

climate, such as agriculture, &c. It should follow from this that whether the annual result of the presence of a forest be an excess or a defect of heat, the one or the other should, thanks to the winds, be communicated to a greater mass of air, and be less sensible in the stratum close to the ground. The thermic properties of other surfaces are more immediately available in the lower stratum, and consequently, from the practical point of view, exert a greater influence on the temperature of the earth and of its immediate vicinity.

"If, then, we confine our consideration to that which from the practical point of view is perhaps the most important, the influence of forests on the state of temperature in the stratum in which man generally lives, in so far as this can be determined in the ordinary way by thermometers, I think that our reply for this country (Sweden) will be less uncertain, and it is as follows:—

"In the districts of our country which are open and are cultivated, during the annual interval of cultivation, a forest lowers the temperature of air and soil during evenings and clear nights, restricting the period of daily insolation; and thereby checks vegetation.

"The other influences of forests on temperature are either so slight that they possess no practical importance, as, e.g., the moderation of cold in winter, or else are of such a character that they elude the ordinary mode of observation by thermometers. Among the effects of this nature we may mention the well-known fact that forests afford shelter against cold and violent winds to vegetation which would suffer from these winds, or to objects whose temperature is higher than that of the environment, as for instance the human body. It is in this last respect that the Swedish saying is true, namely, that 'the forest is the poor man's cloak.' In certain cases it may also yield protection against the cold air or fog which on cold nights comes from districts in the vicinity which are visited by frost. The advantages on the score of temperature derivable from the forest may therefore be considered to resemble that obtainable from a wall, a palisade, a hedge, or any object of that nature.

"On the one hand a forest, where it is close at hand, offers mechanical protection against cold and violent winds. On the other hand, it does injury either by retaining the solar heat required by crops, or by lowering the temperature of the soil during clear nights, and thus favouring the development of hoar-frosts. At a distance forests have no sensible influence on the climate of Sweden.

"If we wish to put these results to a practical application, it is impossible to say in general whether one should, or even could, clear the forest without injuring agriculture. But it appears that as regards the temperature, if we disregard the utility of forests in other directions, we might make extensive clearances without any prejudice to agriculture. It is certainly not a mistake to say that our best cultivated districts are the freest from wood, nor is it a mere chance that the harvests are, on the whole, more sure in the open country than in the forest. In the event of a bad harvest it is, as I well know, the wooded districts which have suffered most. At the same time I must at once admit that these provinces are also influenced by other powerful physical factors, possibly even more active than forests, such as an elevated situation, a bad soil, the presence of swamps, &c. But nevertheless it appears to me, after all that has been said in the preceding pages, that the forest has some bearing on the subject.

"At the present day, the words spoken 130 years ago by Pastor P. Högström, and at that time member of the Swedish Academy, are very generally applicable, inasmuch as it has been found that cultivation can to a great extent remove from a district its tendency to hoar-frost; this same result has frequently been obtained by draining or by clearing the forests, particularly those of deciduous timber, where the fogs, especially those which bring on

frosts, appear to have their origin and their aliment. On the contrary, a pine forest is an excellent shelter against cold, especially when it can stand between the country and marshes or surrounding districts where the cold has its rise. If, however, the forest interferes with sunshine and with wind, it should be cleared. It results, therefore, that while in some districts the clearing of a forest has been beneficial in averting hoar-frost, in others the result has been directly the opposite."

*RESULTS DEDUCED FROM THE MEASURES OF TERRESTRIAL MAGNETIC FORCE IN THE HORIZONTAL PLANE, AT THE ROYAL OBSERVATORY, GREENWICH, FROM 1841 TO 1876*

SIR GEORGE AIRY has recently published a valuable and extensive series of diagrams representing the diurnal changes in the magnetic forces in the horizontal plane at Greenwich between 1841 and 1876. In an introduction, the ex-Astronomer-Royal gives a short statement of the circumstances under which the magnetic work was undertaken at Greenwich, and the various changes which have taken place. With regard to the curves here brought together he writes as follows:—

