NEW PROBLEMS OF THE WEATHER.

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A knowledge of the coming weather enters so intimately into every contemplated human action that the question is often asked: What are the prospects for further improvement in the accuracy of weather forecasts, and can the seasons ever be foretold? The answer is that, while the Government has a corps of forecasters who are now applying all of the knowledge of the atmosphere that has been revealed, little hope for material improvement in their work can be held out until a substantial addition is made to the pure science of the problem. This can only come through experiment, study, and research. With 200 stations engaged in applying the science, it is a wise economy to devote at least one of them to the work of adding to the knowledge that is now costing us nearly a million and a half dollars annually to apply. Accordingly, those in charge have endeavored to lay out a plan of study and research leading to an increase in our knowledge of the laws governing the atmosphere such as should eventually enable our successors, if not ourselves, to add to the accuracy of weather forecasts and to make them for a longer period in advance.

THE MOUNT WEATHER RESEARCH OBSERVATORY.

In order that this country may do its share toward the advancement of meteorology along the lines that specially relate to conditions in America, it is imperative that the Weather Bureau should establish an observatory for its own special research work. A piece of land has therefore been secured and work has been inaugurated at an establishment that is intended to respond to the present and prospective needs of meteorology. This establishment is called the Mount Weather Research Observatory, and is organized on a broad and elastic basis, so that it may from year to year expand with the growing knowledge of our needs. (See Pls. I–III.)

STUDY OF THE UPPER ATMOSPHERE.

In order to prosecute the researches contemplated at Mount Weather, a plant has been established there especially adapted to the investigation of the physical condition of the atmosphere at great elevations above the surface of the earth. Hitherto our knowledge of the

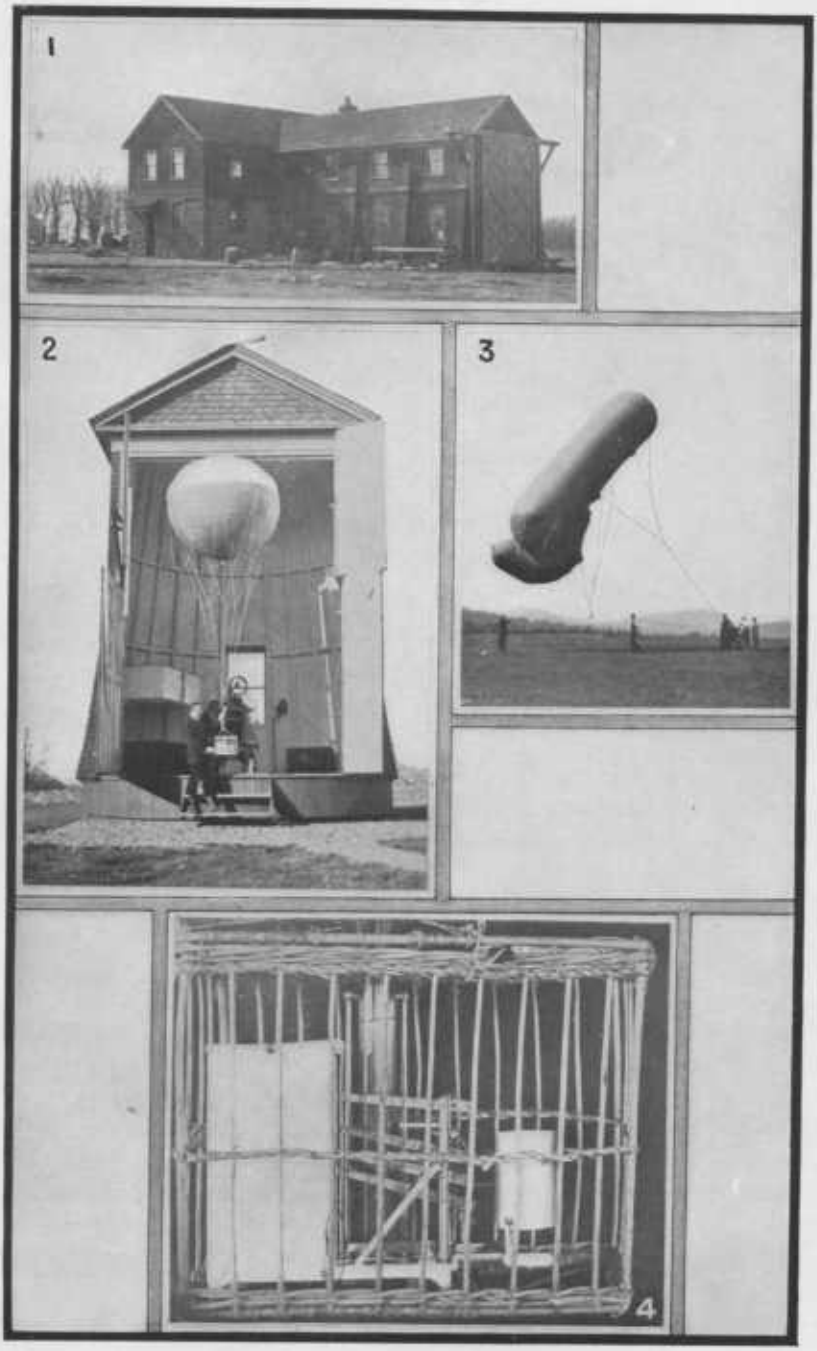
conditions of temperature, pressure, humidity, and wind velocity and direction has been based upon observations made at or near the surface of the earth or upon mountain peaks. Current conceptions of the laws of storms and of the general circulation of the atmosphere are based upon such observations almost entirely. Records obtained in recent years by means of balloons have demonstrated the existence of hitherto unsuspected variations and contrasts in temperature at very great elevations, and have shown that observations on mountain tops and at equal elevations in the free air vary widely.

