late its own system, if it has any, and give us a chance to see whether either is at all satisfactory as a basis of long-range forecasting? The Weather Bureau is not so wedded to the daily weather map, with its clear presentation of the actual state of affairs and the general drift of the weather for the next few days, but what it would quickly adopt the horoscopes of the astrologer or the cycles of the empiricists if there were the least chance of doing anything with these methods more satisfactory than is being done at the present time. It can not be too strongly stated that up to the present time no man has yet appeared who has shown himself able to deduce all the consequences in weather and climate that flow from the action of the sun's heat upon the earth, the ocean, and the clouds, and until that has been accomplished the study of the infinitesimal influences of the sun spots, the moon, the planets, and the stars, is wholly uncalled for and irrational.

UNIVERSITY RESEARCH AT WASHINGTON, D. C.

The proceedings of the last Convention of Agricultural Colleges and Experiment Stations held in November, 1900, have lately been published as Bulletin No. 99 of the Office of Experiment Stations. There are a number of addresses and discussions that will undoubtedly interest those Government officials who are hoping for the broadest development of university education in order that the various departments may secure the highest type of men to carry on the scientific work of the Government. The committee on graduate study at Washington pointed out the great stimulus that has been given to this subject by the appointment of "scientific aids in the Department of Agriculture," whose term of service is at present limited to two years, and whose maximum compensation is $40 per month or sufficient to cover a portion of the living expenses, while the young men who must be graduates of land grant colleges have an opportunity to show what they can do in the way of original research in lines of work that are important to the Department.

The discussion as to the propriety of establishing a national university or a Washington memorial at the capital has also taken a prominent place at the July convention of the National Educational Association in Detroit, and it has also been brought prominently forward by the Chicago address of the Director of the United States Geological Survey, Dr. C. H. Walcott. Apparently all the practical agitators of this subject are in accord with the ideas published in the MONTHLY WEATHER REVIEW,[1] to the effect that the Government has already long since established its land grant colleges representing in general the under graduate or collegiate department of the proposed national university. It has now only to coordinate the systems of instruction in these colleges by the appointment of a board which may very properly be called the regents of the university. It can then authorize these regents to establish the conditions under which graduates from these, and probably other institutions, may continue their studies in Washington and attain the higher or university degree. In this latter portion of the work the investigators and the laboratories, the museums and the libraries, the literary and legal authorities in the employ of the Government can be utilized, but, of course, many additional facilities must be provided.

The fact that there is often a demand for a man who can do original work rather than for one who knows all about what others have done, suggests that there should be an intimate relation and friendly cooperation between such a national university and the Civil Service Commission.

The address by President Stubbs of Nevada, and especially that of J. K. Patterson, contained in the above-mentioned Bulletin No. 99, emphasize the necessity of a systematic coordination of the courses of study.

[1] MONTHLY WEATHER REVIEW: February, 1898, pp. 63–64; Civil service examinations. December, 1898, p. 548; Civil service examinations for observers in the Weather Bureau. December, 1898, p. 564; Civil service examinations for assistants in the Department of Agriculture. May, 1899, p. 213; Scientific aids in the Department of Agriculture.

INSTRUCTIONS TO THE VOLUNTARY METEOROLOGICAL OBSERVERS OF THE UNITED STATES HYDROGRAPHIC OFFICE.

Under the above title a pamphlet by Mr. James Page, Meteorologist to the Hydrographic Office, has just been published from which we make the following extracts which show the work being done at the Hydrographic Office in charting the weather from day to day in response to the demands of modern meteorology, as well as the tabulation of the data for use in preparing monthly and annual means.

We notice that on page 26 mariners are instructed not to apply the reduction to standard gravity when they use mercurial barometers, but that they may apply an inverse correction to the aneroid. This seems to be exactly contrary to the recommendations of all the international meteorological conferences. Our own experience is that at sea the aneroid is quite as reliable as the mercurial, and of course it needs no correction for gravity.

In the days of Maury, and for some years subsequent to the period of his greatest activity, the common aim of the various institutions engaged in the study of ocean meteorology was to obtain for each unit area of the sea's surface (generally a field bounded by the even 5° parallels and meridians, 5°, 10°, 15°, etc.) a reasonable number of observations of wind, weather, etc., extending over any period of years. The observations were then assembled by months, the average for each month taken, and the result stated as the normal condition for the month, i. e., the condition which the mariner might expect to find most frequently prevailing throughout the given field or square during the given month. Sailing routes were then laid down for the successive months in accordance with these normal conditions, and shipmasters were instructed to adhere to these routes as rigidly as the winds would permit, even when convinced by their own experience of weather changes, as well as by the indications of their meteorological instruments, that better results might be attained by adapting the course of the voyage to the conditions actually encountered.

