U. S. DEPARTMENT OF AGRICULTURE, WEATHER BUREAU,

CO-OPERATING WITH THE

MARYLAND STATE WEATHER SERVICE

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The Johns Hopkins University and the Maryland Agricultural College.

CENTRAL OFFICE, JOHNS HOPKINS UNIVERSITY, BALTIMORE, MD.

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VOL. II. MONTHLY REPORT OF OBSERVATIONS, OCTOBER, 1892. NO. 7.

Review of the Month.

WEATHER.

A glance at the table of daily precipitation for October (page 60 of this report) exhibits to the intelligent reader a quite remarkable phenomenon. The rainfall of the month is seen to have come in very light local showers, the only exception being the light rains of the 8th and 9th, which were quite general. The "total" column shows that at one station only (Leonardstown), was there so much as an inch of precipitation, and that at one station (Taneytown) there was no rain at all. This is a common occurrence in many of the States west of the Mississippi, but very unusual for Maryland.

The month's rainfall at Baltimore amounted to but .26 inch, and it is necessary to go back to 1874 to find a smaller amount. But .16 inch fell in October of that year at Baltimore. At Washington the total precipitation for the month was .34 inch, and, as at Baltimore, it is necessary to go back to 1874 to find a less amount, .29 inch.

From a record of nearly a quarter of a century, in the possession of Mr. Howard Shriver, of Cumberland, it appears that the total precipitation for the year 1870, at that place, was but 20 inches, while the amount for the current year is, already, 26.77 inches. Therefore, with the rain or snow that may be expected during the remaining two months of the year, it is probable that the drouth, prevailing in the western portion of Maryland, will scarcely compare with the extreme of 1870.

Prof. G. G. Curtiss, of Oakland School, Fallston, Harford Co., has a record of 22 years' observation for Fallston, and it corresponds with the records of Baltimore and Washington, in that it is necessary to go back to 1874 to find an October with less rain. In that year the amount of precipitation for the month, at Fallston, was but .23 inch, while this year it was .45 inch. In 1879 he had .75 inch, and in 1882 .79 inch.

Every section of the country must have its extremes of heat and cold, of drouth and flood, and it appears that for Maryland, the District of Columbia, and Delaware, in this month, the extreme of dryness was almost reached.

Perhaps an explanation of the dry weather may be reached by a study of the daily weather maps. An inspection of them shows us that the general course of the October storms was from west to east along the southern border of British America, and that the greater number passed so far to the northward that the Middle Atlantic States received little or no rain from them. The areas of high pressure, on the other hand, passed southeast across the country to the south Atlantic coast, or they passed eastward to the New England coast, and then settled southward to the Carolinas. These high, fair weather areas, aside from their general direction, favorable to fair weather, were very extensive and of rather slow movement, thus prolonging the rainless periods.

The temperature of the month was somewhat below the normal, and this may be ascribed to the prevalence of the areas of high barometric pressure.

On the Production of Rain.

The great interest that has been excited throughout the world in the question as to whether or not the progress of science gives us at yet any hope that man may cause rain to fall in times of drouth, or to cease falling in times of flood, renders it proper that a brief sketch should be given of some, at least, of the many methods that have been suggested as a means of accomplishing this end. Although none of these methods have any practical value, still it is important to briefly summarize the results of experience if only as a means of saving present and future generations from an unnecessary waste of money. It is, on the other hand, equally important, after divesting ourselves of erroneous views, to seek for such light on the subject as our limited knowledge affords, and to mark out such further lines of investigation as may elucidate this difficult but important problem.

Although the production of rain is undoubtedly a purely material, physical process, and should be studied by the methods of modern science, yet it is impossible not to recognize that there has always been a certain supernatural aspect to the question, and that probably the majority of mankind, at the present moment, take that view of it. In fact, the importance of rain to human existence has, from time immemorial, led mankind to seek some method by which to secure it when needed. Divinations and incantations, prayers and sacrifices, the fetish of Africa and the gapogari of India illustrate respectively what may be called the superstitious and the theological theories on the subject of man's influence upon the weather. The recent progress of meteorological science has led us, on the one hand, to properly evaluate supernatural methods, and, on the other hand, to query as to whether there really is any material physical principle that we can call to our aid in order to make it rain or cease raining. The following paragraphs may therefore illustrate such methods as have been suggested or tried:

1. Before the use of cannon the church bells were rung vigorously in order to dissipate dangerous storms. Parent states that in 1703 the inhabitants of Iliers, by ringing the bells, forced a hailstorm to break in two and thus saved their fields. It would appear that originally this practice was suggested by the idea that the ringing of the bell called the people to prayer, and that, in fact, the bell represented the voice and prayers of the church, but eventually the theory was advanced by Le Maout (at Le Brieuc in 1854) that the sound, namely the concussion in the air, produced by the bell, in some way caused the clouds to drop rain.

2. It is well known that it has long been the practice among sailors to discharge a cannon at a water-spout, hoping that it can thus be broken up before reaching the ship. Mr. R. de C. Ward (*Am. Met. Jour.*, March, 1892) states that in the memoirs of Benvenuto Cellini there is mention of the fact that an impending rainstorm was averted in the year 1539, at Rome, by firing off artillery in the direction of the clouds which had already begun to drop their moisture. Arago says that as early as 1769 it was the practice to fire guns to break up a storm, but he shows by weather records that such firing has no such effect. The Swiss peasants discharge firearms into the clouds to draw off the rain before lightning and hail can form. The idea was that quiet air produced large hail, but that when disturbed by noise it could only produce small hail and rain—just as a crystallizing solution gives large crystals the more quiet it is. Patricius Heinrich in a prize essay published by the Bavarian Academy, in 1785, showed that cannonading does not prevent hail, and, in fact, has no appreciable influence on the clouds. Kaemtz (in 1831) quoted the case of 36,00c soldiers who fired a salute in order to break up an approaching thunderstorm during their evolutions, but failed. Denize and Parrot maintained that the vapor and smoke of gunpowder exerts a chemical influence unfavorable to the formation of thunderstorms and thus prevents them.

