

nal friction or viscosity of the moist air, and this connection can be quantitatively determined by skillful mathematical and experimental study.

This is but one of a long series of beautiful and fascinating problems in the dynamics of the atmosphere; problems that should attract the students of science in our best universities.

Meteorology has waited long for the collegiate recognition that has lately been accorded it here and there; but its progress is not secured by merely teaching to undergraduates that which is already known; it demands rather that provision be made for the thorough preparation in scientific research of those who desire to devote their lives to the advancement of meteorology. There are half a dozen American universities whose students, instructors, and laboratories could profitably be turned toward the development of those branches of experimental and mathematical physics that bear upon meteorology.

#### METEOROLOGY IN OUR UNIVERSITIES.

Some years since the Editor sketched out a course of reading, study, and experimentation for the guidance of those students who felt themselves drawn toward this important science, and this course has been announced in the annual catalogues of the Columbian University for a number of years. It has, indeed, never been given by the Editor in full, and may perhaps be too elaborate to be generally practicable. However, it constitutes a comprehensive course of subjects for reading and study that may be useful as a guide to teachers who desire to do the very best that can be done under the limitations imposed by their personal and local conditions.

The courses in meteorology are designed to give a complete review of the present condition of that science, and they extend through six years, but each of the six divisions is complete in itself. Each course presents a detailed view of its branch of the subject, such as may be desired by students who need this information in connection with other branches of knowledge to which they are specially devoting themselves.

In addition to the lectures, the professor devotes one hour a week to a "quiz" class, in which, by questions and answers, he seeks to remove any difficulties that remain.

1. *Observational meteorology.*—Personal diary of the weather; general methods of observing without instruments; the rain gage; the thermometer; the barometer; the nephoscope; the anemometer; hygrometry; actinometry; self-registering apparatus; observations in balloons; observations on mountain stations; meteorological expeditions by land and sea; forms for record; methods of computation of means and normals; graphic methods of presenting results. Two hours per week.

2. *General climatology.*—Elements of climate; general distribution over the earth of sunshine, temperature, moisture, pressure, wind, clouds; diurnal, annual, and secular periodicities; variability of local climates; empirical relations between the winds and the other elements; the absorption of radiations by the atmosphere; the theory of probabilities as used in climatology; the computations of the coefficients of the Bessels-Fourier equation; the climatic features of areas of high and low pressure; the relations between ocean currents and the atmosphere; solar and lunar tides; the constituents of the atmosphere and their variations; atmospheric dust; atmospheric moisture; climatic characteristics of oceanic, continental, and littoral regions; sensible temperatures; constitution of the atmosphere as affected by plants, animals, altitudes, and the ocean; influence of snow, swamps, and forests. Two hours per week.

3. *Special subjects in meteorology and climatology.*—Optical phenomena; thermal phenomena; acoustic phenomena; electrical phenomena; climate and geology; climate and vegetation; climate and anthropology; climate and hygiene; climate and engineering; climate and manufacturing industries; atmospheric dust in relation to rain, geology, vegetation, hygiene, manufactures. Montgomery J. Storm's Cloud Engine. Cloudy Condensation, by Barus, Wilson, and others. The relation of the atmosphere to ordnance operations. Two hours.

4. *Experimental laboratory work in meteorology.*—In this higher field of work the student investigates the theories of several meteorological instruments and pushes his study to some decided advance beyond the present state of knowledge. New apparatus is devised and constructed and the nature of its errors investigated theoretically and experimentally. Old series of observations, conducted with imperfect apparatus

and under unfavorable conditions, are reduced and corrected in the light of the newest discussions. The laws of such physical phenomena as have to be considered by meteorologists are investigated by laboratory methods. Among these, for example, are radiation, conduction, and convection of heat; evaporation; the formation of dew, fog, cloud, rain, snow, hail, and lightning; the minute oscillations of wind and pressure; the pressure and movements of the wind, the absorption of radiations from the sun or earth by the atmosphere; the viscosity of the air, convective resistances, etc.; problems in aeronautics, anemometry, kites, resistance of the air to motion; the Schlieren method of Tüppler for studying currents and waves of air.

