the general concordance in the derived unknowns from widely separated stations would appear to be ample justification of the formula employed.

It must be realised that no method of applying an a-cyclic correction, due to an undiscovered cause, can be made perfect; however, when more extensive data for several sun-spot cycles are available, no doubt improvements may be made. In this connexion it may be remarked that Dr. Chree's method of applying a-cyclic corrections to the observed magnetic and electric diurnal variations has not yet been generally adopted. However, no great refinement in mathematical method is requisite to show, even for the data at present available, that a definite relationship between solar activity and atmospheric electricity is sufficiently plausible to merit careful attention. Some of the evidences have already been cited in my previous communication and reference has been made to a later and more complete paper.[3]

Dr. Chree directs attention to some low values of the atmospheric potential-gradient at the Ebro Observatory; by reference to the observatory bulletins it will be found that recent low values, especially during the period June-October 1922, were not unnoticed by the Observatory, and that possible artificial disturbing causes were investigated, as the result of which some changes have been made. The Observatory will doubtless make such additional tests and redetermination of reduction factor as may be requisite in the circumstances. This later information from the Ebro Observatory had not been received at the time of my previous communication, in which data only to 1921 inclusive were utilised. (The date for No. 11 in Table 2 of my previous communication should be 1921·5, instead of 1921·1.)

I am glad that Dr. Chree is helping to keep alive an interest in the highly important question as to possible variations in atmospheric electricity which may have to be associated with changes in solar activity. We may rest assured that until this question is definitely settled no complete theory of the origin and maintenance of the earth's electric charge can be definitely formulated. My main purpose appears to have been accomplished, namely, to bring back into the literature a question for reinvestigation which was actively discussed more than a half-century ago and then dropped for want of sufficiently accurate data of the requisite extent. It is hoped that the renewed discussion will contribute towards the multiplication of atmospheric-electric stations where every possible care will be taken to ensure continuity of strictly comparable data for as long a period as possible. Among other precautionary measures, more frequent and more extensive controls, than is at times the case, of the factor for reducing observed potential-gradients to an infinite plane, are requisite.

LOUIS A. BAUER.

Department of Terrestrial Magnetism,
Carnegie Institution of Washington,
October 5.

[1] *Terr. Mag. and Atmos. Elect.*, vol. 23 (1918), pp. 1-22 and 61-68.
[2] Proc. Phys. Soc., London, vol. 35, part 3, April 15, 1923, p. 132.
[3] It is expected that this paper may appear in the December, 1923, issue of *Terrestrial Magnetism and Atmospheric Electricity*, when it is hoped that, in addition to other data, those for 1922 at Kew and Eskdalemuir will be available.