The necessity for a better knowledge of temperature conditions at great elevations has directed the minds of many meteorologists to the study of the best methods for lifting self-recording instruments high above the earth's surface. The result has been the invention in recent years of ingenious forms of kites and of specially designed balloons for this purpose. The kite has again become an instrument for scientific research, and now enables us to bring down records of atmospheric conditions at elevations of 2 and 3 miles, and even of 4 miles, as was recently demonstrated at the German aeronautical observatory near Lindenberg. By means of small rubber balloons, marvelously light self-recording instruments have been carried up to the remarkable heights of 10 to 15 miles, bringing back records of low temperatures and high wind velocities which have been a revelation to meteorologists—records which are compelling a reconstruction of existing ideas concerning the dynamics of the atmosphere.

Pioneer work along these lines was begun some years ago by means of kites, both at Weather Bureau stations and, under the direction of Mr. A. L. Rotch, at the Blue Hill Observatory, near Boston, Mass. By experiments begun at St. Louis at the time of the World's Fair in the summer of 1904, Mr. Rotch also initiated the practice in this country of sending up small rubber balloons.

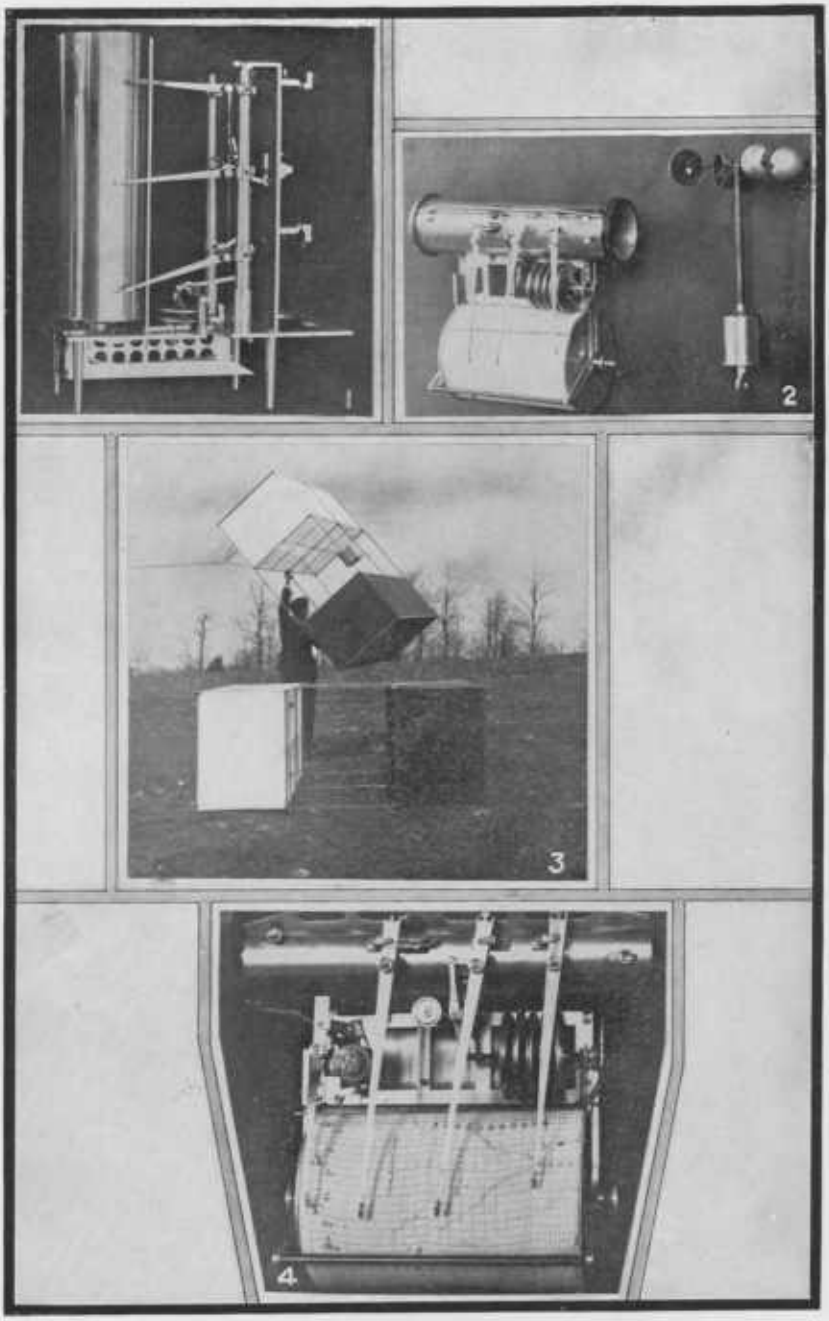
The observatory at Mount Weather is now well equipped with the necessary plant for carrying on this new and promising work of aerial research, and has for nearly a year been cooperating with European institutions and with the Blue Hill Observatory in sending up, on prearranged days, kites or captive balloons. These kites may be raised in winds varying from 10 miles per hour to 35 or 40 miles at the surface. With winds of less than 10 miles per hour it is necessary to employ captive balloons. To attain great heights small free rubber balloons of 2 or 3 cubic yards capacity, called pilot balloons, are employed. The instruments carried by the kites and balloons vary in weight from 1½ to 3 or 4 pounds and record variations in the temperature, the pressure, the humidity of the air, and the wind velocity.

The balloons are filled with hydrogen gas in order to secure the greatest lifting power. This necessitates the use of special apparatus for the manufacture of hydrogen. At the Mount Weather Research



