weather a few days ahead are already made, and we find them in the shape of hints at the end of the daily meteorological summaries of weather." In this paragraph we assume that Prince Kropotkin refers to the work done by European weather bureaus, he probably has overlooked the fact that in the United States predictions have been made by the method of types, as well as by the study of sequences and by the deductive meteorological theories, with systematic regularity for one day, and, whenever possible, for several days in advance, ever since 1869. During the current month of April, 1899, in fact, Prof. E. B. Garriott has made such predictions for forty-eight hours in advance without exception, daily, for all the States east of the Rocky Mountains, whereas in previous years it has generally been considered allowable to omit the 48-hour predictions and confine one's self to the 24-hour prediction whenever the former seemed rather uncertain of fulfilment. In conclusion, Kropotkin states that a knowledge of the general circulation of the atmosphere, at a given moment, is the one thing needed as a foundation for better predictions and that to achieve this the meteorological stations on mountain tops, the cloud observations, the balloon ascensions, and the American kite methods, must be utilized and he promises a future article analyzing the results of this class of work.

The great interest in the subject of long range predictions of the weather and of the season is shown by the numerous quotations from Kropotkin's article that are going the rounds of the daily press and the monthly reports of the climate and crop sections. Each commentator favors some special view of the subject. Our summary of Kropotkin's article given in the preceding paragraphs shows that he does not commit himself to any theory, nor critically examine the reliability or value of any periods that have been announced from time to time. He merely states that we have the two methods of approaching the subject by cycles and by types, and that hereafter he will publish something relative to the bearing of observations at high level on this problem.

Several commentators have quoted Kropotkin as especially indorsing the so-called sun spot cycle in the following paragraph:

> It is now certain that the number and the size of the dark spots which we see on the surface of the sun are in some way connected with the weather that we have on the earth.

This statement by Kropotkin seems to the present writer altogether too positive, although it is intended to be quite guarded. It is quite plausible that the variations in the sun spots have some general relation to the temperature and radiation of heat from the sun's surface, although the observations of solar radiation have not yet demonstrated this. It is quite plausible that if the solar radiation varies, then we should experience a corresponding variation in the temperature of the earth's surface and the air. It is true that observations of deep soil temperatures have shown some relation of this kind. It is true that Kœppen made it appear plausible that an increase of temperature in the equatorial regions follows the formation of many spots on the sun and that a diminution of temperature in the north temperate zone also followed the same event, whereas the general effect upon the whole earth is masked by the influence of currents of air and the formation of clouds. In November, 1870, the present writer published a short article in Silliman's American Journal of Science in which it seemed to be clearly shown that an increase in the number of spots gave a decrease in the amount of heat received on the summit of the Hohenpeissenberg from the sun. But these and similar computations deal only with annual means of sun spots and atmospheric temperatures. They are equivalent to the assertion that if the mean amount of spotted area on the sun's surface slowly increases from zero up to its maximum value, there is a corresponding slow diminution of about 1° Reaumur, or in an extreme case, possibly 3° Fahrenheit, in the temperatures observed at the ground. Such a statement is equivalent to a long range forecast as to the general average temperature of a whole year, but it tells us nothing with regard to special seasons or daily local weather or the weather of the whole globe for a given day. It gives us no long range rules for weather, but only for the most general climatic conditions as to temperature. It gives us no power of forecasting until we can forecast the spottiness of the sun. Similar computations have been made with reference to rainfall, hail, auroras, cloudiness, thunderstorms, cyclonic storms, the direction of the winds, and other phenomena, but all variations in these latter are results of complex physical processes following the changes in solar radiation. So long as the atmospheric processes are little understood, or not at all, it must be hopeless to handle such forecasts. There is at present no immediate prospect that we shall be able to make long range forecasts based on the condition of the sun's spots.

The study of the subject may be worthy the best efforts of those physicists who, like Professor Langley, are in a position to investigate in detail, the action of the solar radiation upon the earth and its atmosphere. But for the present, the ordinary observers and readers, the progressive inventors, and the enterprising financiers, must not allow their hopes to be raised too high by the ready pens of those who substitute brilliant inventive genius for the solid knowledge that can only come by slow and thorough investigation.

