in a basin of water, and the circuit completed through a galvanometer. The temperature of the water in the basin might then be altered till the galvanometer gave zero indication."

Sir Wm. Thomson now adds the recommendation that, in carrying out this method, the two wires, each well covered with gutta-percha, should be twisted together; that the wires should be stout and as homogeneous as possible throughout, and that a piece of stout copper tube should be attached to the lower junction, this tube being uncovered and in close contact with the earth all round, its purpose being to insure that the junction takes the proper temperature.

It would probably be desirable, in filling up the bore, to mix clay with the original material to render it watertight, for it would be impossible to render the filling of the bore as compact as the surrounding rock.

Several pairs of wires would be buried in the same bore, with their lower junctions at different carefully-measured depths.

The upper junctions would be kept in a room provided with a steady table for a mirror-galvanometer.

THE RAINFALL OF THE WORLD[1]

1. THE pamphlet referred to below embodies the outline of an attempt to bring into harmony the disconnected, and in some cases apparently irreconcilable results that have hitherto attended comparisons of terrestrial rainfall and sun-spot variations. It relates, therefore, to the entire rainfall system of the globe.

2. The plan by which it is thought this object will be best attained is one which divides the world into a number of rainfall zones where either *à priori* considerations or actual experience would lead us to expect typical changes in the effects of a recurring secular variation in solar radiated heat upon the rainfall; it being immaterial as far as regards the practical advantages secured by this method of hyeto-graphical subdivision, whether the solar radiation be ultimately found to vary directly or inversely with the sun-spots.

3. The way in which typical changes may arise in different parts of the earth from the effects of an assumed recurring secular change in solar radiated heat, is shown by a reference to the general scheme of atmospheric circulation in conjunction with the two leading factors of variability, viz., season and latitude.

4. A consideration of these points leads the author to divide the world into five zones, which either theoretically might, or are actually known to, involve some typical change in the secular variation of the rainfall either of one season or the whole year.

5. Partly to illustrate this mode of subdivision by applying a reasonable working hypothesis, and partly in the absence of absolutely conclusive evidence in its favour, by exhibiting the harmony of existing facts with the conditions theoretically deduced from it, to promote its ultimate adoption, the theory of the inverse variation of solar radiated heat with the sun-spots is assumed throughout.

6. It is also shown in the Introduction that we have a good deal of evidence in favour of the same theory, both *à priori*, from a consideration of the principle of conservation of energy as applied to the sun, as well as indirect, from the results of thermometrical observations.

7. In applying this hypothesis to determine the rainfall variation, account is mainly taken of the direct relation between wind velocity and temperature, the secular changes in solar radiation being assumed to cause *similar* effective secular changes in the velocity of the larger atmospheric convection currents.

8. An induction from Messrs. Blanford and Eliot's theory of cyclone-generation is then made use of, in combination with the preceding hypothesis, from which it appears that while, owing to the diminished solar temperature, evaporation might be lessened in the tropics at the epoch of maximum sun-spot, the diminished carrying power of the wind (by which the prevalence of cyclones at this epoch would be accounted for, according to Blanford and Eliot's theory) might allow of greater precipitation near the place of evaporation, and therefore of a generally heavier rainfall in these regions. At the opposite epoch, on the other hand, the increased velocity of the wind would probably cause a wider distribution of tropical vapour, and therefore in combination with the direct effects of the assumed increase in solar

[1] *The Rainfall of the World in Connection with the Eleven-Year Period of Sun-spots. With an Introduction and Appendix.* By E. D. Archibald, Professor of Mathematics in the Patna College. (Calcutta and London: Thacker and Co. 1878.)

radiation at the same epoch give rise to a deficiency of rain in parts, more especially those in which the local conditions normally tend to produce aridity.

9. These hypothetical results are then shown to approximately agree with the actual results of observations recorded in these regions.

10. It is next shown that the effects of the assumed secular change in the velocity of the anti-trade (the prevailing wind of the temperate zone) should differ considerably from those in the case of the monsoons and trades of the tropics, an increased velocity in the case of the anti-trade causing a greater quantity of tropical vapour to be conveyed to the temperate regions, and consequently a greater degree of humidity to ensue there. When, therefore, the direct effects of the assumed increase of solar heat at such an epoch are at a minimum, that is to say, in the *winter*, the relative humidity, and consequently the rainfall, should be *increased*. It is also evident that such an effect should be most conspicuously felt in those regions where rain falls *only* in the winter, and is due to the descent of the anti-trade.

11. The occurrence of this inverse variation in the zone of winter rains, which in the case of the Mediterranean stations (*Zeitschrift für Meteorologie*, Band viii. No. 6), had hitherto been deemed unfavourable to Messrs. Lockyer and Meldrum's generalisation regarding the direct variation of terrestrial rainfall with the sun-spots, is also shown to be visible in the winter rainfall of Northern India, and the rainfalls of Jerusalem and California, thereby affording some preliminary support to the notion that it holds over a still wider extent of the globe where the rain falls mostly during the winter.

12. The attempt is then made to show that while the direct effects of the secular change in the sun's heat over extra-tropical continents may, during the summer, operate so far as to destroy the indirect effects produced by the corresponding variations in the strength of the anti-trade, and as Dr. Hahn has shown in the case of the summer rainfalls of several stations in Central Europe, actually cause a *direct* variation with the sun-spots, there are, as there should be, in accordance with the hypothesis, some preliminary indications of an *inverse* variation of that proportion of the total which falls during the winter months alone, even in those places where the rain falls throughout the year. This fact, then, would imply that a change of season causes a change of type in the character of the variation, so that in order to render the variations distinctly apparent we should compare the winter and summer falls separately. It may also be inferred that the quality of the variation in the total annual fall will depend on the preponderance of the summer or winter falls respectively, which fact may help to account for the numerous anomalies noticed by those who have hitherto compared the total annual falls of places in the temperate zone with sun-spots.

13. It is finally inferred in the appendix, as a direct result of the hypothesis assumed throughout, that the winter gales of the temperate zone and the cyclones of the tropics should bear a complementary relation to each other, the former being most frequent about the time of minimum, and the latter about that of maximum, sun-spot. Some evidence in favour of this notion was recently communicated to NATURE by Mr. S. A. Hill (vol. xviii. p. 616).

14. The pamphlet is intended by the author to be considered as merely tentative, and not by any means conclusive. It is the method of division into zones and the separate comparison of seasonal falls, rather than the accordance of data with theoretical deductions, to which he desires to give prominence, and which he thinks may be of some assistance to other workers in the same field.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Cambridge Mathematical Tripos list was published on the 24th. This year the list contains 91 names. There are 28 classed as Wranglers, 33 as Senior Optimes, 29 as Junior Optimes, and 1 Ægrotat. In 1878 the list contained 94 names, 31 being Wranglers, 30 Senior Optimes, 29 Junior Optimes, and 4 Ægrotant. The first three Wranglers are Mr. A. J. Campbell Allen, of St. Peter's; Mr. George Walker, of Queen's, and Mr. Carl Pearson, King's. Mr. Campbell Allen, of St. Peter's College, the Senior Wrangler, is a native of Belfast, and was born in 1856. He received his elementary education at the