


THE  
PROGRESS OF  
SCIENCE.



**T**he Aurora Borealis.—The aurora is a phenomenon familiar enough to every one living in the higher latitudes. It is said to be visible nearly every day during the polar winter, those seen in the United States being displays more extensive than usual. The average height of many auroras has been found to be upwards of a hundred miles, and some streamers are said to reach to the height of four hundred miles. On the other hand, occasionally some have

been seen below fleecy clouds which were floating probably no more than a mile high.

Whenever there is an exceptionally brilliant display there is at the same time what is called a magnetic storm, that is, all the magnetic needles of a continent are disturbed, and sometimes electrical currents in the earth are so strong as to prevent telegraphic work on such lines as use the earth for a part of their circuit. The pressure has been observed to rise as high as two thousand volts during such storms.

To account for the aerial phenomena has been as great a physical puzzle as to account for lightning. It has been common to say that the light was due to electrical currents, or electrical discharges in the rarified air at great elevations, and some countenance was given to such an explanation by the phenomena in the earth, but further study shows that such an explanation is untenable, and to entertain it is to discard some well-established principles of electrical science. Experimentally it is found that electrical currents and electrical discharges, which are only transient currents, require ordinary matter as a conductor, and in its absence there can be no current. It is not difficult to make a vacuum through which no electric discharge can take place. A spark representing millions of volts will jump several feet through the air rather than the tenth of an inch in such a vacuum, and this fact has led to the conclusion that the ether is a perfect non-conductor for electricity.

The number of molecules in a cubic inch of air at ordinary density and pressure is represented by one hundred, followed by eighteen ciphers, and their average distance apart is something like the two hundred and fifty thousandth of an inch. A good vacuum, such as may be produced by a Sprengel pump, may have the number of molecules reduced a million times, when each molecule may have a free path of four inches, without coming into collision with another molecule. In such a vacuous space no current can be started, though urged by millions of volts. At the height of two hundred miles above the earth's surface the air is so rare that a molecule might move millions of miles without colliding with another, and at three hundred miles there is not one molecule to the cubic foot, and one might travel from one fixed star to another without an encounter. This

makes it very certain that whatever may be the true explanation of the aurora, it cannot be due to electrical discharges, for such are impossible in aurora regions. Rapid changes of magnetism are capable of setting up ether waves in the most perfect vacuum, and such waves are known to be capable of making gaseous molecules luminous, whether they be dense or rare. Lemstrom, in Lapland, succeeded in producing an artificial aurora beam resting upon the top of a mountain by stretching a wire there in the form of a spiral. The wire was provided with brass points every foot or two of its length, which was several miles. Poles insulated the wire, one end of which was carried to a lower level, and could be connected to the ground by a switch. When the ground connection was made, a current of electricity always moved down the wire, and whenever there was an aurora, a light beam glowed from the mountain top when the switch connected the wire to the earth. The earth is known to be a magnet. Auroras are more frequent and of greater energy during the time that sun-spots are numerous; these phenomena occur simultaneously in periods of eleven years, and it seems a plausible supposition that the magnetic condition of the earth is disturbed by the activity in the sun, the magnetic waves making the molecules luminous.

A. E. DOLBEAR.



### Unreliable Weather Prophecy.—

In the August number of the *Cosmopolitan* for 1893, appeared a brief note of warning against the rain-makers. In consequence of that note, the writer received many requests to explain certain alleged facts as to the success of the rain-producers. Great stress was laid upon the fact that the government had gone into the business, and consequently that it was very unjust to deny the claims of other operators in rain-making. Several inquirers also wished to know whether weather-prophets could be relied upon any more than rain-producers. The fact that there is a weather bureau, conducted under the auspices of the government, and that weather predictions are officially promulgated, have done much to keep alive and extend the reputation of the so-called weather-prophets.

It should be understood that the weather predictions of the government and other scientific bureaus, made for a day or two in advance, are simple in principle, depending upon well-recognized physical deductions, and partly upon analogical conclusions. There is no mystery either in the theory or practice of such predictions, and the more numerous the observing stations, and the longer the work is continued, the more accurate will become the predictions.

There are also methods of making predictions for a long time in advance which are scientifically justifiable, and upon which considerable reliance may be placed. When the climatic conditions of a place have been carefully recorded, let us say, for every month for a long time, it becomes possible to predict with great probability of accuracy, that certain conditions will prevail in any subsequent month; that there will be so much rain, or snow, or so many windy days. Such predicting is merely asserting that the average will prevail. Again, from collated observations extending over a sufficiently long time, certain ill-defined cycles sometimes appear in weather changes, and by making use of these a general prediction may be made for any future time. While such long-range predictions as these are perfectly legitimate, the data are yet insufficient to make them of much importance.

There are other weather-prophets who pretend to predict for the future, for weeks and even months ahead, and profess to do so by specially, often personally, discovered laws, or by methods not known, at least not appreciated, by scientific bureaus. This kind of prophecy is generally as baseless as the rain-making claim, and should be entitled to no more consideration. Any one who claims to have discovered *definite* laws in the changes of the weather is mistaken. Any one who claims to have discovered cycles in the weather changes from a *few* observations of any sort, is also

mistaken. The whole class of long-range weather predictions professedly based upon the conjunction or opposition of planets, upon the eclipses of the sun, moon, or other celestial bodies, or upon the observed action of animal nature, are unworthy of attention. In general, it may be said that all weather predictions not based upon long, systematic, and extended observations of the weather, are unworthy of consideration, and when any one is found making predictions without such data, he is simply guessing.

