which give him an advantage as an observer of phenomena both on sea and land, and the results of which are apparent in the volume before us. Mr. Clark's narrative relates to the years 1876-77, during which he resided for nearly two years in Buenos Ayres, Paraguay, and Uruguay. The two latter regions are yet sufficiently unknown to make any contribution from a competent observer who has visited them, welcome. The information, especially, which he gives us on Paraguay, is of much importance, and is a valuable addition to that obtained by Mr. Keith Johnston, in his visit two or three years ago. From a scientific point of view, perhaps the most valuable portion of Mr. Clarke's book are the numerous meteorological notes which he made both during his voyage out and his stay in South America. His knowledge of meteorology in its widest sense seems to us both extensive and accurate, and his observations on the instruments he used, on doldrums, tropical evaporation, and other such topics, are really interesting. But Mr. Clark knows something also of botany, as is evident from the frequent observations in this direction to be found throughout his volume. A whole chapter is devoted to the climate and meteorology of Buenos Ayres, important both from a scientific and practical point of view, as it is one of the great centres of emigration for South America. Many interesting sketches are given of the people and their mode of life in the various districts visited by Mr. Clark, and altogether his work is one of substantial value and real interest, and we trust it will find many readers.

Our Railways: Sketches Historical and Descriptive, with Practical Information as to Fares, &c., and a Chapter on Railway Reform. By Joseph Parsloe. (London: Kegan Paul and Co., 1878.)

MR. PARSLOE'S volume contains a large amount of very varied information on railways, their origin, their working; its object, he tells us, being to present a sketch of our railway system in its general details. The contents are so varied it would be difficult to give any idea of their nature without a lengthened notice. Mr. Parsloe goes back to the old days of stage-coaches, coming down to the origin of railways, then speaks of their construction, of navvies, working expenditure, signals, gauges, tickets, and a multitude of other topics all of much interest to the travelling public. The book is certainly both interesting and instructive.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Formation of Mountains and the Secular Cooling of the Earth

THE letters of Mr. Wallace and Mr. Fisher in NATURE, vol. xix. pp. 121, 172, 244, 267, raise the question as to whether or not it is possible that the interior of the earth can be cooling more rapidly than the exterior. The following is an attempt to answer the query as to where the loss of temperature per unit time is greatest.

Sir W. Thomson (see Thomson and Tait, "Nat. Phil.," App. D) considers the cooling of "a solid extending to infinity in all directions, on the supposition that at an initial epoch the temperature has had two different constant values on the two sides of a certain infinite plane." The solution given is—

$$v = v_0 + \frac{2V}{\sqrt{\pi}} \int_0^{\frac{x}{2\sqrt{kt}}} e^{-z^2} dz$$

where k denotes the conductivity of the solid, measured in terms of the thermal capacity of the unit of bulk;

V, half the difference of the two initial temperatures;

v_0, their arithmetical mean;

t, the time;

x, the distance of any point from the middle plane;

v, the temperature of the point x at time t.

The above solution shows that for all values of the time when $x = 0$, $v = v_0$, so that the temperature at the medial plane is constant.

Then differentiating v with regard to the time we have—

$$-\frac{dv}{dt} = \frac{V}{2\sqrt{\pi k}} \frac{x}{t^{\frac{3}{2}}} e^{\frac{-x^2}{4kt}}$$

This expression is that required for the rate of cooling. We now wish to find where it is a maximum. Consider the function ze^{-z^2}; this is clearly a maximum when $\log z - z^2$ is a maximum, and by the ordinary rules this is a maximum when $\frac{1}{z} = 2z$, or when $z^2 = \frac{1}{2}$.

Hence it follows that $-\frac{dv}{dt}$ has its maximum value where $x^2 = 2kt$.

Now when the unit of length is a foot and of time a year, $k = 400$; hence $x = \sqrt{800t}$.

This formula shows that the seat of the maximum rate of cooling moves inwards as the time increases. If the time which has elapsed from the initial state be two hundred million years, or $t = 2 \times 10^8$, we have $x = 400,000$ feet, or a little less than eighty miles.

Sir W. Thomson shows, in his paper on the Secular Cooling of the Earth, that the solution of his ideal problem will be very nearly correct for the case of the earth, which is supposed to be a hot sphere cooling by radiation.

It follows, therefore, from the numerical result which is given above that the seat of the maximum rate of cooling must probably be something like 100 miles below the earth's surface.

It does not, of course, necessarily follow that the seat of the maximum rate of contraction of volume should be identical with that of the maximum rate of cooling; yet it seems probable that it would not be very far removed from it.

The Rev. O. Fisher very justly remarks that the more rapid contraction of the internal than the external strata would cause a wrinkling of the surface, although he does not admit that this can be the sole cause of geological distortion. The fact that the region of maximum rate of cooling is so near to the surface recalls the interesting series of experiments recently made by M. Favre (of which an account appeared in NATURE, vol. xix. p. 103), where all the phenomena of geological contortion were reproduced in a layer of clay placed on a stretched india-rubber membrane, which was afterwards allowed to contract. Does it not seem possible that Mr. Fisher may have under-estimated the contractibility of rock in cooling, and that this is the sole cause of geological contortion?

G. H. DARWIN

Storm Warnings

A NEW YORK telegram occasionally announces that a cyclonic storm will probably reach the coast of Europe in a few days.

Such warnings are often of great value; but many storms are deflected in the Atlantic, while others—without having touched the American coast—come unannounced with destructive violence.

A floating buoy might be constructed to serve the purpose of a marine observatory, when placed in the usual track of storms at a sufficient distance from exposed coasts to be useful for *warnings* for ships in and near harbours.

The chief meteorological "elements" which are of essential significance in such a case are the *height* and changes of the barometer, and the varying force and direction of the wind.

If an experimental buoy were fixed by means of a slightly elastic cable about eighty miles off Valencia Observatory, and connected therewith by submarine telegraph wire, a slight modification of the aneroid lodged therein would enable the observer on shore to determine to about a tenth of an inch the height and changes in its *readings*.

A wind-vane in connection with a magnetic bar, and presenting a disk to the air-current, might be made the means of registering approximately the force and direction of the wind.