3. In opposition to the preceding, the idea has been frequently defended, during the past century, that the violent concussion produced by the explosion of gunpowder caused the minute particles in the clouds to jostle together and fall as rain. The earliest one to advance this idea, so far as I can find, was J. C. Lewis, of Washington, in 1825, but its most prominent advocate since 1870 has been Mr. Edward Powers. On this principle, in 1854, Le Maout, from the rainfalls in western France, predicted that an important battle must be in progress in the Crimea, which, in fact, he subsequently identified as the cannonading at the battle of Inkerman an hour before his predictions. The ideas advocated in this country by Mr. Powers, and in England by Mr. R. D. Belcher, in 1874, received a qualified adherence from Prof. J. K. Laughton, Prof. Elias Loomis and Prof. J. D. Everett, although these distinctly disclaim their approval of the arguments used by Powers and Belcher. Mr. H. C. Russell, of Sidney, Australia, has strongly combatted both the arguments and the ideas. At present this concussion theory certainly has not the support of any prominent physicist.

4. The hypothesis that electrification keeps the particles of a cloud apart, and that its sudden removal by the discharge of lightning directly causes hail, and heavy rains or cloudbursts, was promulgated soon after Franklin's experiments with his electric kite. Montbeillard, of Dijon, in 1776, held that hail would be impossible if the electricity were drawn early and quietly from the clouds; hence followed attempts to quietly discharge electrified clouds by means of lightning rods or wires carried up by kites, or even by captive balloons, in the hope that the formation of destructive hail or rain would be prevented. P. Heinrich, in his prize essay above referred to, Wrede and Wien in 1800, and many since then, have shown by statistics that fields of grain thus protected by lightning rods suffer from the hail, rain and wind quite as much as the neighboring fields without protection.

The rods do not appreciably diminish the number and intensity of destructive discharges of lightning, but when they receive the discharges they save the buildings and the harvested crops from destruction by fire; the rods have no influence on the rain and hail. According to Volta large hailstones are formed from smaller ones that are alternately attracted and repelled between two parallel layers of clouds; the surfaces of the hailstones are cooled by the evaporation of the added water. Volta expressly demonstrates that the electric condition of these clouds cannot be affected by lightning rods.

5. It has been thought that, by setting fire to heaps of brushwood, a destructive storm, with its lightning and hail, can be averted; but Volta, the advocate of this method of depriving the cloud of its electricity, after a first few years of success on the Roman Campagna found that his experience was the same as that of his neighbors, and that no effect was produced. P. Heinrich, in his prize essay, also shows the uselessness of such fires. Piccard compared the data for twenty-five years as to fires and rainy days in Switzerland, but found it demonstrable that there was no connection between them. Professor John Trowbridge, in 1872, showed how a slight possible connection might exist that is worthy of further study.

6. The electrical condition of a moist atmosphere seems likely to have some relation to the formation of raindrops, but our knowledge on this subject is very meagre. Most students agree with Kaemtz, who, in 1831, said that we know not which is cause and which is effect, but that most probably the lightning is the result of the formation of cloud and rain. Professor John Trowbridge in his experiments, above referred to, showed that flames from fires tend, like lightning rods, to reduce the positive electrification ordinarily observed, to a neutral or even to a negative condition. Ordinary observations of atmospheric electricity show that cold, polar winds bring an increase of positive electric tension. In general a positive condition exists in the air in or around a snowstorm, but rapid changes are the result rather than that they are the cause of the precipitation or of the winds or temperature. In 1880 Mr. Ruggles advanced the idea that "by altering the electrical condition of the upper air and the electrical force that controls the atmosphere" he could govern the formation and movements of rain-clouds and thunderstorms, but no adequate means to accomplish such alteration has been devised.

7. A number of interesting laboratory experiments by Rayleigh and others (see Guthrie on "Soap Bubbles") have shown that by electrifying a fine jet of water we may prevent it from breaking up into separate drops. These results are apparently produced by changes of the surface tension of the drops; the electrified drops coalesce when they strike each other, whereas drops of pure water unelectrified rebound and remain separate. Hence follows the idea that by thus electrifying a cloud we may cause the suspended small drops to unite into a steady downpour of rain, but no means has yet been found to accomplish this end. Possibly this idea is equivalent to that present in the minds of those who advocate making it rain (see J. R. Buchanan, 1891) by drawing the electricity from the clouds.

8. Having given up the idea that rain and hail are due to the sudden removal of an intense electrification, such as precedes the discharge of lightning, some theorists reverted to the idea that it is the noise of the thunder attending the lightning that produces a concussion within the cloud, and that this is nature's method of jostling the cloud particles together into larger drops of rain. This is an advance on the idea that noises made by mankind, such as bell-ringing or cannonading, can cause rain; but it is equally contradicted by ordinary observation which shows that there is no necessary connection between thunder and rain. On this whole question of the effect of concussion, namely the rapid vibration of sound, it may be remarked that Champion and Pellet, in 1873, succeeded in inducing the explosion of dry iodide of nitrogen by the high-pitched notes of the Chinese tom-toms and by the explosion of a very little nitro-glycerine, but not by the noise made by the explosion of ordinary gunpowder. It has not yet been shown, however, whether the result was caused by the sympathetic vibration of the molecules of these chemicals responding to the high-pitched note, or whether it was due to the small masses of the chemicals rubbing against each other and the anvil on which they rested, both being set into sympathetic vibrations with the string of the violin. The latter is more probable, but neither case would afford ground for supposing that cloud-particles, which are relatively far apart, could be brought to coalesce by this process. The experimental firing of a pistol or gun into a cloud of fog or steam produces no appreciably agglomerations of the globules of water.