CHARACTERISTICS OF TORNADOES.

Although the Weather Bureau utilizes every opportunity of obtaining reliable descriptions of tornadoes and hopes to even get reliable photographs, yet our progress in that direction is very slow. It is very rare that a cool-headed observer, with sketch book and pencil, notes the phenomena as they are actually present before him. Too much is left to memory and verbal description. The tornadoes of April 27, of which at least four occurred in Missouri, have added to our stock of illustrations a few points that are not always clearly brought out. All of these moved from the southwest to the northeast. With regard to the one at Avalon, Prof. A. W. Baker states that—

> It passed about ¼ mile east of him. It was perfect in form, with a complete funnel extending to the earth. The whirl was from left to right and the path from 100 to 200 yards wide. The path of destruction was about 8 miles long. Light rain and small hail fell just before its passage, and it was followed by heavy rains. There was very little lightning or thunder. The tornado seemed to form at the lower corner of the cloud in the southwest.

The Kirksville tornado had a path of 1,300 feet in extreme width; the path of total destruction was from 600 to 1,000 feet wide; "the whirling motion was from right to left, or counter clockwise." This is rather obscure; from left to right would be counter clockwise. As one stands facing the north the sun passes from the east or right hand behind one's back to the west or left hand. This is clockwise. The earth rotates in the opposite direction, or counter clockwise. If an ordinary watch were laid upon the ground at the North Pole, its hands would rotate in a direction opposite to that of the earth, and this would be clockwise. An ordinary low pressure storm has its winds revolving counter clockwise, and this rule is also almost invariable with respect to tornadoes. Mr. E. L. Dinniston, of Kirksville, who was directly in its path, says:

> A short time before 6 p. m. a funnel-shaped cloud was seen to form high in the air about 12 miles southwest of Kirksville. For a short time it hung almost motionless and then the short funnel seemed to

disappear. Again a short funnel was projected downward and began to move slowly at first, in a northeasterly direction, and an ominous roar could be heard for miles. The funnel gradually lengthened, and when about 4 miles from Kirksville the point seemed to be within 200 feet of the ground. Suddenly it dropped like a plummet and started its work of destruction. Just before it struck our house there was an awful roaring noise, and it was dark as a dungeon while the storm was passing over.

Others state that two clouds came together in the southwest; that on either side of the funnel there was an arc glowing like a halo around the moon; above the arcs there was intense blackness and below them lighter clouds; the funnel extending downward between these arcs alternately approached and receded from the earth, and when it approached the earth a dark mass rose to meet it. The arcs disappeared as the tornado drew near; the funnel-shaped cloud seemed to a distant observer to take a zigzag course, sweeping a path much wider than its own diameter. One house was carried high in the air, where it exploded with a loud report. There was a light fall of rain before the storm and a heavy fall a short time after its passage. Very little lightning was seen.

As in many other descriptions, so here, the light rains, the descending spouts, the dark clouds, the ascending whirl of débris, the heavier rain that occurs sometime later, all harmonize so closely with the phenomena of the waterspout at sea that there must be a very close analogy between these and the tornadoes in the interior of our continent.

MARIANO BÁRCENA.

All who are interested in the progress of meteorology will regret to learn of the death of Don Mariano Bárcena, the illustrious engineer, senator of the Mexican Republic, founder and director of the Central Meteorological Observatory, and member of many scientific societies. In his death, on the 10th of April, in the City of Mexico, meteorology loses one of its most active friends. As a student of engineering, he early showed a special interest in the natural sciences, particularly geology, on which subject he is a well-known author. He was appointed a director of the Central Meteorological Observatory on the 7th of March, 1877, the date of the foundation of the establishment. During his connection with this institution, he published many important works, among which may be especially mentioned his Carpologia.

NO INCREASE IN TORNADOES.

