NOTES BY THE EDITOR.

CIRCULAR BY THE CHIEF.

The following circular letter, in reference to Weather Bureau employees in the yellow fever district, is worthy of permanent record:

U. S. DEPARTMENT OF AGRICULTURE, WEATHER BUREAU,
Washington, D. C., November 19, 1897.

The Chief of Bureau wishes to express his high appreciation of the courage and fidelity displayed by Weather Bureau officials on duty at stations where yellow fever prevailed during the late summer and autumn of 1897. More than 1,700 cases of yellow fever are reported to have occurred at New Orleans between September 6 and November 11, and at other cities in the South the disease prevailed to such an extent as to render the positions of the employees of the Weather Bureau perilous.

In the cities of Galveston, New Orleans, Memphis, Montgomery, and Mobile, there were 23 Weather Bureau employees. At Galveston but one employee asked for and received material leave of absence. At New Orleans no leaves of absence were requested; one employee was stricken with fever and survived. At Montgomery two employees made application for and were granted leave during the prevalence of the fever. At Mobile the official in charge was stricken, but at this writing is convalescent.

While no cases of yellow fever are reported to have occurred at Vicksburg or Pensacola, the proximity of these places to fever stricken towns was such as to expose the employees to danger, which was endured without complaint or effort to evade duty during the prevalence of fever in adjacent communities. At Vicksburg an employee who had been granted leave prior to the appearance of the fever declined to leave his station and requested to have his leave cancelled.

The Chief of Bureau feels that too much can not be said in praise of the action on the part of those officials who, amid constant peril, remained faithfully at their posts and performed their arduous duties under the trying circumstances with such zeal and promptness that in no instance has an important duty suffered so far as the Central Office is informed.

WILLIS L. MOORE,
Chief of Weather Bureau.

MOUNTAIN STATIONS IN NORTH CAROLINA.

Under date of October 10, Mr. Barry C. Hawkins suggests the value of establishing a station on Satulah Mountain, near Highlands, Macon Co., N. C., elevation 4,490 feet. He says:

The entire summit of this peak is reasonably level, and the distance from Highlands only one-half mile, and very accessible, only about one-fourth mile being impossible for vehicles. A small building was erected several years ago on the summit and has not been blown away. It would cost little to set up a suitable shelter for instruments, which could be visited once a week or month. No other mountains obstruct the movement of the air, and the conditions approximate those of the free air. Such stations have proved successful in South America where established by Harvard College. Why should they not be desirable here, considering the advantages, i. e., an elevation of about 5,000 feet, only 1 mile from post office, telephone, and necessary materials, and always accessible even in the worst weather?

The station recommended by Mr. Hawkins is one of the highest practicable at the southern end of the Blue Ridge, and is in the midst of the very interesting meteorological conditions to which he has referred in his article on heavy rainfall, published on a previous page of the current number of the REVIEW. A continuous record at the summit would undoubtedly contribute to the elucidation of some interesting meteorological problems if the observers were wide awake to their importance. On the other hand, in view of the many unsuccessful attempts to maintain self-registers in isolated places, without watchful observers, it would scarcely be deemed worth while to court a new failure at this place. The most that could be recommended would be the establishment of a maximum and minimum thermometer and a rain gauge, with a large attachment, so that at the end of each month a visiting observer could measure the total monthly rainfall, and reset the maximum and minimum thermometers. But to secure only these three monthly items seems to savor of meteorological curiosity rather than meteorological science, when we consider the many more important questions that are pressing upon us from all sides for a detailed investigation. Self-registering apparatus maintaining a continuous or very frequent record of temperature, pressure, wind, and rain can not be relied upon to keep in working order many days through all the variations of weather, in spite of troublesome insects, insidious rust, the drying up of the oils, the freezing of the ink, and many other vicissitudes, to say nothing of the curiosity and prying fingers of every visitor, or the superstitions of the ignorant who happen to espy the mysterious station.

A continuous record at a great elevation is one of the greatest desiderata of meteorology, and hundreds of thousands of dollars have been spent in the effort to secure a few such, but they can not be maintained without the attendance of a faithful observer. To this end the Weather Bureau for many years maintained its stations on the summits of Mount Washington and Pikes Peak; to this end the highest possible balloon ascensions are being made by international cooperation; to this end, lately, a systematic exploration, by means of continuous apparatus carried up by kites, has been begun. Eventually, these works may be supplemented by a renewed attention to the establishment of mountain stations, but that labor is too expensive to be entered into without counting the cost.