9. The advocates of the theory that great battles are followed by rain, not content with maintaining the influence of great noise in producing rain, have also gone to the extreme of maintaining that the heat of the conflict and the moisture from the breath and the perspiration of many men has an appreciable influence in producing the subsequent rain. In general, however, it does not appear that rain is any more likely to follow a battle, great or small, than it is to occur without a battle.

10. About a hundred years ago Hutton advocated the idea that rain is naturally formed by mixing warm, moist air with colder moist air; this idea has long since been dispelled.

as it has been shown that by mixture alone we can produce only a haze of fog, but not a rain; nevertheless it has been lately proposed to produce rain artificially by this method of mixture. Mr. G. H. Bell proposed to erect a tall tower, which might also serve for other purposes and through which warm air is to be sent up into the upper regions and mixed with the cold, moist air above, producing a local rain in the immediate neighborhood whenever desired. This inventor also proposed, when need be, to reverse the motion of the fan, thereby bringing the clouds down to the earth and preventing rain. A similar idea is advocated by Mr. James W. Pitkin, of Kansas City, who would have a large sheet of canvas held up by balloons so that a horizontal wind striking against it will be deflected towards precisely as when blowing against a mountain side. Mr. Pitkin also proposes to support large canvas tubes by means of balloons, the cold air to be drawn down a long tube and driven up through a short tube until it can be delivered at the proper elevation in the atmosphere.

These ideas of Pitkin and Bell must utterly fail of their object because of the mechanical impossibilities as well as because of the erroneous principle on which it was proposed to make rain.

11. The idea that an extensive fire may, under certain circumstances, determine the formation of cloud and rain was maintained by Espy as a necessary consequence of his theory of the cooling by expansion of rising air. In fact, numerous examples are at hand to show that when the air is very moist a large fire may initiate a rising current of air and a cloud that shall grow into a local rainstorm; the fire is simply the initiative and determines where the cloud will start; it can hardly be said to cause the rain, nor does it decide, in any case, where the rain will fall; it simply performs the same office that the pulling of a trigger does for the discharge of a gun and the fall of a distant bird; or that an act of the will does for our physiological muscular machinery.

Prof. Espy's ideas have been widely supported, and the fact that rain cannot be started by an artificial fire when the air is very dry is really a further confirmation of the views expressed by him. Prof. J. K. Laughton, in England, and Mr. H. C. Russell, of Sidney, New South Wales, have shown how rarely the bush fires of Australia are followed by rain owing to the dryness of the climate; in general, when the winds are blowing up over a mountain range, plenty of rain falls and usually without lightning, so that we have no reason to invoke the aid of electricity, noise, smoke or fire. The power contained in the sunshine that is received on a single acre of ground, when the sun is near the zenith, is greater than that exerted by a steam engine of 4000 horse-power; when this power is exerted to heat the air and cause it to rise it is fully equal to the work of lifting 60 tons of moist air 1000 feet high per minute.

12. The experiments of many physicists have shown that certain solids have the power of attracting around themselves a condensed atmosphere of one or more gases; especially is this true of carbon, so that the fine particles that constitute smoke and soot may be conceived of as surrounded by dense atmospheres of aqueous vapor. These nuclei being good radiators of heat are supposed to become especially cooled and to condense the vapor upon themselves, so that they may become the nuclei of cloud particles. Then these dust-particles, whether they result from forest fires or the spray of the ocean, the pollen of plants, the dust of the highway or the consumption of shooting stars, may be an essential feature in the formation of rain or snow. Therefore any process that increases the quantity of dust in the air contributes to the formation of rain, and in fact visible drops of vapor are not easily formed, even by cooling the air below its dew-point, unless dust nuclei be present; this is made the basis of Aitken's method for determining the number of particles of dust in the air. Prof. Blake, of Kansas University, proposes to make rain by distributing fine dust in the atmosphere, but human agency cannot economically increase the percentage of dust already in the cloud region.

13. The idea has been promulgated that possibly there exists some gas or vapor or other substance that, like smoke, can be injected into the air and that will initiate the condensation of the aqueous vapor. This is the method claimed by Mr. Frank Melbourne, but the chemicals used by him are kept a secret, and other parties having adopted the same idea appear to be using chemicals different from Melbourne's. The general method of procedure seems to be that the operator, within a building, makes the gas in secret, and it is seen escaping from a chimney, while an assistant circulates among the spectators outside and takes their bets as to the success of the operation. There is no principle known to chemists that would justify us in expecting this method to succeed in producing rain, and actual experience shows that the failures have been quite as numerous as the successes, just as would be the case if the chemicals had nothing to do with the rain.

14. The explosion of balloons, filled with a mixture of oxygen and hydrogen, produces a small quantity of aqueous vapor, which is at first hot and expanded, but in a few moments becomes cool and condensed. Dysenforth advances the theory that these few particles of nascent water serve as natural nuclei, attracting to themselves the aqueous vapor already in the atmosphere resulting in the formation of mist, cloud and rain. No suc-

cessful experiment of this kind has ever yet demonstrated the truth of this ingenious theory. Evidently the great heat produced by the chemical combination of oxygen and hydrogen must, in some way, be got rid of before the surrounding aqueous vapor can condense into drops.

