thick; still a little less rapidly towards the Malverns, where they are only 800 feet thick; and most slowly towards St. David's Head, where they are 7,400 feet thick. The Cambrian rocks of Wales were in all probability the deposits of a river system which drained some vanished land once situated to the west. How great was the extent of this land none can say; some geologists imagine it to have obliterated the whole or greater part of the North Atlantic Ocean. For my part, I am content with a somewhat large island. What area of this island, we may ask, would suffice to supply the Cambrian sediments of Wales and Shropshire? Admitting that the area of denudation was ten times as large as the area of deposition, its dimensions are indicated by the figure *a b c d* on the chart. This evidently leaves room enough on the island to furnish all the other deposits which are distributed along the western shores of the Cambrian sea, while those on the east are amply provided for by that portion of the European continent which then stood above water.

If one foot in a century be a quantity so small as to disappoint the imagination of its accustomed exercise, let us turn to the Cambrian succession of Scandinavia, where all the zones recognized in the British series are represented by a column of sediment 290 feet in thickness. If 1,600,000 years be a correct estimate of the duration of Cambrian time, then each foot of the Scandinavian strata must have occupied 5,513 years in its formation. Are these figures sufficiently inconceivable?

In the succeeding system, that of the Ordovician, the maximum thickness is 17,000 feet. Its deposits are distributed over a wider area than the Cambrian, but they also occupied longer time in their formation; hence the area from which they were derived need not necessarily have been larger than that of the preceding period.

Great changes in the geography of our area ushered in the Silurian system: its maximum thickness is found over the Lake district, and amounts to 15,000 feet; but in the little island of Gothland, where all the subdivisions of the system, from the Landovery to the Upper Ludlow, occur in complete sequence, the thickness is only 208 feet. In Gothland, therefore, according to our computation, the rate of accumulation was one foot in 7,211 years.

With this example we must conclude, merely adding that the same story is told by other systems and other countries, and that, so far as my investigations have extended, I can find no evidence which would suggest an extension of the estimate I have proposed. It is but an estimate, and those who have made acquaintance with 'estimates' in the practical affairs of life will know how far this kind of computation may guide us to or from the truth.

This address is already unduly long, and yet not long enough for the magnitude of the subject of which it treats. As we glance backwards over the past we see catastrophism yield to uniformitarianism, and this to evolution, but each as it disappears leaves behind some precious residue of truth. For the future of our science our ambition is that which inspired the closing words of your last President's address, that it may become more experimental and exact. Our present watchword is Evolution. May our next be Measurement and Experiment, Experiment and Measurement.

W. J. Sollas.

THE INTERNATIONAL CONGRESSES OF METEOROLOGY AND AERONAUTICS AT PARIS.

These Congresses were held nearly simultaneously on account of their allied interests. The Meteorological Congress, which began its sessions on September 10th, had the same character as the Congress held during the Paris Exposition of 1889, that is to say,

it was open to all meteorologists, and although the countries participating in the Exposition were invited to send delegates, yet these had no power to pledge their respective countries to any action. More than thirty countries were represented this year at the Congress and about one hundred persons of various nationalities attended its sittings, which, consequently, were more truly international than was the case with any preceding congress. The absence of the Chief of the United States Weather Bureau was much regretted and the United States was represented solely by the officials in charge of the Weather Bureau exhibit at the Exposition and by the writer, who had also been the delegate of the United States in 1889. The place of meeting was again at the rooms of the Société d'Encouragement, outside the Exposition grounds.

