best that can be done is to save the water that falls in wet regions and use it to irrigate in dry. An alternative method is to shade the dry regions from the midday heat and wind, so as to diminish the loss of moisture by evaporation.

WEATHER BUREAU MEN AS EDUCATORS.

In the Department of Agriculture number of the Vermont Bulletin, the official publication of the University of Vermont and State Agricultural College, we find the following synopsis of the courses in meteorology given by Mr. W. H. Alexander, local forecaster, Burlington, Vt.:

1. Elementary Meteorology: The atmosphere; its moisture; dew; frost; haze; fog; clouds; precipitation; winds; cyclones; thunderstorms; climate; weather; weather bureaus. The use of ordinary meteorological instruments; observations; the construction and study of weather maps. Lectures, recitations, laboratory. *Elective, one hour, Junior or Senior, second half.*

2. Advanced Meteorology.--Theories relative to various meteorological phenomena; the law of storms; application of the principles of meteorology to the interpretation of climates; climate as a factor in social and economic problems. Discussion of charts, diagrams, photographs; conduct of a series of meteorological observations; weather forecasting. Lectures, theses, laboratory. *Elective, two hours, Junior or Senior, first half.*

Mr. M. L. Fuller, observer, Canton, N. Y., reports that in the new State Agricultural School of St. Lawrence University he is to give considerable instruction. It is intended to introduce lectures on climatology and the work of the Weather Bureau early in the course, and to make the instruction in these lines as extensive as practicable.

Mr. George Reeder, section director, Columbia, Mo., reports that he has been appointed lecturer on climatology at the University of Missouri.

Mr. G. N. Salisbury, section director, Seattle, Wash., reports that his regular course of instruction in practical meteorology at the State University was given to a class of 7, and consisted of a series of 14 lessons of two to three hours each, extending from October 11, 1906, to January 24, 1907. The work comprised impromptu talks, quizzes, and laboratory work, which embraced observations, and the drawing and study of weather maps.

On June 26, 1907, instruction in elementary meteorology was begun with a class of 10 at the summer school of the university. The course comprised 16 lessons of two hours each, three times a week. Davis's Elementary Meteorology was used as a textbook, and was supplemented by talks and laboratory work.

Mr. A. H. Thiessen, section director, Raleigh, N. C., reports that the president of the Agricultural and Mechanical College, at West Raleigh, has authorized the expenditure of $50 for lantern slides to be used in giving instruction in meteorology and climatology to the students of that college. There seems to be an increasing desire on the part of the students to take up this study.

Mr. J. R. Weeks, local forecaster, Binghamton, N. Y., reports that on July 25 he had the pleasure of visiting Mr. DeLancy M. Ellis, Chief of the Division of Visual Instruction, New York State Department of Education, at his office in the Capitol at Albany. This division has charge of the work in the schools of the State relating to the use of lantern slides, pictures, photographs, etc., as a means of instruction. Until recently, however, no attempt was made to furnish material of this nature for use in physical geography classes, and the views used were of descriptive geography or of a general nature, a collection of over 25,000 selected negatives having been made from which sets of beautiful colored slides for use in the stereopticon are issued to the schools, about $20,000 being spent yearly by the State for the purpose.

But now, in addition to the lecture entitled "The weather, what it is and how it is observed and forecast", which, beginning with February last, has been loaned free to such schools as request it, by cooperation between the United States Weather Bureau and the New York State Department of Education, Division of Visual Instruction, Mr. Ellis is now selecting the negatives and having prepared in his office a beautiful set of colored slides illustrating four divisions of physical geography study—the earth as a globe, the atmosphere, the geosphere, and the hydrosphere. The entire series, containing, when completed, several hundred views, will be reproduced in large numbers and the duplicates deposited in many of the public high schools of the State for permanent use. These stereopticon views are not intended for lectures simply, but are to take the place of wall maps, charts, and pictures for daily class room use. For instance, in looking over the nucleus of the collection Mr. Weeks was shown a number of beautiful colored photographic reproductions, in the form of lantern slides, of the charts of isotherms, isobars, rainfall, etc., for the world, found in Bartholomew's Physical Atlas, permission to make them having been kindly granted by the publishers. These, like most weather maps and charts, are too complicated and rich in detail for ordinary lecture use, but are unexcelled for daily class room study. Publications of the U. S. Weather Bureau, Davis's Meteorology, Hann's Lehrbuch, etc., have also been freely drawn upon for reliable diagrams and charts, and striking views showing contrasts of weather influence on humanity and on vegetation have been selected from the best collections of many travellers. Helpful pamphlets are to accompany the series, and Mr. Ellis expects to visit many of the schools in the interest of this work.

