arch we find that the highest clouds that receive the sun's light appear white, while the lower clouds are of rich salmon and golden tints, and that every shade of intermediate color is found here and there between, down to the very lowest clouds, which receive no direct sunlight and are of ashy white or dark gray. If we recall that the color of the sun was dark red or bright salmon when last seen at sunset, we shall at once realize that if we could rise upward a little way until we again saw the sun in the horizon we should be where these brilliant-colored clouds now are and that the color of the illumination of the clouds must grow deeper and deeper as the sun sinks deeper in the west, or rather as the earth, revolving eastward, carries the clouds more and more deeply into its own shadow, until finally they receive no direct sunlight at all, but perhaps a little reflection from surrounding objects. The deep-red arch seen in the east is the boundary between the illuminated part of the atmosphere and the darker portion below; it rises higher every minute, and eventually passes over our zenith and sinks in the west or northwest. The so-called civil twilight ends and night begins when this arch passes westward over the zenith, but the astronomical twilight ends only when the arch disappears in the western horizon, so that the entire sky is free from diffuse sunlight. Owing to the influence of clouds or hills in the distant west and of possible haze at great heights, such as that of 1884–85, the end of the astronomical twilight may vary to a very great extent. In northern latitudes, such as St. Petersburg, on the 21st of June, when at midnight the sun is only a few degrees below the northern horizon, the twilight arch at that time stretches from east to west, reaching up half way to the zenith and is very sharply defined. Observations of this arch were formerly used as a basis for the calculation of the altitude of the upper limit of the atmosphere and gave results of from 40 to 50 miles, but it is now well understood that this can only refer to the height of such layers of dust or aqueous vapor as are capable of reflecting appreciable light to the eye. The most remarkable sunsets of modern times are those supposed to be due to the vapor thrown up by the eruption of Krakatoa. The aqueous particles that produced the red sunsets of 1884 were undoubtedly large as compared with those ordinarily present at great heights, and may have been correspondingly lower in the atmosphere.

In several of the reports of State sections and in the daily press we find quotations from the bulletin on Storms and Storm Tracks, by Prof. F. H. Bigelow. The reference to this should always be Weather Bureau Bulletin No. 20 and not No. 114, as the latter is simply the current number in the chronological list of publications of the Weather Bureau.

NEBRASKA.

Prof. C. E. Bessey, of the University of Nebraska, contributes the following interesting note on the so-called "false dew," known also as "guttation," or the exudation of water drops from leaves:

Observations and experiments made upon many plants in the physiological laboratory and the plant houses of the University of Nebraska show that under certain conditions water may exude in drops from the surface or margin of leaves. It is well known, of course, that water escapes from living leaves in the form of vapor whenever the air is not saturated with moisture. Thus, when a geranium plant is placed upon one of the pans of a pair of scales (after wrapping the pot with sheet rubber so as to prevent evaporation from the soil), it is found that in a little time the loss of water vapor from the leaves is great enough to be readily measured. If the plant be allowed to remain upon the scale pan for a day or two, the amount of water lost will be quite considerable in quantity and weight. This kind of water loss has been well-known for a long time, but there is another loss of water with which we have not been so familiar. To show this, experiments were made as follows:

1. In a box of sandy soil fifty or more kernels of wheat were planted and kept growing vigorously until the plants were two or three inches high. They were kept well watered, so that the roots were fully supplied with water. The air of the laboratory during the experiment was pretty dry, requiring the roots to be quite active in absorbing water to make good the loss of water by evaporation from the leaves. The box was then put over a warm radiator, and the soil slowly warmed to a temperature of 77° to 78° Fahrenheit. After an hour or so drops of water were observed upon the leaves, and these continued to increase in spite of the fact that the humidity of the air was shown by observation to be only 31 per cent.

2. Another box, containing vigorously-growing wheat plants, was treated as follows: Warm water was slowly poured upon the soil, so as to quite considerably raise the temperature. The box was then put under a bell jar and the temperature of the air suddenly lowered by sprinkling the bell jar with water, when water was seen to ooze from the leaves, usually near the tips. This was repeated again and again, always with the same result.

3. Similar trials were made with small plants of maize (indian corn) with similar results.

4. In the plant house small cabbage plants were observed to exude drops of water from the projecting points on their margins under similar conditions.