5. *Practical meteorology.*—Methods of projection in cartography; daily weather charts of all nations; international charts of the northern hemisphere; influence of land and ocean on weather and climate; empirical rules as to the variability and constancy of weather and climate in general; the computation of the index of variability of climate by the law of errors; weather types and typical weather charts, both for the United States and for the whole globe; predictions of daily weather by various methods, such as chance, persistency of current conditions, weather types, etc.; special rules for predicting frost, cold waves, rain, snow, and wind; predictions for one, two, and three days; long-range predictions for seasons and climates; precise definition of climate by Hinrich's method, and long-range predictions of Hinrich's climatic exponent; climates in past geological ages; codification of empiric and rational rules for prediction; verification of predictions and the laws of chance involved therein.

6. *Physical and theoretical meteorology.*—Insolation; the absorption, conduction, and radiation of heat by the air, the earth, and the ocean, and the resulting distribution of temperature; the thermo-dynamics of the atmosphere; convective equilibrium; the general circulation of a dry atmosphere on a rotating globe; the influence of oceans and continents, and the motions of the actual atmosphere; local cyclones and anticyclones; atmospheric waves and tides; the distribution of fog, cloud, rain, and snow; optical and electrical phenomena.

#### WEATHER BUREAU MEN AS UNIVERSITY LECTURERS.

In continuation of our remarks in the MONTHLY WEATHER REVIEW for August, page 365, we note that according to a report from W. M. Fulton, Observer, Knoxville, Tenn., he was authorized by the Chief of the Weather Bureau, in compliance with the request of President Charles W. Dabney to attend farmers and teachers institutes in the State of Tennessee. His absence from station and his expenses were considered a part of his official duty. Mr. Fulton reports as follows:

From August 17 to 21, inclusive, I was engaged in making lantern slides, enlarged charts, and in preparing other equipment for use in my work. I then attended and participated in institutes, as follows: Boons Creek, Tenn., August 22 and 23; Rogersville, Tenn., August 25 and 26; Morristown, Tenn., August 29, 30, and 31; Jackson, Tenn., September 5 and 6; and Larimore, Ala., September 8 and 9, 1899. In regard to the last named point, I would state that Larimore is located in the northeastern portion of Alabama, near the Tennessee State line. I was assured of a large hearing consisting of farmers from north Alabama and east Tennessee, and, not being otherwise engaged, felt it my duty to accept an invitation to lecture at that point. The institute, which was planned for Lenoir City, Tenn., September 12 and 13, was indefinitely postponed in order to avoid conflict with subsequent arrangements made by the State Commissioner of Agriculture.

The institutes enumerated above, except the one at Larimore, were conducted under the supervision of the Agricultural Experiment Station of the University of Tennessee. I was given a prominent place on all programs and took an active part in the work. Stereopticon views (lantern slides), enlarged charts, and milligraphed notes were used to illustrate and supplement lectures. The work of the Weather Bureau was explained and discussed. Especial attention was given to the Climate and Crop service; Cotton Region service; cold wave and frost warnings, with some discussion of methods of protection from frost; weather and temperature forecasts, and daily weather charts. The institutes, without exception, were largely attended by intelligent and representative farmers. A decided interest was everywhere manifested in the presentations of the Weather Bureau work. In several instances I was requested to extend a unanimous vote of thanks to the Honorable Secretary of Agriculture and the Chief of the Weather Bureau for having thus brought this work before the institutes. Question boxes contained many pertinent queries concerning all phases of the work. It was my endeavor to first explain the methods which the Bureau is employing to aid the farmer, and, secondly, to furnish information that would enable him to derive the greatest benefit from the service. There was every indication that these two ends were ac-