plete discussion of the facts as proof. He turns next to Espy's conviction, that rain might be produced economically whenever it was wanted, and cites Professor Henry's opinion in the matter:—

"I have great respect for Mr. Espy's scientific character, notwithstanding his aberration, in a practical point of view, as to the economical production of rain. The fact has been abundantly proved by observation, that a large fire sometimes produces an overturn in the unstable equilibrium of the atmosphere, and gives rise to the beginning of a violent storm."

The opinion of Professor Everett, president of the Meteorological society, is also cited. He believed that great battles and great fires tend to produce rain, but that rain does not, of necessity, follow battles or fires.

The climate of Australia being peculiar, Mr. Russell has endeavored to collect the records bearing upon the question there; and, there having been no battles (except a mimic one, which produced no rain), he passes to an examination of the meteorological conditions of the times of the great fires which have occurred in Sydney since 1860, and assumes, that, if a fire produced rain, it would fall within forty-eight hours. His record embraces forty-two large fires (including two serious explosions), extending over a period of twenty-one years; and he concludes that there is not one instance in which rain has followed within the forty-eight hours as an evident consequence of the fire.

In cases where it is asserted or believed that rain has been produced artificially, it would be interesting to examine whether the rain was due to the fires or to ordinary meteorological changes. While it is evident that some of the most competent authorities in England and America think that under certain circumstances rain may be produced artificially, Mr. Russell thinks they all carefully avoided saying what the circumstances were; and he proceeds to develop some idea of what they are, from a consideration of the natural conditions under which rain is deposited, and adducing certain instances as illustrations, from nature, of the conditions under which the leading scientific meteorologists of the day tell us that rain is formed. He says,—

"If we can get a measure of these [observed] effects, it will serve as a guide in estimating what would be required to make rain. At Sydney the average relative humidity is 73, and at Windsor it is rather less; and we have just learned that such atmosphere lifted from Windsor to Currajong, 1,800 feet, deposits 60 per cent more rain. If we could make it rise up over Sydney 1,800 feet, we might fairly expect to get 60 per cent more rain. Now, a wall built 1,800 feet high, and of considerable length, so that a wind would not divide and go round it, but go over, would have the desired effect; i.e., to lift the air and cause rain: but any thing that would do this would serve the purpose, and it may be done by fire; but of course the fire must have the effect of lifting the atmosphere up. It will not do for the products of the fire to rise up slowly, mixing with the air, and making it drier as they rise. If it is to have the effect of a wall,—that is, making the whole of the air passing over rise up 1,800 feet,—it must act as an explosion would do, suddenly, or by a constant uprush of such violence that it would rise up 1,800 feet. The force necessary to do this is easily computed, and we can in this way get a money value for the work to be done. At Sydney the average velocity of the wind is 11 miles per hour; and all the air passing over is to be lifted, and the weight of it on the surface is, say, $14\frac{1}{2}$ pounds on the square inch, and $13\frac{1}{2}$ pounds at 1,800 feet high. At least, for our present purpose, these figures are sufficiently exact. The average weight to be lifted, therefore, is 14 pounds on the square inch. The fire must have the same length as the proposed wall, for the same reason, and a breadth equal to the forward motion of the air in a given time. We have therefore to lift a weight of 14 pounds on the square inch over a surface of 1,000 feet by 10 miles (52,800 feet), and raise it up 1,800 feet every minute. To do this we will assume that coal is employed, and that, as it is burnt in the air, the whole of its heat will be effective. The mechanical equivalent of good coal is 14,000,000 foot-pounds for each pound of coal used. We have, therefore,—

$$\frac{14 \times 12 \times 12 \times 1{,}000 \times 1{,}800 \times 52{,}800}{14{,}000{,}000 \times 112 \times 20} = 6{,}110 \text{ tons per minute} =$$

8,800,000 tons in a day, or nearly 9,000,000 tons of coal per day, to increase the rainfall 60 per cent, at a cost, at 10*s*. per ton, of £4,500,000.

"Of course this is only a theoretical experiment, and ignores all the heat lost by radiation and imperfect combustion; but it serves to give some idea of what is necessary to disturb the course of nature, and, I think, shows how utterly futile any such attempt would be, even near the sea, where the air is moist."

It would seem unreasonable, Mr. Russell concludes, to hope for the economical production of rain under ordinary circumstances; and our only chance would be to take advantage of a time when the atmosphere is in the condition called unstable equilibrium, or when a cold current overlies a warm one. If under these conditions we could set the warm current moving upwards, and once flowing into the cold one, a considerable quantity of rain might fall; but this favorable condition seldom exists in nature.

ROTATION OF JUPITER.

