1889, March 20, there was a succession of twelve flashes of zigzag lightning followed by as many loud peals of thunder; this was the longest display of lightning ever recorded here.

1889, April 2, a severe storm of forked lightning and thunder.

1891, September 5, a tree was struck by lightning.

1897, December 1, the second time that lightning occurred in December. The thunderstorm began at 4:05 a. m., seventy-fifth meridian time, and lasted about six minutes, during which time there were four flashes of lightning in the southwest, and the same number of loud peals of thunder. The lightning flash was of the zigzag or chain or forked variety, and was intensely white in color; the rainfall during the night (from 8 p. m. to 8 a. m.) was 0.10 inch; during these same twelve hours 5 inches of snow fell at Summit, 4 at Truckee, and 1 or 2 inches at other points on the mountains 50 or 100 miles west of Sacramento, and at points 3,000 feet or more above that station.

DISTANT CLOUD BANKS.

A letter from Mr. James Gun, of Durham, Grey County, Ontario, says:

> I have often, when engaged in my practice in the country, observed these banks of clouds; especially when, having reached a height of land, I found myself placed in such a position that (by the refraction of the rays of light?) these clouds assumed the appearance of bodies of water, something after the appearance of a mirage. These cloud banks have been invariably, in my experience, followed by changes of weather and storms.

The Editor remembers to have seen in the distance about the time of sunset low clouds that closely resembled a distant lake or an ocean horizon. Of course the resemblance to such a solid mass of water was purely an optical delusion, and not due so much to the refraction that produces mirage, as to the peculiar tints of the blue sky, the clouds, and the ground at sunset. These were not the cloud banks that the Editor had especially in mind in his little note in the October REVIEW, but we are much obliged to Mr. Gun for calling our attention to them, and hope that other observers may put their observations on record.

CLOUDY CONDENSATION.

The researches of John Aitken, which have for the past twenty years been published from time to time in the "Transactions of the Royal Society of Edinburgh," have made the English-speaking world familiar with the fact that has been established by him and others, that whenever the aqueous vapor of the atmosphere condenses into the little globules that constitute fog or cloud it, by preference, condenses first upon the particles of so-called dust floating in the air which are, therefore, the nuclei of cloudy condensation. According to the last publication by Aitken (R. S. Edin., XXXIX, Part I, p. 15, 1897) he states that he has never said that dust particles are absolutely essential, but simply that as the air is full of dust and the condensation takes place on these by preference, therefore, practically all of our cloud particles have dust nuclei. The researches of Robert von Helmholtz and Professor Richarz and those of Prof. Carl Barus, as published by the Weather Bureau, agree with those of Aitken in showing that, in the absence of dust cloudy condensation also occurs, but the solid nuclei are replaced by molecules of some other foreign substances, such as the vapor of sulphuric acid, or the particles given off by anhydrous sulphuric acid, or even from metal surfaces when heated or electrified.

It has been suggested that, in the absence of dust nuclei, condensation may be produced by a molecular shock due to chemical processes, and more especially by the presence of the unsaturated molecular compounds known in chemistry as "ions." This last memoir by Aitken gives in detail an experimental method of determining the importance of these ions, especially those produced by the burning of pure hydrogen in pure air. Special pains were taken to obtain air and hydrogen perfectly free from dust, for when a single particle of dust is burned in the flame it gives rise to innumerable free atoms of carbon which becomes solid nuclei for condensation. Aitken's experiments show that in his apparatus the ions had no perceptible influence, whence he draws the safe conclusion that if they really had much influence in producing condensation they could have retained that power for only a very short time, viz, a fraction of a second, and it is not likely that they play any important part in the ordinary cloudy condensation of the atmosphere.