15. Man may not hope to assist nature in the formation or prevention of rain until he better understands the details of nature's own methods. The ideas most widely accepted, at present, as to the natural process of the formation of rain, go only so far as to say that the moisture present in the atmosphere is extracted from the air by three different steps, namely, first, the saturation with aqueous vapor that is produced by cooling the air; second, the condensation of the vapor into small visible particles of cloud and fog; third, the agglomeration of these droplets of water into drops large enough to be precipitated as falling rain, hail or snow.

I. The ordinary natural methods of accomplishing the cooling required in the first of these steps are: (a) the mixing of cold and warm air by which, however, only a very slight amount of precipitation can be formed; (b) the radiation of heat to the colder earth and air and space by which at first thin layers of fog or stratus clouds are formed, which then slowly thicken with time; (c) the rise and expansion of large masses of air; the mechanical work done by the expansion simultaneously of the whole mass may cool it to any extent whatever. This last is the important process on which all our rain depends.

II. The second step, namely condensation, is a molecular process that has been likened to the crystallization of solid salts from liquid solutions, although there is too little known about either process to warrant the belief that they are really similar. Aitken and others maintain that the condensation of vapor, like the crystallisation of salts, demands some nucleus as a starting-point, and that every minute droplet of fog or cloud must have a particle of atmospheric dust as its initiative.

III. The third step in the above process of rain formation is the agglomeration of fog or cloud-particles into larger drops. About this there is very little known from actual observation, and the hypotheses are quite various. The hypothesis that among these particles some are larger than others, and, by their more rapid descent, overtake the smaller ones, and thus grow larger as they descend, seems at first quite natural, and is sufficient to explain the fact that the quantity of rainfall is an exceedingly small percentage of the water that is visible as a cloud and, of course, a still smaller percentage of the water that is present as vapor in the air. On the other hand, a microscopic observation of the sizes of the particles of fogs do not show a variation in the diameters sufficient to allow of one of the particle falling much faster than its neighbor; therefore as the air always has a motion sufficient to carry these minute particles along with it, it would seem that if they are to come into contact and form larger particles it must be through a process of jostling together rather than through a process of falling by gravity.

But the contact of two particles, whether by gravitational fall or by the jostling of wind-currents, will not necessarily cause their union; it is essential that the surface tensions of the two particles be properly adjusted to each other, and this latter point seems to demand further study. It is true that by proper electrification we are able, in the laboratory, to alter the surface tensions and to cause small fog particles to coalesce, but it is not so evident that this is the ordinary process of nature. We are also able in the laboratory to alter surface tensions by surrounding the particles with a different gaseous or vaporous atmosphere, or even by changing the temperature of the particles; but neither of these processes is likely to be the process that takes place in the clouds. Rayleigh's experiments on jets of soapy water make it plausible that a slight impurity in the rain water, such as ammonia or nitric acid, may make it possible for certain cloud-particles to agglomerate, while the neighboring droplets of pure water ought not to do so. Again, a thin film of foreign substance, such as oil on the water, lowers the surface tension and allows two such oily drops to combine into one, when the film is broken at any point, by pressing the drops close together. But none of these laboratory experiments seem applicable to the formation of the natural cloud and rain.

16. As to the various hypotheses that have been suggested concerning the method by which the agglomeration of droplets into large drops is actually affected by nature in her regular process of making rain, I must remark that it is not yet clear to me that any one has demonstrated that small drops actually do agglomerate into larger ones to any considerable extent. I think it quite possible that the union of small cloud-particles into larger ones is only effective in driving fogs or clouds whose upper surfaces cool by radiation, but is, after all, not an important feature in the natural production of generous rains and summer thunder showers. It is a reasonable "working hypothesis" that the particles which were originally too small to fall from the clouds with any rapidity actually remain there entangled in the currents of air that characterize clouds, and that they are subsequently evaporated, while, on the other hand, only those fall as rain which originally had a size vastly larger than the average size of the smaller particles that constitute the major portion of a cloud. There may be some reason why the condensation of the superabundant

molecules of a saturated vapor should form, not merely cloud-particles whose diameter is ordinarily less than one one-hundredth of an inch, but also, here and there, large drops which fall to the ground as rain with very much the same size as when originally formed a few moments before in the clouds. The sudden pour of heavy rain from a limited region within a thunder cloud cannot be due to a general slow progressive agglomeration of droplets into drops.

On this point I submit the following modification of ideas suggested by reading von Bezold's fourth paper on the "Thermodynamics of the Atmosphere," Berlin, 1892; it suggests a new point of view, and one that demands further experimental elucidation.

Bezold suggests that the heavy rains generally known as cloud-bursts are immediately preceded by, and may owe their origin to, a supersaturated state of the atmosphere, by reason of which a greater quantity of vapor is contained in the air than would, under other conditions, be possible at a given temperature. Following out this hypothesis, I conclude that, whatever molecular condition it be that permits the existence of a supersaturated atmosphere, it is evident that the removal, or annulment, of that condition must give rise to an immediate and heavy condensation. This principle may be extended to all ordinary rains as well as to the violent thunder showers and cloud-bursts.

The supersaturated condition must be considered as a case of adiabatic expansion[1] accompanied by a delay in the occurrence of the appropriate condensation. So far as we at present know this condition can occur only in those cases where all foreign substances, or dust-particles, are absent, which might serve as nuclei for the formation of fog-particles. A slowly rising and cooling atmosphere first condenses its moisture on the dust nuclei and forms minute droplets; these grow very slowly, by diffusion, up to a definite size proper to the prevailing temperature and vapor tension, but the intermediate air, in which these droplets are floating, keeps on cooling as a dust-free, supersaturated vapor. If the sun shines on these droplets its heat powerfully contributes to evaporate them and further saturates the surrounding air.