Here we have an exudation of water drops (known as "guttation") quite resembling the dew which so often wets the grass. At first we might suppose it to be nothing more than dew, but careful tests, which I need not describe here, show it to be an actual exudation. It appears that the roots in the warm, moist soil become very active in absorbing water to supply the water loss through leaf evaporation, and when the latter is suddenly checked by the cooling of the air and consequent increase in its humidity the root pressure forces out the water in the little drops just described. When unusually active, the roots may even force out drops in dry, warm air, as in one of the experiments described above. Exudation may thus take place when the soil is moist and warm, especially when, with these conditions, the air is quickly changed from a hot and dry to a cooler and more humid condition.

SULPHUR RAINS.

The Cincinnati Enquirer of March 22 reports that a "sulphur rain" fell at Mount Vernon, Ky., early on the morning of March 21, as also at several other places in Rockcastle County; the stuff burned and gave out fumes of sulphur.

Those who are not seeking after mysteries may rest assured that such a rain of sulphur simply brings down to the ground some pollen from the pine woods, or some other light substance that has only a short time before been carried up by a strong gust of wind. It saddens one to think that any superstition should attach to such an ordinary phenomenon, one that occurs every day of the year at some place on the globe. Still more is it a pity that our daily press should repeat, and apparently indorse, any of the popular errors regarding these and other meteorological phenomena. It is quite as easy for a popular journal to present the best thoughts of the best people as it is to merely diffuse and strengthen the errors of the ignorant. The past century has witnessed the banishment from our text-books of innumerable erroneous ideas that were accepted by our ancestors. Why can not the daily press assist in the work of educating the public and resolutely refuse to print such nonsense as "the people generally consider this a sure harbinger of war," or such headings as "a red sun: bloody omen," or again, "great drought: belief that the world is drying up and that its end is drawing near"? If any one thing is more clearly taught than another by all our teachers, both religious and secular, it is that the future is not and can not be revealed by signs and omens.

MOONSHINE AND FROST.

Among the many mysterious meteorological influences ascribed to the moon, the following is quoted from the Evansville (Ind.) Courier of April 4, 1898:

Within the past week there have been several frosts, but to all appearances vegetation is not injured in the least. The reason of the immunity is explained by James Wiltshire, one of the oldest inhabitants of that city, who states that he obtained the idea from Mr. Willard Carpenter more than fifty years ago. Mr. Wiltshire says: "Since then I have carefully observed this every year, and have yet to see the

first time that the frost hurt the fruit or plants in the light of the moon. By 'the light of the moon' I do not mean any time the moon is shining, but only the period when it is getting bigger each night. As soon as the moon is full it is then 'the dark of the moon,' and frost will injure the green things that it would not affect before. During the present lunation the light of the moon ends April 6 when the moon is full, if we have any cold weather after that you may look out for damage to fruit but none before that."

The Editor does not believe that there is any such lunar influence as above described, and appeals to the intelligent farmers who have kept full records of this subject to give him the actual data of observations whereby this subject may be tested. Every belief in lunar influence has thus far proved to be contrary to the facts, and he expects that this one will also be proved to be so.

RAIN IN THE HAWAIIAN ISLANDS.

Our correspondent, Mr. Curtis J. Lyons, in his report for March, printed elsewhere, states that—

The month has been an unusually rainy one throughout the group. Kaumana (near Hilo), Hawaii, reports 55.58 inches; 10.18 inches fell at Luakaha, Oahu (5 miles from Honolulu); on the 24th unprecedented floods did much damage, especially in Oahu and Kauai; heaviest rain on north side of Oahu on the 27th. Frequent thunder and lightning from the 12th to the 24th.

As before stated in the MONTHLY WEATHER REVIEW, the Editor's study of the general circulation of the atmosphere leads him to believe that the conditions that bring droughts or floods to the Indian Ocean, Asiatic coasts, and Australian regions move slowly eastward over the Pacific and are eventually felt in North America. We shall, with interest, look for a rainy season at some time following these floods in the Hawaiian Islands.

RECENT EARTHQUAKES.

The seismographs maintained by Professor Marvin at Washington, D. C., and Professor Morley, at Cleveland, Ohio, were not affected during the month.

The following reports have been received from the observers of the Weather Bureau, or culled from newspaper correspondents:

2d.—California, Visalia, 2:48 p. m.

3d.—California, Descanso, slight shock at 2:30 a. m.

17th.—California, Upperlake, at 11:40 p. m.; motion from east to west.

19th.—Montana, Marysville, 6:00 a. m., a rumbling noise followed by a severe shock lasting three seconds.

29th.—Kentucky, Mount Hermon, 7:30 p. m., very slight shock.