In regard to public lectures and reviews, Mr. Ellis said that enthusiastic letters had been received by him from users of the Weather Bureau lecture, and that it is desired to continue permanently the plan adopted this year and approved by the Chief of Bureau.

Mr. Weeks further reports that this lecture, prepared by himself, entitled "The weather, what it is and how it is observed and forecast", continues in great demand, requests for it coming not only from all parts of New York, but from Nebraska and other States, so that the use of text and slides is usually arranged for several weeks in the future.

The following lectures and addresses by Weather Bureau men have been reported:

Mr. George S. Bliss, of the Philadelphia, Pa., office, March 20, 1907, before the physics class at George School, Pa., on "The work of the Weather Bureau"; May 2, 1907, at Darlington Seminary, West Chester, Pa., on "The causes and controlling forces of storms"; also June 22, 1907, before the Brandywine Grange, at West Chester, Pa., on "Methods of weather forecasting".

Mr. M. E. Blystone, October 2, 1907, before the Men's Club of the Trinity Union Methodist Episcopal Church at Providence, R. I.; October 15, 1907, before the Men's Club of the Episcopal Church at Pontiac, R. I.; also October 16, 1907, before the Men's Club of the Broadway Baptist Church of Providence, R. I., on "Weather forecasts".

Mr. W. T. Blythe, of the Indianapolis, Ind., office, October 30, 1907, before the Young Men's Christian Association at Peru, Ind., on "Meteorology and the work of the U. S. Weather Bureau".

Prof. H. J. Cox, April 9, 1907, before the Chicago Yacht Owner's Association, on "Wind squalls"; also August 13, 1907, before the Wisconsin Cranberry Growers' Association, at Cranmoor, Wis., on "Temperature and frost conditions in cranberry marshes".

Mr. H. W. Richardson, October 23, 1907, before the Ladies'

Guild, Holy Apostles Episcopal Church, West Duluth, Minn., on "The U. S. Weather Bureau and its work"; also November 30, 1907, before the Saturday Club, at the Duluth Carnegie Library Building, on "The Weather Bureau".

Mr. M. R. Sanford, August 9, 1907, before the summer school of Syracuse University, on "The work of the Weather Bureau".

Mr. R. H. Sullivan, November 21, 1907, before the Wichita, Kans., Chamber of Commerce, on "The work of the Weather Bureau and its relation to public interests".

Mr. J. F. Voorhees, of the Knoxville, Tenn., office, October 10, 1907, before the Farragut School, Concord, Tenn., on "How forecasts are made and distributed".

Mr. E. C. Vose, November 15, 1907, before the physical geography class of the Concord, N. H., High School, on "The work and usefulness of the Weather Bureau".

Classes from universities, colleges, schools, and academies have visited Weather Bureau offices to study the instruments and equipment and receive informal instruction, as reported from the following stations:

Albany, N. Y., June 8, 1907, the physical geography class from the La Salle Institute of Troy; also November 14, 1907, a class from the Teachers' Training School of Albany; also November 23, 1907, the physical geography class from the Union School, Rhinebeck, N. Y.

Baker City, Oreg., October 30, 1907, the class in physical geography from the local high school.

Dubuque, Iowa, October 18, 1907, the sixth grade pupils of the Prescott School; also October 25, 1907, the sixth and seventh grade pupils of the Jackson School.

Duluth, Minn., July 23, 1907, a class from the Superior, Wis., State Normal School; also July 25, 1907, a class from the Duluth State Normal School.

Huron, S. Dak., July 25, 1907, a class from the summer school of Huron College.

Los Angeles, Cal., October 15, 16, and 30, 1907, the physical geography class of the Hollywood, Cal., high school, in three sections.

Philadelphia, Pa., March 14 and 16, 1907, classes from the Pennsylvania State University.

Salt Lake City, Utah, September 16, 1907, a class from Lafayette school.

Seattle, Wash., November 14, 1906, a class in physical geography from Ballard High School; January 11, 1907, a class in physical geography from the Franklin High School; April 19 and 24, classes in physical geography, and April 30 a class in elementary meteorology from the Seattle High School.