HYDRODYNAMIC EQUATIONS FOR THE ATMOSPHERE.

Under date of November 5, 1897, Dr. Charles Chree, Director of the Kew Observatory, near London, writes to the Editor as follows:

In the July number of the MONTHLY WEATHER REVIEW I notice a deduction of the hydrodynamical equations in polar coordinates, by Mr. Joseph Cottier, whose death I regret to see mentioned later in your columns. Unknown, doubtless, to Mr. Cottier, I solved the problem in practically the same way without the intervention of Cartesian coordinates, in the Proceedings Edinburgh Mathematical Society, Vol. VIII, 1889–90. My equations (22), (23), (24), l. c., p. 50, agree exactly with Mr. Cottier's (8), p. 301, so far as the hydrodynamical terms are concerned, allowing for the difference of notation (his u, v, w are equivalent to my v, w, u). Like Mr. Cottier, I had not met with Ferrel's corrected equations, but unlike him, I had not even encountered Ferrel's original equations. As Mr. Cottier refers to Basset's (Basset, Hydrodynamics, Vol. II, Equations (24), p. 245) deduction of the equations for stationary axes, it may save trouble to some of your readers if I call attention to a slight error in the third of Basset's Equations (v for w, doubtless a misprint).

The first and last of Cottier's equations (8), on p. 301, may be put in a shorter form by combining v and w terms, writing, for instance, in the first:

$$-\frac{\cot\theta}{r_1}(v+\omega r\sin\theta)^2 \text{ for } -\frac{v^2}{r}\cot\theta - v\omega\cos\theta - \omega^2 r\sin\theta\cos\theta$$

The viscosity terms in the equations on page 302 would, in my opinion, be more conveniently given in a purely polar form, like Basset's Equations (24). These latter equations of course, unlike Mr. Cottier's, are intended to apply to an *incompressible* fluid.

RAIN-DROPS: THEIR SIZE AND RATE OF FALL.

In the course of a detailed study of the phenomena of waterspouts, Prof. F. H. Bigelow suggests the desirability of further statistics as to the actual size of large drops of rain. This is a matter that suggests a series of beautiful laboratory experiments, and we hope that it will be taken up by some of the many physicists who are seeking to apply their skill and the resources of their laboratories to the problems whose solution will give precision to meteorology.

It is evident that the size of the drops must depend upon the surface tension of the water relative to the air or other gas through which the drops are falling; it must, therefore, vary with the purity and temperature of the water and the electrification of the drops. Experiments should include the salt water of the ocean. As drops falling from a tube or other metal surface depend for their size upon the capillary action between the water and that surface, it would be better to avoid that method of formation of drops and to imitate the rain either by allowing a mass of water to fall through a sieve or by studying the drops formed near the summit of a vertical jet of water at a point where the falling stream breaks into drops. The best memoir upon this subject known to the Editor is one published by J. Wiesner at Vienna in 1895. No copy of this memoir is at hand, but an excellent review is given in the Meteorologische Zeitschrift, July, 1896. In general, Wiesner concludes that the largest drops that fall in tropical rains, and, therefore, anywhere throughout the world, weigh less than 0.26 gram. This result was arrived at by three different methods, but in all three the water was allowed to drop from some solid support, such as the end of a tube or the lower surface of a cloth filter. However large the drops may be at their origin, they soon break up, so that after falling 5 meters their weight does not exceed 0.20 gram, and measurements made during the heaviest natural rains give the maximum rain drop 0.16 gram, while by far the largest number were between 0.06 and 0.08 gram. If drops are ever found larger than these, they can only hold together when falling with velocities much less than would be attained by falling 5 meters. Drops are said to have been observed of one inch in diameter. These must have weighed 7.14 grams and could only have existed for an instant before breaking up. The suggestion that they are simply melted hailstones does not account for their formation, since it would require a considerable time for such large hailstones to melt. They might have been formed by the agglomeration of large drops held up by a momentary rising gust of wind, but could not have held together after that gust had ceased.