Although the Weather Bureau has for many years repeated the statement that our data do not justify us in believing that there has been any material change in the number of tornadoes, nor, indeed, in any other feature of the climate, during the present geological epoch, yet the belief in such changes still lingers, and we are much pleased whenever the daily press comes to the relief of the meteorologist in the attempt to disseminate more correct views as to the permanency of our climate.

We copy the following from the Iowa State Register and the Iowa Weather and Crop Service, as it undoubtedly gives the true explanation of a popular mistake:

Many think that the railroad tracks banding the nation, and the continually increasing and large aggregate of metal on the surface throughout the country, aid in creating electrical disturbances in the atmosphere, and they call attention to the manner in which the needle is affected by the pole to sustain their theory; but the contrary opinion is presented by others, who assert that the railroad tracks and telegraph lines are useful as lightning rods for the earth. The scientists have many theories in regard to this subject, but the fact remains that all countries had windstorms of all degrees before there was a railroad track or telegraph line on the face of the earth, and it is probable that the number has not been increased by the added years. All of the civilized world's disasters are now published within twenty-four hours after occurrence, and that is the reason why there is an apparent large proportional increase in comparison with the days when telegraph and cable lines and daily newspapers were unknown—only one hundred years ago.

NO CHANGE IN THE CLIMATE OF APRIL.

The remarkable storms that we experienced during the spring of 1899, promptly started the query as to whether the climate has changed—that perennial theme about which the "oldest inhabitant" always freely expresses his ideas, though he knows little or nothing of it. It was soon shown that 2, 3, or 4 feet of snow had occurred in the Middle Atlantic States in a single storm several times during the past two hundred years; but, of course, each time over only a small district somewhere between Cape Hatteras and Cape Cod.

Now comes an interesting item with reference to Missouri, contributed by Prof. C. W. Prichett, of Glasgow, Mo., who says:

On April 7, 1837, it snowed all day in St. Charles and Warren counties, and on the morning of April 8 the snow was 2½ feet deep on the level. In April, 1857, the snow lay on the ground near Fayette from the 17th to the 20th to the depth of several inches. On April 15, 1842, the ground was so frozen in Warren County that we could not set stakes in the woods as guides for a worm fence.

RAINS OF SAND, DUST, AND MUD.

In the REVIEW for January, 1895, is given a full description of the general character of the dust that falls on our western plains, with snow or rain, and sometimes as perfectly dry dust; a recent occurrence of this kind is chronicled for April 30. At that time an area of low pressure moved from Colorado northeastward into Iowa. During the prevalence of the southerly winds on the southeast side of the storm center, the dust was carried in great quantities northward, but when the clouds coming from the west began to drop a little rain, preliminary to the heavy northwest winds that were to follow, then the dust became mud and the rain became a very dirty rain. This succession of dust followed by muddy rain moved eastward over the greater partof Nebraska, between 1 and 5 p. m., and during most of this time the sunlight was so obscured that lamps were lighted. The muddy rains occurred in Iowa as late as 9 p. m., but preceding that, viz, about 3:30 p. m., there were one or more tornadoes. A muddy rain began at Yankton, S. Dak., at 8 p. m. On the same day the severest northerly storm of the season occurred in Montana.

Both the dust storms and the tornadoes and northers indicate that there must have been ascending and descending currents of air of great violence, such as characterize what is called the unstable condition of the atmosphere in which air that has once started to ascend or descend, continues on its way with accelerated velocity. This condition of instability is sometimes spoken of as a condition in which colder air exists above and warmer air below, so that the colder air by virtue of its greater density, presses downward with sufficient force to displace the warmer air near the ground; but this is not a correct statement of the case, as the air is always colder overhead than it is below, and the mere deficit of temperature does not constitute instability. If the temperature diminishes with altitude at the rate of 1° F. in 185 feet, the atmosphere is said to be in neutral convective equilibrium, that is to say, if a cubic yard of this air is raised upward 1,000 feet, thereby cooling about 6° F., because of the internal work done by its own expansion, it will find itself surrounded by air of the same temperature, and will have no tendency to fall back or rise further. On the other hand, if the actual temperature of the air diminishes with altitude at