Syracuse, N. Y., July 19, 1907, the class in physical geography from the summer school of Syracuse University.

A UNIVERSAL SEISMOGRAPH FOR HORIZONTAL MOTION AND NOTES ON THE REQUIREMENTS THAT MUST BE SATISFIED.[1]

By C. F. MARVIN, Professor of Meteorology.

If we try to analyze and represent graphically the movements of the ground, such as result from seismic activity of different kinds and under different conditions, we find that we require several different diagrams, something like those shown in fig. 1.

At 1 are represented the minute motions of the ground, of small magnitude and short duration, such as might be produced by the passage of a heavy car or train; this might even represent a slight shock from a nearby local earthquake, of sufficient intensity to attract the attention of a few people, one that would be recorded by a seismograph of high magnification, as little more than a mere thickening of the line of the recording stylus or photographic trace. The short transverse dashes along the line are intended to mark the minutes of time, and the same time scale is used in the succeeding diagrams.

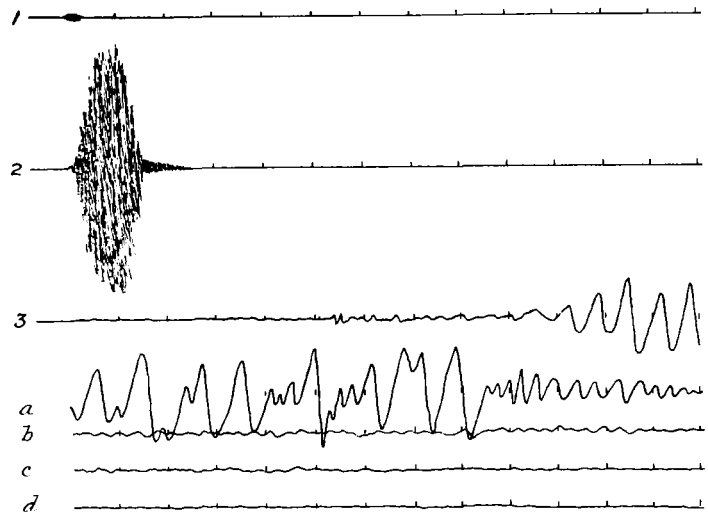

FIG. 1.—Diagrams of different species of ground vibrations.

At 2 we attempt to show, in relative characteristics, a destructive earthquake—such for example, as the earthquake in California in 1906. The time scale is too short to give more than a very general idea of the motion. A multitude of wave vibrations of short period and of great amplitude, as compared with those in 1, are crowded into a short period of time. Practically no details can be made out from such a record as this.

Finally at 3, with continuations of the record at *a*, *b*, *c*, and *d*, for lack of adequate length in a single line, we show the kind of record that will be obtained at a distance of 1000 miles or more from the origin of any great disturbance. As already stated, the time scales are the same thruout the several records, and the amplitudes may be taken to be half size, at least for the larger waves. The smallest tremors are of very great importance in seismic records, and these are greatly exaggerated in the diagrams simply to make them apparent under the scale adopted in the figure.

The three diagrams thus described represent what we may regard as the three limiting classes of shocks. It is plain that one class merges imperceptibly into the other in proportion to the intensity of the disturbance and the distance from the origin at which the record is made. Such diagrams as these may be regarded as representative of one of the two components of horizontal motion, whereas a third set is necessary for the vertical motion, and, in some cases, there may be tilting and twisting motions, all of which require careful consideration.

The problem presented to the instrumental seismologist is to devise and design an instrument or instruments that will record these several degrees of motions in a satisfactory manner. It would be of great interest, at this point, to describe the more important seismographs now in extensive use to meet this demand. To do so, however, even in the briefest manner, would require much more time and space than are available, and it seems best to pass at once to the description of the new forms, recognizing that the present work marks, perhaps, only a step in the evolution and development of the seismograph toward which so much has been already contributed by Zoellner, Ewing, Milne, Gray, Vicentini, von Rebeur-Paschwitz, Omori, Wiechert, Galitzin, and many others.

It may fairly be said that at the present time none of the existing instruments are adapted to register all kinds of earthquake motion. If we wish to record microseismic motions we must get one sort of instrument. A different instrument is

[1] The substance of this paper was presented at the Chicago meeting of the American Association for the Advancement of Science, December 31, 1907.