In general, therefore, the ascending portions of every cloud contain supersaturated, dust-free vapor separating the isolated droplets. When by further expansion and cooling the supersaturation has proceeded to such an extent that further condensation must occur, this latter molecular change permeates the supersaturated space with a rapidity comparable to that with which any other chemical change takes place, just as when the explosive union of chlorine and hydrogen, or of oxygen and hydrogen, starting at any point, almost instantaneously permeates a mass of these mixed gases, or, as when combustion runs along a train of gunpowder. The vapor molecules from the supersaturated spaces are quickly brought together by their molecular attractions into heavy drops of warm water which are often distinct from the intermediate cooler droplets and descend rapidly from the clouds, while the latent heat of condensation is communicated to the adjoining air and is left behind in the cloud. Thus simultaneously with the formation and fall of the big drops there is a sudden expansion of the clouds from which they came. Bezold thinks that such expansion may possibly be felt at the earth's surface as a sudden rise in the barometer, while it is also visible to the eye as a sudden expansion of the cloud into the so-called "thunder-head." I myself doubt whether there would be any appreciable barometric result, yet I consider that the sudden expansion and ascent of the white cloud and its subsequent rapid dissipation into the surrounding air, together with the simultaneous lightning, thunder, rain, hail and ascending whirl of wind, all conspire to make it very plausible that there really existed a supersaturated condition at the moment immediately preceding.

If the temperature of the dew-point of the ascending air, or the temperature of supersaturation is below freezing, the condensation of the vapor may at once form, not drops, but large snowflakes, such as will fall rapidly to the ground, or the small hail that is ordinarily called sleet.

Correlated phenomena occur when a cloud consists of small particles of water cooled below the freezing-point, as is known to be frequently the case. When for any reason these particles are suddenly converted into ice, as will happen when they are cooled low enough or when they jostle against each other, their temperatures at once rise to the freezing-point, a large quantity of heat is set free, the cloud expands and rises and the droplets of water are converted into spiculae of ice, or small snowflakes; large flakes and hailstones are not to be explained in this manner.

There is some plausibility in the hypothesis that the critical electrical condition, which results in lightning, is directly due to the disruption of the condition of extreme supersaturation and the sudden formation of large drops of water, or the disruption of the condition of water cooled below the freezing-point and the consequent sudden formation of ice or snow, but this remains to be investigated.

Therefore, according to this latest view of the subject, the problem of the artificial formation of rain will be partially solved, and sufficiently so for practical purposes, if some method is invented by which to bring about a sudden formation of a small percentage of

[1] i. e., without adding or subtracting heat.

large drops out of the moist air that exists between the small particles of every cloud.

At present our attention and experiments should be directed toward understanding and completing the natural and obscure process involved in the formation of rain within the cloud and not toward the forcing of any unnatural process.

PROF. CLEVELAND ABBE
in *Agricultural Science*.

Monthly Summary.—October, 1892.

Temperature (degrees).—Mean monthly, 54.3. Highest monthly mean, 59.2, at Leonardtown. Lowest monthly mean, 52.0, at Woodstock. Highest temperature, 84.0, at Boettcherville, Solomon's, and Washington, on the 1st. Lowest temperature, 26.0, at Woodstock, on the 31st. Greatest monthly local monthly range, 54, at Boettcherville, Seaford, Del., and Washington, D. C. Mean monthly range, 48.1. Mean maximum, 65.5. Mean minimum, 44.1.

Precipitation (in inches).—Average, 0.37. Greatest amount, 1.13, at Leonardtown. Least amount, 0.00, at Taneytown.

Wind.—Prevailing direction, northwest. Total movement in miles, Baltimore, 5484; Norfolk, Va., 5975; Washington, D. C., 4505.

Thunderstorms.—At Cumberland *a*, on the 3rd; at Dover, Del., on the 8th; at Jewell, on the 8th; at Solomon's, on the 4th and 8th; at Norfolk, Va., on the 4th.

Hail.—Hail at Frederick, on the 5th; at Solomon's, on the 4th.

Halos.—*Lunar*, at Baltimore, on the 2nd; at Jewell, on the 31st; at Mt. St. Mary's, on the 31st.

Halos.—*Solar*, at Barron Creek Springs, on the 19th, 20th; at Mt. St. Mary's, on the 31st.

Frost.—At Baltimore, on the 6th, 7th, 31st; at Barron Creek Springs, on the 6th, 10th, 12th, 24th, 25th, 26th, 27th, 28th, 31st; at Cumberland *a*, on the 1st, 2nd, 6th, 11th; at Darlington, on the 3rd, 6th, 7th, 10th, 22nd, 24th, 25th, 26th, 27th, 28th, 31st; at Dover, Del., on the 3rd, 6th, 7th, 10th, 12th, 21st, 22nd, 24th, 25th, 27th, 28th, 31st; at Fallston, on the 2nd, 3rd, 7th, 10th, 22nd, 27th, 31st; at Frederick, on the 6th, 7th, 9th, 10th, 11th, 22nd, 25th, 27th, 31st; at Jewell, on the 3rd, 6th, 27th; at Leonardtown, on the 3rd, 5th, 28th; at Mt. St. Mary's, on the 6th, 10th, 31st; at Norfolk, Va., on the 27th, 31st; at Solomon's, on the 27th, 31st; at Washington, on the 2nd, 3rd, 6th, 7th, 10th, 25th, 26th, 27th, 31st; at Woodstock, on the 3rd, 6th, 7th, 10th, 15th, 25th, 26th, 27th, 28th, 29th, 31st.