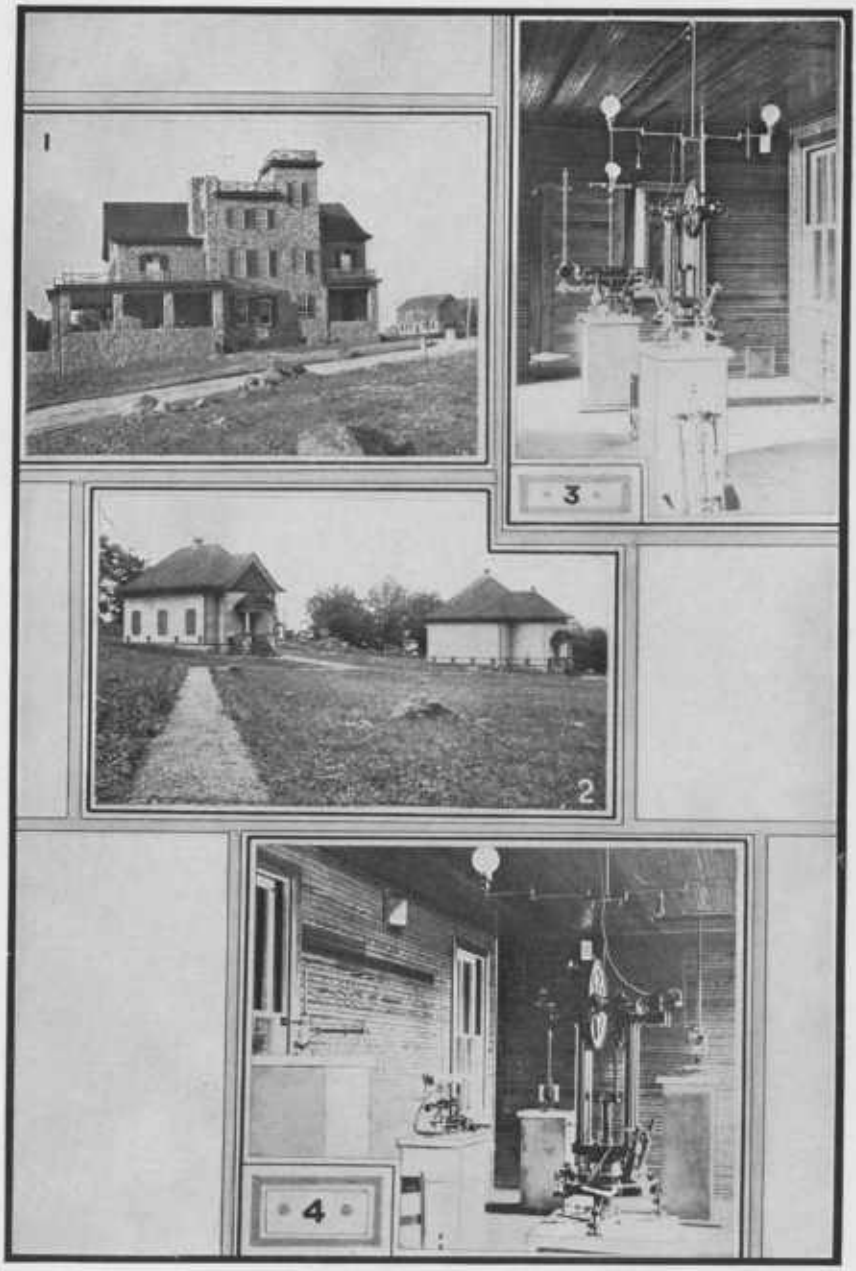
BUILDINGS AND APPARATUS AT MOUNT WEATHER, VA.

[1.—Power house and balloon shed. 2.—Revolving kite and balloon shed. 3.—The Siegsfeld kite balloon. 4.—Hergesell balloon meteorograph in protecting basket.]



APPLIANCES IN USE AT MOUNT WEATHER, VA.

[1.—French balloon meteorograph. 2.—Marvin kite meteorograph with anemometer. 3.—Hargrave-Marvin box kites. 4.—Marvin meteorograph, with record.]



BUILDINGS AND INSTRUMENTS AT MOUNT WEATHER, VA.

[1.—Administration building. 2.—Magnetic observatory buildings. 3.—Interior of magnetic observatory—magnetometer and indicator. 4.—Interior of magnetic observatory—declinometer and theodolite.]

Observatory a strong electric current is passed through water, breaking up the liquid into its constituent elements of hydrogen and oxygen. These gases are then collected and stored in appropriate tanks for future use as occasion may require.