M. Mascart, the director of the French Meteorological Office, was chosen president of the Congress, which he directed with his usual ability, being ably seconded by M. Angot as general secretary. Three vice-presidents represented England, Russia and Norway, respectively. At least half of the hundred papers presented were discussed by five standing committees whose sittings were open to any persons interested in the subjects. The most important work of the Congress was performed by these committees, foremost among them being the Aeronautical Commission, presided over by Professor Hergesell, that discussed the results obtained in the exploration of the atmosphere by the international use of balloons and kites, and the improvements that could be effected in instruments and methods. Professor Violle, as president of the Commission on Solar Radiation, summed up the state of the subject and heard several papers. Professor Rücker left the meeting of the British Association to preside over the Commission on Terrestrial Magnetism which had presented to it the work being done by magnetic observatories and surveys throughout the world. The Cloud Commission, the oldest of these committees, has always had at its head the indefatigable Professor Hildebrandsson, who was now able to summarize the results of the cloud measurements that through his efforts had been executed in various parts of the world during the so-called 'international cloud-year.' It was resolved to invite the meteorological observatories to undertake special observations of clouds each month on the days that the international ascents of balloons and kites were made in Europe. Eminently practical was the Commission for Weather Telegraphy, which proposed to accelerate the weather despatches in Europe by introducing the 'circuit system' of the United States, but found it necessary to refer the matter to the International Telegraphic Bureau at Berne. From the scope of these committees it will be seen that comparatively few subjects were left for discussion in the general sessions, which, consequently, had less interest than usual and served mainly to confirm the resolutions of the commissions.

Among the institutions visited, the most interesting was the observatory for dynamic meteorology at Trappes, near Versailles, where M. Teisserenc de Bort maintains an admirably equipped observatory, especially engaged at the present time in investigations of the upper atmosphere. This observatory, designed in general after that at Blue Hill, possesses, besides, means of obtaining temperature data at very high altitudes by the 'ballons-sondes' which are sent up twice a week and carry self-recording instruments to the height of ten miles or more. Owing to the many distractions of Paris, the only general entertainment was the banquet on the Eiffel Tower, and this was notable for the eloquent discourse of M. Leygues, Minister of Public

Instruction, who welcomed the meteorologists assembled from all parts of the globe as engaged in a science that benefits humanity and is independent of nationality. Coincident with the Congress, the International Meteorological Committee held a meeting and filled the vacancies existing in it, caused by the retirement of Dr. Scott, of England, and Professor Tacchini, of Italy, by electing to membership Dr. Shaw and Professor Palazzo, their successors as heads of the meteorological bureaus in their respective countries. Professor Hildebrandsson becomes secretary of the committee, a position long and faithfully filled by Dr. Scott.

The Aëronautical Congress convened on September 17th, the day that the Meteorological Congress adjourned. The general sessions were held at the Astro-physical Observatory at Meudon, but the sections met at the Institute of France in Paris. The committee of organization continued in office, namely M. Janssen as president and M. Triboulet as general secretary. Among the honorary vice-presidents was Professor Langley, who, with the writer, was a delegate of the United States. No other Americans attended the meeting, and the difficulty of getting to Meudon, no doubt, was one reason why so few persons came of the one hundred and fifty enrolled. M. Janssen's address was a masterly *résumé* of the progress of aëronautics since the Congress of 1889, and contained appreciative mention of the exploration of the atmosphere by balloons and kites. In speaking of the future, M. Janssen predicted that the nation which first learned to navigate the air would become supreme, for while the ocean, which has given preeminence to the people using it most, has its boundaries, the atmosphere has none. What then, asked the illustrious orator, will become of national frontiers when the aërial fleets can cross them with impunity? Two important conferences were given by the Renard brothers, the well-known officers in charge of the Central Establishment for Military Aëronautics at Chalais-Meudon. Major Paul Renard described the present state of aëronautics as exemplified at the Exposition. Colonel Charles Renard, who, with Major Krebs as collaborator, constructed at Chalais in 1884 the dirigible balloon named *La France*, the performance of which has never been equaled, gave a critical account of the various attempts to navigate the air by such balloon methods, terminating with the balloons recently constructed by M. Santos-Dumont in Paris and the huge one of Count von Zeppelin on the Lake of Constance. The other lectures were by M. Teisserenc de Bort on the meteorological results at Trappes from 'ballons-sondes' and kites and by the writer on the use of kites at Blue Hill to bring down such data from altitudes of three miles. In Paris special and technical papers were presented to four sections relating to different branches of aëronautics, and at the closing general session these communications were summarized and some resolutions were adopted. An international aëronautical committee was appointed, consisting, besides the officers of the Congress, of ten Frenchmen and ten foreigners, whose duty it is to advance aëronautical work throughout the world. On September 21st a delightful banquet at the Orangerie of the Château of Meudon, where the first balloons were constructed during the Empire, closed the Congress, and predictions were freely made that the conquest of the air was near at hand and that possibly members might come to the next reunion in aërial conveyances.