Average number of cloudless days, 19; partly cloudy days, 10; cloudy days, 2; rainy days (.01 of an inch or more), 3.

Local verifications of weather and temperature signals for October, reported by displaymen:

Weather - - - - - -	90 per cent.
Temperature - - - - - -	93 " "
Average - - - - - -	92 " "

Notes by Observers.

Baltimore.—2nd, *lunar* halo, 10.30 P.M. to 11.25 P.M. 5th, wind storm from N.W. 6th, killing frost, first of the season. 7th, light frost. 20th, eclipse of the sun observed. 29th, wind storm from N.W. 31st, killing frost; light fog, 8 A.M.

Barron Creek Springs.—1st, distant thunder S.W., 4 P.M. to 5 P.M. 2nd, semi-cold wave 3rd, killing frost; ice in trough 1-16 inch; light smoke, 7 A.M. 4th, distant thunder S.W. to N.E., noon to 2 P.M. 5th, heavy fog; northwest wind, with snow-clouds flying; white and black gum trees have scarlet leaves. 6th, frost; ice. 8th, distant thunder and lightning W. to N.W., 5 A.M. to 7 P.M., followed by change of wind. 9th, snow clouds N.W., 2 P.M. 10th, cold wave; butterflies and snow-birds seen; meteor going S.E., 8 P.M. 11th, light fog, 6 A.M. 12th, frost; heavy fog and smoke. 13th, heavy fog, 6 A.M. 14th, very heavy fog, almost a mist, 7 A.M. and 9 P.M. 15th, heavy fog and smoke, 6 A.M. 16th, forest fires about Barron Creek Springs. 17th, dense smoke from forest fires; full tide at Barron Creek bridge. 19th, halo of sun. 20th, halo of sun, 1 P.M. 21st, corona of Mercury, 9 P.M. 22nd, heavy fog and smoke, 6 A.M.; semi-cold wave. 24th, cold wave; frost. 25th, cold wave; frost; large flock of wild geese going S.W., 4 P.M. 26th, heavy white frost. 27th, heaviest frost of the month; ice, ground crisp, milk frozen. 28th, white frost; smoky, 7 P.M. and 9 P.M. 29th, corona of moon, 9 P.M.; a black snake killed. 30th, an unusually blustery night. 31st, very smoky; frost.

Cumberland *a*.—2nd, light frost. 3rd, thunderstorm during the night from N.W., accompanied by wind and lightning. 6th, killing frost, first of the season. 11th, light frost. 30th, lunar disk, followed by light rain. The great drouth keeps the springs and streams nearly dry. Very few winds of any power. Hazy Indian summer weather for the last two weeks. Mountain fires raging in every direction; smoke so dense as to conceal all clouds in the sky.

Salisbury.—The fall has been like the summer, excessively dry. Late crops have greatly suffered in consequence. The till of wheat will be short. Forest fires are prevailing in the counties and have damaged much timber.

MONTHLY SUMMARY OF REPORTS, OCTOBER. 1892.