S. E. TILLMAN, PROF. U.S.M.A.



**uban Revolutions.**—The recent geological history of Cuba has been remarkably eventful, as compared with that of the Carolinas and Georgia. Since the beginning of the glacial epoch (or, in other words, since the close of the Tertiary), these southern states have undergone only a gentle warping, accompanied by some additional cutting by pre-existing streams, and minor alterations in their courses. Prior to the glacial epoch, the island had been for a long time nearly or wholly

submerged, and had accumulated upon its surface a mass of limestone many hundred feet in thickness. About the time when the continental ice-sheets began to form (according to Mr. R. T. Hill), there took place in the Caribbean sea a great continent-making disturbance which drove the great island up to a maximum elevation of about two thousand feet above sea-level, folding and crumpling the limestones in the process. Erosion at once set in, of course, and, indeed, in so efficient a manner that a large part of the island was cut away nearly to sea-level, leaving, however, some hills or mountains carved out of the limestone mass. Still later, upheaval was resumed, but in a more gentle manner, and intermittently, each pause being marked by a series of cliffs along the shores. The first plain of erosion or "base-level" now forms the inland plateau of Cuba, some six hundred feet above the sea, while the later sea-cut terraces are one of the most prominent features of Cuban scenery. Only the lowest of these, not reaching above one hundred feet, is formed of coral—the rest being of the older Tertiary limestone.

Catastrophic theories have long been abandoned by most geologists. The uniformitarian theories which succeeded them are also somewhat out of vogue. When one compares the recent histories of Cuba and the southeastern states, the rapidity of change in the island seems almost catastrophic, and in utter contradiction to the doctrine of uniformity. The law of nature is not merely change, but change at changing rates.

GEORGE F. BECKER.



**lectric Motor Regulation.**—A patent contest, now in progress, has brought to notice an inventor and an invention of exceptional interest to science. The inventor, Mr. Granville T. Woods, is notable for his ancestry. His mother's father was a Malay Indian, and his other grand-parents were by birth full-blooded savage Australian aborigines, born in the wilds back of Melbourne.

Mr. Woods has taken out some thirty-five patents in various countries, and has many still pending. He is the inventor of a telephone which he sold to the Bell Telephone Company, and of a system of telegraphing from moving railway trains, which was successfully tried on the New Rochelle branch of the New Haven road in 1885. Three years ago, an electric railway system of his invention was operated at Coney Island. It had neither exposed wires, secondary batteries, nor a slotted way. The current was taken from iron blocks placed at intervals of twelve feet between the rails, in



GRANVILLE T. WOODS.

which, by an ingenious arrangement of magnets and switches, the current was turned on to the blocks only as they were successively covered by the cars.

The most remarkable invention of Mr. Woods is for the regulation of electric motors. In almost all applications of electric power it is necessary at times to control the speed of the motors without changing the loads or disturbing the voltage at the source of supply. This has usually been done by introducing large dead resistances in series with the motors. These quickly become hot, and are extremely wasteful of electricity. Mr. Woods has, by his improvements, reduced the size of these resistances, so as to materially lessen the losses by them, and to remove other objectionable features. It is accomplished by employing a dynamotor to regulate the main motor, and controlling the former with a small series of resistance coils. A dynamotor is an electrical apparatus in which two machines, a dynamo and a motor, are placed on the same shaft, one of the machines receiving current, and the other generating current, usually of a different voltage. As applied to motor regulation, the motor part of the dynamotor takes up the surplus electric energy and converts it into mechanical energy by rotating the armature shaft; this in turn, by revolving the armature of the dynamo part, generates electrical energy which is returned to the line.

Certain features of this invention are now involved in interference proceedings in the United States Patent Office with five rival inventors. Of these, only one had the invention perfected to the extent of using a dynamotor. This one is Dr. Schuyler S. Wheeler, of the Crocker-Wheeler Electric Company. The proceedings, however, showed that Woods completely developed his invention when there was no prior model to guide him, and when the others were at most only taking the preliminary steps which led them years later in the same direction. The Crocker-Wheeler Company have consequently been obliged to ally Mr. Woods with them in order to retain the improvements independently invented by Dr. Wheeler.

When a boy of ten, Mr. Woods was set to work at bellows blowing in an Australian railroad repair shop. He soon made himself familiar with all its departments, and with his spare earnings engaged private instruction from the master mechanic of the establishment. At the age of sixteen, Woods was brought by his parents to America, and he became a locomotive engineer on the Iron Mountain road, in Missouri. Later, he secured a position as engineer on the British steamer *Ironsides*, and in 1880 established a repair shop of his own in Cincinnati.

Mr. Woods has a remarkably thorough knowledge of the intricate mathematics of electricity, and of legal practice respecting inventions. He is fluent in conversation, and his speech is entirely free from dialect. All this has been acquired while in active business, by reading and keen observation.

S. W. BALCH.