30th.—California, Oleta, 11:40 p. m., Peachland, 11:40 p. m., vibrations from southwest to northeast, severe. Riovista, 11:40 p. m. San Leandro, 11:40 p. m. Santa Clara, severe at 11:40 p. m. Santa Cruz, heavy, 11:40 p. m., duration from 30 to 40 seconds. Stockton, severe at 11:42 p. m. Vacaville, 11:45 p. m. Fort Ross, 11:45 p. m. Georgetown, between 11:30 p. m. and midnight. Hollister, about midnight, slight but of long duration. Iowa Hill, about 11:45 p. m. Lytton Springs, violent shock, no time given. North San Juan, at 11:42 p. m., vibrations southeast to northwest.

Sonoma: 11:45 p. m., one of the most violent and prolonged shocks ever felt here. The vibrations were from north to south accompanied by a rattle and a noise. The first shock was followed at intervals by four other tremblers that were very heavy and over twenty lesser ones.

Sacramento: 11:38 p. m., three shocks were felt here; they were of an easy undulating motion and seemed to be from southeast to northwest.

Ignacio: Tubbs Island, among the tules, sloughs, and salt water creeks, was surely the center of the great earthquake of the 30th; the island heaved, rocked, and trembled like a platter full of jelly, and everything on it was moved out of place.

Agnews: 11:30 p. m.; Campbell, 11:42 p. m.; duration forty seconds; vibrations from west to east; the motion was slow; it was considered as heavy, if not the heaviest, ever known here.

Centerville: 11:43 p. m., direction north to south; duration thirty seconds; 2 shocks. First shock rolling motion, second and severest seemingly an up and down motion; severest felt since October 21, 1868.

San Jose: One of the heaviest ever experienced occurred at 11:42:22. Lick Observatory reports the total duration forty seconds, and that after the first twelve and thirteen seconds the shocks were more violent than has ever been recorded there. The greater motion was southeast and northwest; the earth moved approximately one-quarter of an inch.

Santa Rosa: Most severe ever felt here; chimneys and plate glass windows destroyed.

Stockton: Severe quake at 11:40; vibrations for thirty seconds.

Los Angeles: No shock was felt here and all reports indicate that the quake was confined to a limited area close to San Francisco. The vibrations died away in Monterey County to the south and in Mendocino and Colusa counties to the north. The greatest energy was exhibited at Vallejo.

Oakland: Lasted several seconds. Tremor not so violent but the duration much longer than usual; at the Chabot Observatory the mean time clock stopped at $11^h\ 42^m\ 24^s$ p. m.

Bolinas: 11:43, seventeen seconds duration, vibrations from north to south; shocks short and sharp.

San Rafael: Severe shock shortly before midnight.

Suisun: Severe and prolonged shock at 11:45 p. m.; vibrations seemed north and south but the shake was very confusing as to direction.

San Francisco: Davidson Observatory, 37° 47′ 28″ N., 122° 25′ 41″ W., 54.5 miles north, 53.5 miles west from Lick Observatory. The first shock was at $11^h\ 42^m\ 16^s$, Pacific standard time, and lasted seventeen seconds. An ivory carving hanging in front of a mirror and almost touching it indicated by its gentle tapping that tremors continued passing until $11^h\ 44^m\ 48^s$, and then after a pause, again at $11^h\ 45^m\ 48^s$, and again later still. The mirror faces south and indicates north and south motions. The vibrations increased for the first six seconds; decreased somewhat to the twelfth second and died away, as far as could be perceived, at the seventeenth second.

San Francisco: The earthquake which occurred at 11:43 p. m., as shown by the hands of the clocks stopped in San Francisco, was the severest which has visited this region for many years. There was no preliminary tremor, but the rocking began without an instant's warning. The 19-story building of Claus Spreckels swayed somewhat, but sustained no injury. One house collapsed, while hundreds of chimneys fell and many panes of glass were broken, but on the whole the damage was slight. The water in the bay rose 2 feet and immediately subsided.

Mare Island: The navy yard on this island appears to have been the center of this earthquake. Many of the brick buildings and costly engineering plants belonging to the Government were injured, and the most conservative estimates place the damage to Federal property at more than $100,000, while about 1,300 men have been temporarily thrown out of employment.

Berkley: At the Students Observatory, University of California, severest experienced here since 1868. The large astronomical clock was stopped by the vibrations at exactly 11:42:26, Pacific standard time, but it is difficult to say how many seconds after the beginning of the disturbance this occurred. The best record of the direction and the intensity