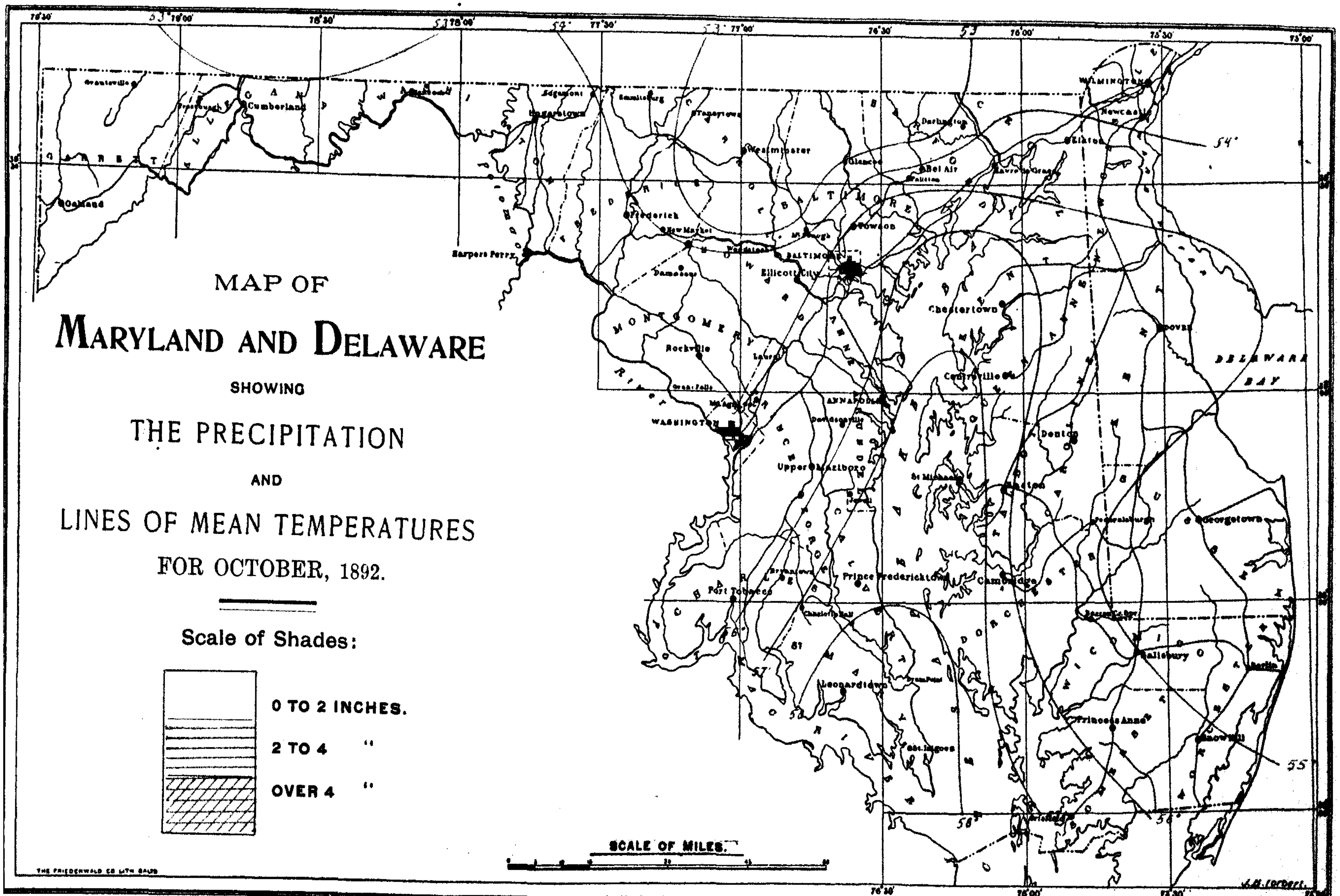
Stations.	Counties.	Altitude above Sea in feet.	Latitude.	Longitude.	† Barometer.					Temperature.								Total Precipitation.	Clear Days.	Fair Days.	Cloudy Days.	Rainy Days. (.01 inch or more.)	Prevailing Wind.
					Monthly Mean.	Maximum.		Minimum.		Monthly Mean.	Mean of Maximum.	Mean of Minimum.	Maximum.		Minimum.		Monthly Range.						
						Height.	Date.	Height.	Date.				Degrees.	Date.	Degrees.	Date.							
Baltimore	....	179	39°17′	76°36′	30.050	30.460	13	29.630	29	55.8	65.5	46.1	83	1	34	31	49	0.26	17	14	0	3	N.W.
Barron Ck. Springs	Wicomico.	25	38°30′	75°39′	....	....	..	....	..	54.8	66.7	42.8	81	{ 1, 15	28	{ 27, 31	53	0.09	14	14	3	2	N.W.
§Boettcherville	Alleghany	....	39°39′	78°48′	....	....	..	....	..	52.9	65.6	40.2	84	1	30	{ 27, 31	54	0.20	....	....	....	....	....
Cumberland (a)	Alleghany	650	39°39′	78°46′	30.081	30.450	13	29.662	29	53.4	64.1	42.6	78	1	34	27	44	0.27	....	....	....	....	....
Cumberland (b)	Alleghany	700	39°39′	78°45′	....	....	..	....	..	52.6	62.7	42.4	78	1	30	31	48	0.24	25	5	1	2	....
Darlington	Harford	300	39°39′	76°14′	....	....	..	....	..	54.3	64.2	44.4	80	1	31	31	49	0.38	26	0	5	4	N.W.
*§ Distribut'g Res., D.C.	....	....	38°52′	77° 0′	....	....	..	....	..	54.8	....	....	81	1	35	6	46	0.31	....	....	....	....	....
Dover, Del	Kent	....	39° 9′	75°31′	....	....	..	....	..	55.4	65.9	45.0	82	1	33	31	49	0.46	24	7	0	5	N.W.
Easton	Talbot	35	38°42′	76° 6′	....	....	..	....	..	56.4	68.1	44.7	79	23	32	{ 27, 31	47	0.79	17	13	1	3	N.W.
§Fallston	Harford	450	39°31′	76°24′	....	....	..	....	..	53.0	....	....	80	1	33	6	47	0.45	....	....	....	2	....
Frederick	Frederick	280	39°24′	77°18′	....	....	..	....	..	54.0	64.5	43.6	82	1	32	31	50	0.19	25	6	0	3	....
*§Great Falls	Montgomery	....	39° 0′	77°14′	....	....	..	....	..	54.1	....	....	81	1	29	31	52	0.10	....	....	....	....	....
§Jewell	Anne Aru'del	....	38°44′	76°36′	....	....	..	....	..	53.2	....	....	....	....	..	....	....	0.50	24	7	0	1	....
§Kirkwood, Del	New Castle	....	39°35′	75°40′	....	....	..	....	..	54.5	....	....	80	16	36	27	44	....	....	....	....	3	....
Leonardtown	St. Mary's	....	38°18′	76°40′	....	....	..	....	..	59.2	69.4	49.1	81	15	34	5	47	1.13	20	5	6	2	N.W.
McDonogh	Baltimore	535	39°23′	76°44′	30.074	30.461	13	29.680	29	53.6	63.2	44.1	78	1	33	31	45	0.34	....	....	....	3	....
Mt. St. Mary's	Frederick	720	39°41′	77°21′	30.069	30.453	13	29.671	29	54.4	65.0	43.7	82	1	31	6	51	0.22	17	10	4	3	N.W.
§New Market	Frederick	500	39°23′	77°18′	30.072	30.472	13	29.659	29	48.7	....	....	75	16	32	6	43	0.21	...	...	....	....	N.W.
*§Receiving Res., D. C.	....	....	38°52′	77° 0′	....	....	..	....	..	54.4	....	....	79	1	33	31	36	0.26	....	....	....	....	....
Seaford, Del	Sussex	....	38°40′	75°35′	....	....	..	....	..	55.0	67.0	43.0	84	1	30	{ 27, 31	54	0.84	....	....	....	....	....
Solomon's	Calvert	20	38°19′	76°27′	....	....	..	....	..	58.0	66.0	49.9	84	1	40	6	44	0.67	10	16	5	4	N.W.
Taneytown	Carroll	....	39°40′	77° 9′	....	....	..	....	..	....	....	....	....	....	..	....	....	0.00	....	....	....	....	....
Washington, D. C.	....	112	38°52′	77° 0′	30.070	30.460	13	29.660	29	55.4	66.3	44.4	84	1	30	31	54	0.34	17	12	2	3	N.W.
Woodstock	Howard	392	39°20′	76°49′	30.069	30.469	13	29.659	29	52,0	64.2	39.8	79	1	26	27	43	0.24	15	13	3	1	N.W.
‡Norfolk, Va.	....	43	36°51′	76°17′	30.064	30.416	31	29.714	4	59.1	67.7	50.5	84	1	37	31	47	0.52	21	6	4	3	N.
Averages	....	....	....	....	30.069	....	..	....	..	54.3	65.5	44.1	....	....	..	....	48.1	0.37	19	10	2	3	N.W