Mr. Aitken next turned his attention to the question of the direct influence of sunshine in producing condensation, a matter which was first brought to the attention of the world by the brilliant experiments of Tyndall, who describes the beautiful clouds produced by allowing a beam of light to pass through a long tube full of dustless, saturated vapor. Mr. Aitken finds that many of the vapors which we call impurities in our atmosphere, such as ammonia, nitric and nitrous acids, peroxide of hydrogen, sulphurous acid, sulphuretted hydrogen, hydrochloric acid, and chlorine give rise to nuclei of condensation when acted on by sunshine. Each of these, in a clean tube, was exposed to sunshine for about a minute. Ordinary pure air, after being filtered of dust and exposed to sunshine, does not show any cloudy condensation when expanded, but when any of the above-named gases are in the air a great deal of cloud is formed. Ammonia, after being sunned for a minute, has a very powerful effect; nitric acid not so much; nitrous acid probably as much as nitric acid. Hydrogen peroxide is a powerful generator of nuclei; sulphurous acid gives rise to condensation even in the dark and in a weak solution, but sunshine increases it; illuminating gas and the gases given off by the combustion of anthracite coal give a dense condensation after being exposed to sunshine, but these gases probably contain sulphur; pure sulphuretted hydrogen and hydrochloric acid give dense condensation after being exposed to the sunshine, but none when they are kept in the dark; chlorine causes condensation if kept in the dark and without being expanded and is still more fogged on exposure to sunlight. Some of these nuclei of condensation, due to the action of sunshine on the abovementioned vapors, are very short lived, so that the air in the experimental flask loses the power of cloudy condensation in from fifteen to thirty minutes; but the nuclei from sulphurous acid do not lose their power for a long time; these nuclei are probably particles of fine sulphur dust and their action is as permanent as ordinary atmospheric dust. The light of burning magnesium acts on sulphurous acid easily, but scarcely at all on the other vapors. These experiments on the effects of sunshine on the gases ordinarily present in the atmosphere show that it is possible for cloudy condensation to take place in the absence of dust, since the sunshine may convert vapors into the nuclei of condensation. There is, indeed, always dust enough in the lower atmosphere, but we now see how it may become possible for clouds to form in the dustless higher strata.

ON THE TENSION OF AQUEOUS VAPOR.

Prof. Joseph Henry early called attention to the fact that the air is not necessarily saturated during rain, and he says (Smithsonian Annual Report, 1855, pp. 213–214, or Scientific Writings, Vol. II, p. 5):

> That the air should ever be undersaturated during rain is at first thought a very surprising fact; it may, however, be accounted for on the principles of capillarity. The attraction of the surface of a spherical portion of water for itself is in proportion to the curvature or to the smallness of the quantity, and hence the tendency to evaporate from a raindrop ought to be much less than from an equal portion of a flat surface of water.

Mr. Aitken puts this principle in a very clear light, as follows:

What is generally called a saturated vapor is one whose tension is equal to the tension of the vapor at a flat surface. Now this tension is not so high as the tension at a surface of extremely small convex curvature; and vapor that is in equilibrium with the vapor at a convex surface is supersaturated with reference to that at the flat surface; so that saturation is a relative and not an absolute quantity, relative to the curvature of the condensing surface, and a vapor that is supersaturated to a flat surface is not necessarily saturated to a surface of very small curvature. It would thus appear that there is no strain in a vapor till a surface makes its appearance, but after *it* is formed the lower tension at this surface determines a movement of the vapor molecules toward it. * * * From this way of considering the subject it would appear that there is no such thing as supersaturation in a pure vapor free from nuclei, consequently no strain in the vapor that needs to be relieved.

The figures for vapor tension, considered as a meteorological datum, should, of course, always be considered as reduced to the normal value for a flat surface, but this is only important for surfaces of very small curvature.

CYCLES IN METEOROLOGY.

The important and laborious computations by Mr. Dallas, the officiating meteorological reporter for the Government of India, as published in full in the current number of the MONTHLY WEATHER REVIEW, do not encourage further efforts to discover arbitrary cycles that are likely to be of importance either to meteorology or to the weather forecaster. If one had a myriad of observed temperatures, pressures, or rainfalls he could apply the harmonic analysis and represent the whole set of values accurately by a series of cycles, but every new observation of pressure, etc., would require the addition of a new cycle or the modification of an old one to represent it. The computations of Mr. Dallas have resulted in showing that an 11-year plus a 9-year cycle does not enable us to determine beforehand, with any certainty, the probable amount of the total annual rainfall. There are, of course, numerous coincidences between cyclic predictions and actual rainfall, but the frequent outstanding discrepancies are such as to rob the predictions of all real value. As with rainfall so with pressure; the departures of mean annual pressure from a uniform normal value are so small that we find ourselves discussing arbitrary cycles whose amplitudes are matters of 0.008 or 0.010 inch of pressure; these small quantities are at the very limit of the accuracy of our observations. If we apply the method of least squares to the differences between the observed and the computed values, we shall only arrive at a proper appreciation of the extrinsic but not of the intrinsic value of the cycles.