With the advent of weather forecasting as a science, using as a basis the daily synoptic weather charts, a new importance was attached to the sailor's meteorological observations. It was seen that in taking them he was not only adding to the stock of general knowledge of the climatology of the sea, the value of which to him was future and problematical, but also that he was putting himself in possession of certain special knowledge the value of which might prove absolute and immediate. His last preceding observation revealed a certain existent condition of the meteorological elements, his present observation a more or less different condition. What did the changes which had taken place during the time intervening between the observations foretell? Did the existence of adverse winds in his immediate neighborhood imply better or worse conditions elsewhere? If better, would he not, in this instance be justified in abandoning the route which had been laid down for him as the best under average circumstances, and seeking that which his present observations led him to believe would prove more favorable?

A satisfactory answer to these various questions demands, in addition to a knowledge of the general periodic changes which occur in the several meteorologic elements from season to season, and from month to month, a knowledge of what may be termed the nonperiodic or accidental changes which occur from day to day; of the relation which exists between the simultaneous changes in the several elements and of the effect which a decided variation of pressure, temperature, or wind in any one neighborhood has upon the conditions existing in other parts of the ocean.

To obtain this latter knowledge it is requisite that we have at hand for the purpose of study a series of charts or pictures, as it were, of the weather covering the entire ocean at a given instant of time, taken at regular intervals so brief that we may be confident that no marked change can occur without appearing in its different stages upon several of the pictures in succession. An examination of this series will then serve to reveal what changes have taken place in the interval separating any two of them; to trace the development and progress of any

disturbance of the normal conditions that may have arisen; to compare the conditions of wind and weather prevailing simultaneously at points of the sea more or less remote from each other; to determine the constant relation, if any, which exists between these conditions; to make plain the manner in which a vessel, beset by foul winds, might have been navigated, with the result that these winds would have been avoided, or even been replaced by fair; and finally to instruct the navigator as to the conclusions to be drawn from his meteorological observations, in order that this result may be accomplished.

It was with a view of combining these two equally essential methods of meteorological investigations—the old, having for its aim the collection of a large number of reliable observations to serve as a basis for the study of the climatological changes as they occur from month to month,—and the new, having for its aim the collection of a large number of daily simultaneous observations to serve as a basis for the study of the weather changes as they actually occur from day to day—that the present form of weather report was adopted. It demands but a single observation per day, instead of the twelve demanded by the Meteorological Journal, this large reduction being made in the hope that the number of observers would increase in the same ratio as the services required of them would diminish, a hope which has proved more than justified. This single observation, however, is to be taken each day over the entire globe at the same instant of time, viz, Greenwich mean noon. The local or ship's time of the observation will thus vary with the longitude.

The daily synoptic weather charts.—The next step is the utilization of the observations in the construction of the daily synoptic weather charts.

A suitable series of outline charts of the various oceans having been prepared and dated, one for every day in the year, the observations contained in the report are plotted, one by one, each in its proper position upon the chart of corresponding date. For this purpose a system symbols is employed which shows at a glance the height of the barometer, the direction and force of the wind, the proportion of clouded sky, the nature of the precipitation, whether rain, snow, or hail, the presence of fog, the character of the weather, etc., all precisely as recorded by the observer, with the exception of the reading of the barometer, which is first corrected for initial error, and (if mercurial) for temperature. For the North Atlantic Ocean, the first reports to reach the office, and consequently the first observations to appear upon the chart, are those returned by the westward bound transatlantic liners. These are closely followed by the slower steamships from Europe and the West Indies, and these in turn by the homeward bound sailing vessels. The last reports to appear are those of eastern Asia. These are sometimes as much as a year late in reaching the Hydrographic Office, owing to the practise of holding them until the return of the vessel to the United States. Masters are therefore earnestly requested to avoid this delay by forwarding their observations on reaching their first port. The contingent furnished by the sailing vessels is of the highest value, as the observations taken aboard the latter are free from certain constant sources of error introduced by the speed of steamships.

As the reports from these various sources accumulate, the plotted observations become more and more densely distributed over the chart, each plotting representing the position of an observing vessel at the instant of Greenwich noon and the conditions prevailing in its vicinity at that instant, until in its final shape the chart for each day offers to view a complete picture of the pressure, wind, and weather covering the entire ocean at the hour and minute of Greenwich mean noon of the day in question.

A word as to the value of such a series of charts to the navigator. As is well known, the governing features of the weather in the extra-tropical regions of both hemispheres is the practically ceaseless procession of areas of alternately high and low barometer which move around the earth with varying velocity in a general easterly direction, each accompanied by its own system of winds circulating about the center, the direction of the circulation being cyclonic around the area of low barometer, anticyclonic around the area of high. The synoptic charts of the various oceans enable us to follow up the movement of these areas from day to day, to mark the changes which take place in them, and to study the effect of these changes in modifying the weather. It is from this source that the path followed by each of the several barometric depressions that occur during the month, as given on the Pilot Charts of the North Atlantic Ocean, is derived, the aim in thus displaying the daily movement of the storm centers being not only that mariners may have at hand the means of explaining in accordance with the law of storms the occurrence of any heavy weather encountered, but also that by studying this feature of the Pilot Chart, seeing track after track repeat itself with some slight modifications, they may come to know in what part of the ocean to expect disturbances, what will be their character, extent, and duration, and what the direction and velocity of motion of the vortex.