* Received too late to be used in computing means. † Readings reduced to sea-level. ‡ Omitted in computing means. § Extremes of temperature from observed readings.

DAILY PRECIPITATION FOR OCTOBER, 1892.

STATIONS.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total.
Baltimore	....	....	....	T	....	....	....	.22	.02	....	....	....	....	....	....	....	....	....	T	....	....	T	....	....	....	....	....	....	.02	....	....	0.26
Barron Crk. Spr.	....	....	....	....	.05	....	....	.04	....	....	....	....	....	....	....	....	....	....	....	....	....	....	T	....	....	....	....	....	T	....	....	0.09
Boettcherville	....	....	....	.20	T	....	....	....	....	....	....	....	....	....	T	....	....	....	....	....	....	....	T	....	....	....	....	....	....	....	....	0.20
Cumberland (a)	....	....	....	.20	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.07	....	....	....	....	....	....	....	....	....	0.27
Cumberland (b)	....	....	.17	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.07	....	....	....	....	....	....	....	....	....	0.24
Darlington	....	....	.03	....	....	....	....	....	.29	....	....	....	....	....	....	.02	....	....	....	....	....	....	....	....	....	....	....	....	.04	....	....	0.38
Dist. Res. D. C.	....	....	....	....	....	....	....	....	.31	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0.31
Dover, Del	....	....	....	....	....	....	....	....	.33	....	....	....	....	....	....	....	....	....	....	....	....	....	.03	....	....	....	....	....	.10	....	....	0.46
Easton	....	....	....	....	....	....	....	....	.68	....	....	....	....	....	....	....	....	....	....	....	....	....	.03	....	....	....	....	....	.08	....	....	0.79
Fallston	....	....	....	T	....	....	....	....	.40	....	....	....	....	....	....	....	....	....	T	....	T	....	....	....	....	....	....	....	.05	....	....	0.45
Frederick	....	....	....	.04	.01	....	....	.14	....	....	....	....	....	....	....	....	....	....	....	....	....	T	....	....	....	....	....	....	....	....	....	0.19
Great Falls	....	....	....	....	....	....	....	....	.10	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0.10
Jewell	....	....	....	T	....	....	....	.50	....	....	....	....	....	....	....	....	....	....	....	....	....	T	....	....	....	....	....	....	T	....	....	0.50
Leonardtown	....	....	T	....	....	....	....	....	1.10	....	....	....	....	....	....	.03	....	....	....	....	....	....	....	T	....	....	T	....	....	....	....	1.13
McDonogh	....	....	....	....	....	....	....	.31	.01	....	....	....	....	....	....	....	....	....	....	....	....	T	....	....	....	....	....	....	.02	....	....	0.34
Mt. St. Mary's	....	....	....	.03	....	....	....	.18	....	....	....	....	....	....	....	....	....	....	....	....	.01	....	....	....	....	....	....	....	....	....	....	0.22
New Market	....	....	....	....	....	....	....	.21	....	....	....	....	....	....	....	....	....	....	T	....	T	....	....	....	....	....	....	....	....	....	....	0.21
Rec. Res. D. C.	....	....	....	....	....	....	....	....	.26	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0.26
Seaford, Del	.25	....	T	....	....	....	....	.40	....	....	....	....	....	....	....	....	....	....	....	....	....	T	....	....	....	....	....	....	.19	....	....	0.84
Solomon's	....	....	....	.07	....	....	....	.56	T	....	....	....	....	....	....	....	....	....	....	....	T	T	.02	....	....	....	....	....	.02	....	....	0.67
Taneytown	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0.00
Washington, D. C.	....	....	....	T	T	....	....	.32	.01	....	....	....	....	....	....	....	....	....	T	....	T	.01	T	....	....	....	....	....	T	....	....	0.34
Woodstock	....	....	....	....	T	....	....	.24	T	....	....	....	....	....	....	....	....	....	....	T	T	....	....	....	....	....	....	....	....	....	....	0.24
Norfolk, Va.	....	....	....	.18	....	....	....	....	.12	....	....	....	....	....	....	....	....	....	....	....	....	....	T	....	.22	....	....	....	....	....	....	0.52

NOTE.—"T" indicates a trace of rain or snow.


MAP OF
MARYLAND AND DELAWARE
SHOWING
THE PRECIPITATION
AND
LINES OF MEAN TEMPERATURES
FOR OCTOBER, 1892.
Scale of Shades:
0 TO 2 INCHES.
2 TO 4 "
OVER 4 "
SCALE OF MILES.
DELAWARE BAY