The form of the curves, and the position of the points on them corresponding to hours of solar time, leave no doubt that the diurnal inequality is due mainly—and, as far as I can judge, entirely—to the radiant heat of the sun; and, it would seem, not to its heat on the earth generally, but to its heat on points of the earth not very distant from the magnets. In the hot months of the year the curve, though far from circular, surrounds the central point in a form which, as viewed from that central point, never crosses itself, and is, generally speaking, usually symmetrical with regard to E. and W. But in the cold months the space included in the curve is much smaller, in many cases probably not one-fifth of what it is in the summer months; and the curve often crosses itself in the most bizarre fashion, with irregular loops at these crossings. In the summer months there is a certain degree of symmetry; but here is, constantly, a preponderance on the west side, which leads me to imagine that the magnetic effect of the sun's heat upon the sea is considerably greater than the effect on the land.

To obtain some numerical basis for a report which, though undoubtedly imperfect, may convey some ideas on this wonderful subject, I have adopted the following course. I have confined myself to the months of June and July as probably the two hottest, and the months of December and January as probably the two coldest. In each of the curves applying to these months I have laid down a system of rectangular co-ordinates corresponding to the Greenwich astronomical meridian, and the line at right angles to the meridian (the geographical E. and W.). The extreme north ordinate and the extreme south ordinate were measured, and their sum taken, and interpreted by a scale of measure formed in accordance with the theory of the instruments, and this interpretation forms the "range of meridian force in terms of the mean horizontal force." In the same manner, the "range of transversal force" is measured. As the time of each two-hourly or hourly result is marked on the curve, there is no difficulty in fixing approximately on the solar times corresponding to the extreme N. and S. values and the extreme E. and W. values mentioned above. These are all the elements of the magnetic record which are included in the table.

*MOVEMENTS ON THE SUN'S SURFACE*

M. A. BELOPOLSKY, of the Moscow Observatory, states in *Astronomische Nachrichten*, No. 2722, some considerations of much interest regarding the solar

rotation. They are based upon a hydrodynamical investigation by Dr. Jukowsky, showing that in a liquid globe of which the angular rate of rotation increases from centre to surface according to a certain law, superficial currents set from the poles towards the equator, but take the opposite direction if the rotation be accelerated from surface to centre. These theoretical deductions have been experimentally verified by M. Belopolsky. A new criterion is thereby furnished as to the fashion of the sun's internal rotation. For both Spörer and Carrington have recognised that the motion of spots in latitude tends, on the whole, poleward; while the closing in towards the equator, with the progress of each epoch of disturbance, of the zone in which spots, faculæ, and prominences chiefly manifest themselves, is a well-recognised feature of periodical solar activity. This zonal movement is held to depend upon currents at considerable depths, but the drift of individual spots upon surface-flow; hence the sun's system of circulation is such as to indicate, according to Jukowsky's theory, rotation accelerated towards the centre.

The cause of this inequality is found by M. Belopolsky in the non-homogeneous character of the solar globe. Assuming that the variations of its density conform to the law adopted by M. Roche for the terrestrial spheroid ( $\rho = \rho_0 (1 - \beta r^2)$ ), it follows that gravity must attain a maximum at a certain depth below the surface (this depth, in the case of the earth, is  $1/6$ th of the radius). Under these circumstances the rate of rotation and amount of polar compression of successive solar strata must vary with gravity, and in the same sense. It is, moreover, highly probable that gravity and angular velocity will attain a maximum simultaneously. The ensuing frictional acceleration of the superimposed slower-moving layers is so conditioned as to lead directly to a law of surface-rotation identical with the empirical formula arrived at by Spörer from observation solely ( $\xi = \omega + a \cos \phi$ ).

The minimum period of rotation for an interior solar shell, computed according to the foregoing hypothesis, is 21.3 days; the longest observed period for any part of the superficial globe is 27.5 days. The mean of the two (24.4 days) differs very little from the period of 24.5 days deduced by Hornstein from magnetic observations. It is pointed out that Faye's *rationale* of the peculiar character of the sun's rotation implies for an inner nucleus the improbably short period of 2.2 to 3 days.