As the small pilot balloons carry up their instruments to heights of many miles, where the prevailing temperatures are at all times very low (sometimes exceeding 100° Fahrenheit below zero), it is necessary to test the accuracy of the thermographs at these low points. For this purpose the observatory is equipped with a plant for the manufacture of liquid air, by means of which the instruments may be tested to the lowest points likely to be reached at great elevations.

In the near future these small rubber pilot balloons, carrying with them to elevations of 30,000 to 50,000 feet the light self-recording instruments referred to, will be liberated simultaneously at 20 to 30 Weather Bureau stations surrounding typical storm centers. Observations obtained in this manner at various elevations when compared with the records made at the same time at the surface of the earth will doubtless throw much new light upon the mechanism of storms, cold waves, etc., and give to meteorologists a better understanding of the general circulation of the atmosphere.

STUDY OF RELATIONS BETWEEN SUN AND WEATHER.

As one of the primary objects in view in establishing Mount Weather Observatory is to make a study of the relations existing between the various forms of solar radiation and terrestrial weather conditions, much attention has been given to the instrumental equipment and to securing men to study the variations in the amount of heat energy given off by the sun from day to day and variations in the amount of heat absorbed by the atmosphere. Some work along these lines has already been done; but a special building and instruments will soon be necessary for the study of these important problems of solar physics.

At present the most sensitive index of changes in solar energy is the suspended magnet. There is no doubt that changes in the intensity and direction of the magnetic force as registered at the earth's surface are coincident with the appearance and disappearance of certain well-recognized periodic phenomena observed on the face of the sun. It is fortunate that we have in the magnetism of the earth a terrestrial element which varies in delicate sympathetic relation with the activities of the sun and is at the same time subject to continuous observation and registration. To appreciate the value of terrestrial magnetism as a faithful index of the state of the sun it should be understood that not only are there regular ebbs and flows of magnetic force in response to the sun's annual approach and recession, his axial rotation and daily passage through the heavens, but even the outburst of a solar spot is simultaneously announced by a disturbance of the earth's magnetism.

So important to the study of the sun is a continuous record of the magnetic variations that one of the first steps in the establishment of the observatory was the installation of a magnetic plant consisting of the best modern instruments for the direct observation and for the continuous registration of the variations in the magnetism of the earth. The standard observatory instruments, both for continuous registration and direct measurement, are of the type devised by Wild for the model magnetic observatory at Pavlovsk, Russia. These are supplemented by a set of Eschenhagen magnetographs, the extreme sensitiveness of which peculiarly fits them for recording minute fluctuations of the earth's magnetic force.

The principal application of the results of the observations will be to supplement the direct observations of the sun, and thus to carry on the record of the solar activity continuously day and night in all conditions of weather. Researches will also be carried on to determine the existence and measure the extent of probable direct relations between meteorological disturbances and magnetic variations. The magnetic records will also be specially studied in conjunction with the results of observations of the radioactivity and the electrical condition of the air, particularly during thunder-storms and at times of auroral displays, for the purpose of revealing their relation to meteorological conditions.

EXPERIMENTAL PHYSICS.

The physical laboratory is not yet completed, and consequently it has not been possible to undertake investigations here in experimental physics. However, through the kindness of the authorities of the University of Virginia a good deal of spectroscopic work has been done at that institution. Some of the results have been published in the Astrophysical Journal, and there are many data yet on hand to be worked up at the earliest opportunity. An investigation, by the aid of a large telescope, of the causes and meteorological relations of the scintillation of stars is in progress at the University of Virginia along lines suggested by one of the Mount Weather officials. A special photometer has been devised for the purpose of measuring the relative densities of clouds, particularly when the entire sky is covered. As soon as the laboratory is completed and equipped investigations will be begun on atmospheric electricity, its origin, distribution, and laws, the causes and nature of precipitation, heat and light absorption, and other physical phenomena of importance to the meteorologist.