Experiments made at Vienna on the velocity of falling drops show that during a fall of 20 meters there is no sensible increase in the velocity, so that drops weighing from 0.01 to 0.25 gram, falling through distances of from 5.5 to 22.2 meters, fall with uniform and approximately the same velocity of somewhat more than 7 meters per second. Special experiments were made to ascertain how far such drops must fall in order to attain this uniform constant speed. The method of determining this distance consisted in examining the characteristics of the blotches made by the falling drops on striking white blotting paper. A maximum velocity is apparently attained by a fall of a few meters, as shown in the second column of the following table, the weight of the drop being given in the first column:

Weight of drop.	Falling distance.	Eventual maximum velocity.
Gram.	*Meters.*	
0.01	1 to 2	7 meters per second in all cases.
0.03	2 to 3	
0.06	2 to 4	
0.07	3 to 5	
0.10	5 to 8	
0.16	8 to 11	
0.20	9 to 14	

It is probable that the acceleration of drops falling from a great altitude does not become zero until the drop has fallen much more than 22 meters. It is also probable that the increasing velocity does not attain a maximum before reaching the earth.

If the latter be true, it seems to the Editor likely that it results from the fact that the drop is perpetually changing its shape, ever adapting itself to the increasing velocity, so that it preserves continuously the shape of a body of swiftest descent for a given velocity and resistance. The resistance is made up of three factors, viz: The inertia of the disturbed air and the viscosity, or internal friction, of the air and, also, of the drop. As the drop passes from the cloud to the earth the inertia resistance increases with the steadily increasing density of the air; the viscous resistance to the air increases with the increasing temperature; the viscous resistance to motions within the interior of the drop diminishes with increasing temperature. Finally, the size of the drop diminishes steadily by evaporation, viz, diffusion, even if the speed does not attain such a limit that the internal motions of the drops break it up into fragments.

These several considerations make it probable *a priori* that the drop eventually falls with uniform velocity and this conclusion is confirmed by the observation made by Mach, that the apparent line of descent, when a gentle uniform wind is blowing, is approximately a straight line.

This whole subject lends itself to beautiful laboratory experiments, and the Editor hopes soon to present in the MONTHLY WEATHER REVIEW a very full account of the important experimental methods first invented by Toepler, but perfected by E. Mach and his students at Vienna, for the study of the flow of air around any obstacle, a method that is peculiarly adapted to the study of falling drops. The hydrodynamic formula deduced by Stokes for the viscous resistance to falling spheres does not apply rigorously to the shapes assumed by these liquid drops.

ATMOSPHERIC ELECTRICITY—BRILLOUIN'S THEORY.

The progress of meteorology—like that of all the other sciences—depends much less upon chance discoveries or hasty suggestions than it does upon the wisdom and sagacity of its devotees. The progress of the past two centuries has been marked by the overthrow or complete remodeling of many so-called theories which now seem to us crude, but which in their day represented the best that was known. An immense body of truth is contained in the hundred thousand volumes of experimentation, observation, and mathematics that are preserved in the great scientific libraries, and no one can at the present day afford to disregard the work of his predecessors, or even provisionally give credence to any theory that flies in the face of the facts and principles that constitute modern science. We are all engaged in the study of Nature and shall not make any advance therein, except as we confine ourselves closely to the laws that are manifested in the material creation around us. Owing to the slow progress of our knowledge of electricity we have, until within the past ten years, been completely in the dark as to the origin of atmospheric electricity, earth currents, terrestrial magnetism, and cognate phenomena. Indeed, it is not at all evident that even now we have got at anything very satisfactory. We have, therefore, not encouraged many publications upon this subject in the MONTHLY WEATHER REVIEW. A few years ago Hallwachs showed that the radiation from the sun facilitated electric discharges or neutralized the electrified state of the air, and upon this Arrhenius formulated the theory that the illumination of the air by the sunshine lay at the base of all our phenomena of atmospheric electricity. Since the discoveries of Hertz, Lenart, and Röntgen, the subject has been rapidly developed and Arrhenius' idea has now been further elaborated by Brillouin; although in many respects the theory developed by him in the article that we have reprinted in the current number of the MONTHLY WEATHER REVIEW seems unsatisfactory, yet it has enough of truth and reason to justify calling to it the attention of the students of physics in the United States. Meanwhile, however, the subject of atmospheric electricity is one that demands elaborate observation of facts before we proceed to hypotheses as to its ultimate cause. An admirable summary of our knowledge of the sub-