#### EDUCATION IN THE UNITED STATES<sup>1</sup>

THE work of education in the United States of America, as delineated in the Commissioner's report, is making steady progress and keeping pace with the great increase of population in that country, where are 266 cities with an average of 40,000 inhabitants, and a lowest limit of 7500. Various States are able to perceive that a more efficient course of education provided in them for the next generation is one of the greatest attractions to those earnest striving settlers who are the backbone of a growing country; and money and energy in increasing amounts are devoted to the purpose. The successful guidance of these powers to desired results depends largely upon the selection of capable district superintendents who will provide for the more careful selection and improvement also of teachers, and introduce the best methods and the best facilities of instruction; thus making common to the many what would have been confined to the extra intelligent few. The first use, therefore, to be made of liberal money votes is the provision of high-class inspectors, who can be secured only by higher salaries. One important duty of these officers arises from the system of establishing schools in every

district being so perfect in all of the United States, that in Connecticut, for example, there are 158 school districts which have less than eight scholars in attendance during the year, and one case is quoted, not as being by any means unparalleled, of a school having only four scholars during the year, and for three months having one only, whose education consequently cost the district 60 dollars. In such circumstances the State inspectors can recommend the consolidation of several of these school districts into one. Where this cannot be done, it is not likely that an efficient, qualified teacher can be secured for each. Yet rather than this scattered population should grow up half taught, the New York superintendent of popular instruction recommends that a sufficient salary shall be made good out of State or general Government funds. It is the more necessary to meet this difficulty as population is not everywhere increasing. In Maine, for example, population has decreased, and the number of school districts has been reduced already.

In Massachusetts a greater number of scholars than the whole number of the school population (from 5 years of age to 15) were enrolled; but, on the other hand, Maryland and Virginia showed only 23 and 29½ per cent. attending, and what reports could be gained from Louisiana showed only 19 per cent. enrolled, and not above 13 per cent. attending. Of course, in such a State, there is the double difficulty of getting the coloured population to school and of raising the money to pay for it; poverty standing in the way of fair remuneration of teachers as much as the lazy ignorance of the blacks in that of regular attendance. Naturally half-day sessions have suggested themselves as being economical in every way, requiring only half the staff of teachers, and half the schools and school-furniture. But a danger in this system is lest the teacher should be overworked; and, where he is able to do so greatly increased work, it is fairly recommended that his salary should be increased accordingly. A great variety of work therefore presents itself to the inspectors, and much discretion and knowledge will be required to meet all emergencies.

It is easy to see that no New World organisations or ambitions are any match for the evils of population bred down to the point of a hard struggle for existence. These evils are developing in America as fast as they did in ancient cities. Truancy is increasing, and many children never attend school even in such a city as Providence, R.I. New York experience acquits employers of labour of any mischievous influence in the matter. It is curious to note that while in England charitable funds have been diverted gradually to the education of the more promising children, and School Boards have had intrusted to them the unpromising residuum, in American great cities the public schools take in all the former, while the benevolent are urged to take up the work of teaching the latter, for whom the regular course is too advanced. Free education, approved by certain States, can be more easily adopted in such a state of things; where the large ratepayers get large advantages, than in a country like ours, where payment made and advantage to be gained would be in exactly inverse ratio.

A very large proportion of the pupils in the primary schools are of the ages of 8 and 9, and the number who pass on to the secondary schools is about 40 per cent.; but not 1 in 12 of these reaches the higher standards of the secondary schools. Since also 60 per cent. never get beyond the elementary schools, the report urges how needful it is that the education given in these schools should be as complete in itself as possible, and not merely a preparatory step towards the "grammar" or secondary studies. The different proportions of arithmetic required in the different cases will force this upon the mind at once. Elsewhere in the report it is taken as an accepted rule that more cultivated fitness is required to teach a primary than a model school.

<sup>1</sup> "Report of the Commissioner of Education for the Year 1883-84." (Washington, Government Printing Office, 1885.)