It is, however, in the light of the assistance with which careful study of these charts will ultimately furnish the mariner in properly interpreting his own isolated observations, that they have their main value. If we look through a series of such charts, the first impression gained is that they are of endless variety, each one being apparently a law unto itself. Close observation, however, will soon reveal certain points of similarity, especially in the position and extent of the areas of high barometer, and consequently in the outflowing winds which surround them, a given distribution of pressure often appearing to hold sway for several days in succession, only to be supplanted by some quite different but equally persistent arrangement. Careful study has thus shown that the daily synoptic weather charts of the North Atlantic Ocean may, with certain restrictions, all be referred to one or another of a limited number of types, each type possessing certain characteristic features, which vary from season to season, and each exhibiting a certain degree of persistency.

It is upon the study of these *types* of weather, their character, duration, and order of succession, that the hope of eventually predicting the weather over the ocean several days in advance rests. Such a study demands that the meteorologist have at hand a series of daily synoptic charts, accurate in every respect, and covering the ocean, especially in the higher latitudes, as widely and as completely as possible, and it is to the merchant marine that he must look for the material necessary for the construction of these charts. Once having attained a knowledge of these types, moreover, the ability of the mariner to forecast the weather from his own isolated observations would be vastly increased. Knowing the type of weather prevailing, his observations of pressure, temperature, winds, and clouds, would gain a new importance, showing whether the type was about to change, and in what direction.

The tabulation of the observations.—Having served their purpose in the construction of the daily synoptic charts, the observations are ready for tabulation. For this purpose the surface of the ocean is supposed to be divided into a number of fields or squares, bounded by the even 5° parallels of latitude and meridians of longitude, 0°, 5, 10°, 15°, etc. The observations are then separated according to months, and all of those within a given square and during a given month (irrespective of the year) are assembled. The next step is to obtain for each month and each square the average temperature of the surface of the sea, the ratio that the winds from each compass point bear to the total number of winds, the average force of the winds, the frequency of the various forms of clouds, varieties of weather and character of the sea, and the average velocity and set of the current. These final values are then carefully tabulated and mapped, and the results given to the seafaring community in the shape of the Monthly Pilot Charts published by the Hydrographic Office.

LUNAR INFLUENCES IN METEOROLOGY.

The admirable elementary treatise on meteorology by Prof. Alfred Angot of the Central Meteorological Bureau in Paris, published in 1899, concludes with a chapter on the prediction of the weather and the regular periodicities that have been sought for in meteorology. After showing that long-range predictions can not yet be made by utilizing any such periods, and that even the sun spots have not yet been shown to have any special influence. Angot adds a paragraphs with reference to the lunar periods, which we translate as follows:

The idea that the moon exerts any influence on meteorological phenomena goes back to the most ancient times; there is no belief that has left more traces in the popular traditions in regard to the weather, nor that has been the subject of more controversy.

Let us recall that the time occupied by a true or sideral revolution of the moon is 27d. 7h. 43m, or 27.322 days; the apparent or synodic period, after which the sun, earth, and moon return to their same respective positions, is a little longer, viz, 29d. 12h. 44m., or 29.531 days, it is after this latter interval that the *phases* of the moon again become the same. The *anomalous revolution* or mean value of the intervals of time separating two consecutive passages of the moon through its shortest distance from the earth, is 27d. 13h. 19m., or 27.555 days. Finally the orbit of the moon has a mean inclination to the ecliptic of 5° 8′ 48″; the maximum declination of the moon, therefore, varies between 18° 10′ and 28° 45′, while the maximum declination of the sun is 28° 27′.

The moon imparts to us only a very small proportion of the light and heat that she receives from the sun; the heat that she sends toward the earth is so feeble that the most powerful instruments and the most delicate methods of measurement must be employed to discover it; there can, therefore, not be any question of a luminous action of the moon and much less of a caloric action, and we can scarcely think of anything else but an attraction analogous to that produced by the tides on the great masses of water of the oceans. It is, therefore, necessary to first seek to discover whether the action of the moon does produce atmospheric tides that show themselves by the periodic variations in the height of the barometer.

If we observe the pressure at the lunar hours, that is to say, when the moon passes the meridian, and she is distant from it 15°, 30°, 45°, etc., and if we take hourly means of the values observed during a very long period of time, in order to eliminate the disturbances, these means