The noteworthy feature of this meeting, which could hardly be called international, was the demonstration of the practical status of aëronautics in France. Through the courtesy of the Minister of War, the establishment of Chalais was opened to the

public for the first time, permitting the construction and manipulation of the war-balloons to be seen, and what was more interesting to the student, the apparatus employed by Colonel Renard in determining the resistance of the air to various bodies moving through it. At the Park of Vincennes, in connection with the aëronautical section of the Exposition and through the cooperation of the Aëro-Club, balloon races were organized, and each Sunday the novel spectacle was presented of a great number of balloons starting on their journey without delay or difficulty. On one afternoon seventeen balloons rose successively, each aëronaut endeavoring to land as near as possible to some point that he had fixed beforehand. The skill shown in utilizing the prevailing currents and in manipulating the guide-ropes may be inferred from the fact that one aëronaut, after a voyage of thirty miles, landed within half a mile of his goal. The same evening eight more balloons ascended and on the following Sundays there were competitions for height and distance. In the former contest a balloon, filled with 106,000 cubic feet of illuminating-gas and carrying a single aëronaut rose more than 27,000 feet, a height never before attained in France, unless perhaps by the ill-fated *Zenith*, when two of its passengers were asphyxiated. In the final long-distance race, about 1,400 miles were traversed in thirty-seven hours and three of the six balloons landed in Russia. All these voyages, accomplished without accident, tend to popularize ballooning as a sport and to facilitate its practical employment whenever the dirigible balloon shall be realized. As before mentioned, a very interesting attempt to solve this problem is being made at Saint Cloud, near Paris, by M. Santos-Dumont, who sits beneath a cigar-shaped balloon and controls a gasoline engine driving the propeller placed in front. In the trial witnessed of his balloon No. 4 an accident to the rudder made it necessary to hold the balloon captive but, nevertheless, it advanced into a light wind and was easily managed. This balloon will compete for the Deutsch prize of twenty thousand dollars for a voyage to the Eiffel Tower and back, a distance of seven miles, in half an hour. The aëronautical exhibit in the Champ de Mars was chiefly retrospective, but a novelty was the *Avion*, or flying machine of M. Ader, which resembles a gigantic bat and although it has never been tried in the open air yet the ingenious construction of the supporting surfaces and the extreme lightness of the steam-engine rendered it an object of attention. The kite competition at Vincennes, which the writer was called upon to judge, was several times postponed for lack of wind and had little interest, since the cellular kite of M. Lecornu was the only one possessing merit.

The Congresses of Meteorology and Aëronautics in 1900 are especially interesting as affording a general retrospect of the progress made by the twin sciences in the century just closing, and as giving a forecast of their possibilities in the next century, for meteorology and aëronautics are mutually dependent upon each other. The exploration of the air will give a better knowledge of the meteorology of the upper regions and perhaps will result in a more complete utilization of natural forces, such as solar energy and wind. The sea, at present the great medium of international communication, is only navigable on its surface while the aëronaut can use a vast depth of atmosphere and, while oceans separate continents, the atmosphere unites and dominates them. It is certain, therefore, as M. Janssen said, that man will not stop until he has conquered the last domain open to his activity.

A. LAWRENCE ROTCH.