MR. W. F. DENNING has recently published an investigation of the rotation of certain spots on Jupiter which confirms in a remarkable degree a theory already propounded that this planet resembles the sun in not only rotating in different times in different latitudes, but in having the period of rotation of its equatorial region shorter than that of regions in middle latitude. From the red spot which has formed so conspicuous an object on the planet for nearly five years, the following rotation periods are obtained at different times:—

Interval.	Number of rotations.	Period of rotation.
		h. m. s.
1880, Sept. 27–1881, March 17	413	9 55 35.6
1881, July 8–1882, March 30	640	9 55 38.2
1882, July 29–1883, May 4	674	9 55 39.1
1883, Aug. 23–1883, Dec. 5	251	9 55 38.8

A gradual lengthening of the period is thus indicated. On the other hand, from a white spot near the equator the following times are obtained:—

Interval.	Number of rotations.	Period of rotation.
		h. m. s.
1880, Oct. 20–1881, Sept. 30	842	9 50 5.8
1881, Sept. 30–1882, Dec. 23	1,095	9 50 8.8
1882, Dec. 23–1883, Nov. 25	823	9 50 11.4

We thus have the paradoxical result that the rotation period is more than five minutes less at the equator than in the latitude of the red spot. The effect of the motion of matter from one part of the planet to the other would be to make the actual time of rotation longer as we approach the equator. The opposite effect noticed in the times of rotation of spots suggests the possibility that the latter may be endowed with a motion of their own; partaking, perhaps, of the nature of cyclones on the earth's surface.

RED SKIES A CENTURY AGO.

I venture to suggest that recent phenomena are a re-appearance of those of 1783. It will therefore be interesting to give a sketch of the phenomena of 1783, in order to ascertain their similarities and differences.

In the spring of 1783 one of the greatest eruptions of Shaptar Jokul in Iceland resulted in the largest lava-streams ever observed, ten miles long, five miles wide, and a hundred feet deep. Obviously, great quantities of ash must also have been thrown up.

Towards the end of May, *höhenrauch* (dust-haze) was remarked first on the western coast of Europe. It was so thick as to render the sun invisible on the horizon, and even at mid-day it was only a red indistinct disk. It was first noticed, May 29, at Copenhagen, then in England, on July 6 and 7 in France, and rapidly spread over Europe, northern Africa, and eastern Asia. Neither rain, heat, nor cold dispelled it; and, having reached a maximum at the end of July, it remained visible till Sept. 26, 1783, at Copenhagen, thus lasting four months.

There are numerous instances of volcanic ash being carried very great distances. The dust from Coseguina in Central America was carried a hundred and seventy miles, towards Jamaica, and was so dense there as to darken the sky. Hence meteorologists concluded that the *höhenrauch* of 1783 was due to dust from Shaptar Jokul.

The similarity of the 1783 phenomenon with the present seems to me extraordinary. The frightful volcanic explosion of Krakatoa in the Sunda Straits, which began on Aug. 26, 1883, supplies, as did Shaptar Jokul, the material. The splendid redness at sunrise and sunset was first reported from India; and it will be an interesting inquiry to study the spreading of the phenomenon, as was done in 1783.

It was first seen in Japan at the end of August, but only reached Germany in November; and, from the dates of the various records, it seems evident that the ash was thrown into the upper regions of the atmosphere in the tropics. The extraordinary duration corresponds with that of 1783, and is to be explained by the fineness of the dust.

The differences are, that in our country the obscuration of the sun is less than in 1783, which would accord with the greater proximity of Iceland than Java.

It seems probable that rain and snow may bring some of the dust to the earth. I have therefore examined the residue of the rain-gauges from the 1st of December, but thus far without any positive results. Hence I infer that the dust is at present too high for it to be brought down: it is therefore most necessary that such observations be made in many places.

These views have been advocated by Lockyer, who, through spectroscopic research, has been led to the same conclusion.

Before, however, a final decision upon one or another hypothesis can be given, it will be necessary to collect observations, researches, and investigations, from as many points of the earth's surface as possible, which will doubtless be done in meteorological journals.

G. Karsten.

Kiel.

BROWNE AND BEHNKE'S VOICE, SONG AND SPEECH.

A practical guide for singers and speakers; from the combined view of vocal surgeon and voice-trainer. By Dr. Lennox Browne and Emil Behnke. New York, *G. P. Putnam's Sons*, 1884. 322 p., illustr. 8°.

A careful perusal of this work must establish the conviction in the mind of the reader, that the authors thoroughly understand their subject. In reference to voice-formation, many hitherto obscure points are made clear, and many hitherto doubtful points are settled, on physiological, and therefore indisputable, grounds. Thus, the distinctions between the various 'registers' of voice are proved to be due to demonstrable differences in the adjustments of the 'voice-box' and the vocal ligaments. A great deal of information is communicated on the subject of voice-cultivation, and the prevention and treatment of the ailments of 'voice-users.' The precepts in regard to hygienic habits for singers and speakers, their diet, and their clothing, so as to secure unrestricted freedom for the chest and the abdomen, are both judicious and important. About one-half of the book is taken up with the single subject of respiration. The proper management of the breath is shown to be a matter of the highest possible value to singers and speakers. The conclusions arrived at, in reference to the healthful and efficient use of the lungs, commend themselves as thoroughly sound and practical; but condensation in the treatment of the subject would have been a great improvement, as the same principles are again and again repeated under different heads.

The use of the laryngoscope is recommended more than will be thought generally advisable, so far as practical results are concerned; but the authors have handled this instrument to