Arbitrary cycles are only resorted to when we have no clew to the rational connection between the phenomena and their ultimate causes. But the study of the motions of the earth's atmosphere has progressed far enough, both from an observational and a theoretical point of view to justify a determined effort to establish long-range forecasts of seasonal rainfall upon a higher plane than that of purely arbitrary cycles. Such higher methods may be empirical, but they are not necessarily arbitrary; they may be numerical and special, rather than analytical and general, but they may still be based upon a rational consideration of the mechanics of the atmosphere.

The laws of the mechanics of fluids show that there must be many temporary periods or cycles. Thus, for instance, if there are changes in the intensity of solar radiation, there must be corresponding immediate changes in the temperature, moisture, pressure, and motions of the atmosphere. Every such change of insolation will be perceived for a long time, possibly many years after its occurrence, by the existence of subsidiary phenomena that will spread over the entire globe until the whole influence of the change has permeated the atmosphere uniformly and the periodicities have died away.

On the other hand, without any change in solar or cosmic influences, but simply by reason of the production of rythmic changes as to pressure and wind within the atmosphere itself, the influence of that which is happening to-day in one region may be felt years hence far away. It other words, it is not necessary to go outside of the atmosphere to look for the origin of cycles and other less regular changes. The study of the droughts of recent years in the Southern Hemisphere (when elucidated by the study of a daily map, or even of a monthly summary of the conditions over the whole globe, and when interpreted by the general principle that rainfall at any locality depends directly upon the wind below and the currents above) shows why the drought of the South Pacific slowly advanced, month after month, northeastward into America, and eventually died away over Europe. The relation between the meteorology of Mauritius and that of India, as studied by Mr. Dallas, or the relation between India and the distant southern Indian Ocean, as studied by Mr. Eliot, or the relation between Australia and the South Pacific, on the one hand, and that of Hawaii and the North American Continent, on the other, as recently referred to by the Editor, is determined by the so-called general circulation of the atmosphere. This latter has certain broad features that result from the interaction of those portions of the atmosphere that are above the continents and the polar regions, upon those other portions that are above the oceans and the equatorial regions.

In seasonal predictions for large regions the general movements of the atmosphere and certain general principles in physics must be borne in mind. Consider first the connection between rainfall and the clouds. As a general rule, the lower the clouds the greater the chance that rain will fall from them. Now, the height of a cloud depends somewhat upon the method of formation. If the wind is blowing against a mountain side, the resulting cloud and its rain are due, primarily, to the dynamic cooling of expanding air; the height of the cloud will depend upon the dew-point and temperature of the air; the quantity of rain at any spot on the mountain will also depend upon the strength and persistency of the wind. This class of rains is well illustrated by the perpetual cloud and drizzle due to west winds on the summit of Pike's Peak or to the southeast trades on the summit of Green Mountain on the Island of Ascension, and also by the heavy rainfall during the southwest monsoon season on the windward side of the Ghats, and frequently also, of the Himalayas in India. On the other hand, when a warm wind is pushed aside and lifted up by an underflowing colder wind, as happens at the front of our "northers" and northwesters, we have not merely dynamic cooling due to ascent, but a still further cooling and, also, a drying due to the mixture of the two layers of air; the resulting clouds are colder because of this mixture, and the rainfall is less not only for this reason, but also because the mass of warm air and clouds is pushed forward, and is very soon entirely replaced by the advancing dry, cool, clear air. In general, clouds formed even partially by mixtures give little rain, but those due only to expansion give generous rain. The drizzles and daily showers from mixtures may, however, be very important to agriculture.

Consider now the layer of air next above the lowest. After the lower current has left a little rain on the windward side of a mountain range, it partially recurves as an overflow upon itself. The relative amount of the overflow depends upon the speed of the current and its depth as compared with the height of the mountain range. When that depth is considerably greater than the height of the obstacle the main part of the current goes on beyond the range as an upper current