It has also been evident that during periods of abnormal depression in the Bering Sea low area, the Pacific area of high barometer increases in mass and overlaps the southwestern coasts of the United States, producing over a greater or less portion of the region lying west of the Rocky Mountains temperatures below the seasonal average. The warmer weather over central and northwestern Europe that is usually associated with excesses in winter temperature in North America, appears to be in a great measure due to an increase in the magnitude of the Asiatic high area that attends an abnormal depression in the Bering Sea low area. At such times an unusually steep barometric gradient from Asia over Europe, and an increase in the Atlantic high area, cause an undue prevalence of warm southerly winds over central and northwestern Europe, and, coincidently, the augmented Siberian high area causes a sweep of cold north or northwest winds over southeastern Asia.

During the cold months of 1903–4 and 1904–5 an entirely dissimilar distribution of pressure in the great "centers of action" obtained. Pressure was unusually high in the Bering Sea and Iceland low areas, and the magnitude, or extent, of the Asiatic high area was vastly less than during the winters of 1889–90 and 1905–6. The Pacific high area did not impinge on the California coast, and the Azores high area was inconspicuous and unpermanent. The northwestern portion of the American Continent was not subjected to the influence of abnormally low pressure off its western coast and British America therefore became the seat of an area of high barometer from which cold waves were drawn southward in the wake of areas of low barometer that traversed the United States. The absence of the Pacific high area seemed also to contribute to a more southern origin of American storms, and to undue barometric depression and precipitation over the southwestern portion of the country. In Europe, where the winters of 1903–4 and 1904–5 were also cold we look first for the Iceland low area, and find instead pressure much above the normal in that region; the Azores high does not exist in a permanent form. The Asiatic high occupies about one-half the area that marks its limits during the warm seasons in Europe and America. The effect of this abnormal distribution of pressure over Asia and Europe is to cause an unusual prevalence of northwest winds over a greater part of Europe, and to lessen the force of winds blowing from the interior of Asia over the southeastern portions of that Continent.

The above general presentation of a few facts regarding the influence on climate and weather of the dominating "centers of atmospheric action" of the Northern Hemisphere opens or reopens the problem of so-called long-range weather forecasts. Admitting the competency of the evidence submitted regarding the influence upon general weather conditions of abnormal phases of the great centers of high and low barometric pressure, the conclusion follows that a knowledge of the development of these phases would permit legitimate calculations of the results of which they are known to be the associated contributory causes. That changes in the greater areas are consummated with extreme deliberation is a recognized fact. The fact is also presented that these changes can to some extent be followed day by day with present telegraphic facilities. Cablegrams are now available from the seat of the Siberian winter high area and from the Azores region. They will in the near future be available from Iceland and the Alaskan coast, and it will be feasible to transmit them by wireless messages, either from islands of the Aleutian chain, or from vessels taking the Great Circle route across the Pacific. With this information daily available forecasts can undoubtedly be made of the general character of the weather for at least one week in advance. Such general forecasts could specify the character, whether warm or cold, wet or dry, of the weather of the near future, and could indicate the duration and termination, days in advance, of periods of abnormal weather.

Summarized in a general way, the indications afforded for the United States would be about as follows:

Barometer rising and above the normal in the Asiatic high area and falling and below the normal in the Bering Sea low area, and, incidentally, rising over the Azores and falling over Iceland, indicate a period of mild weather over northern and eastern districts of the country.

Barometer falling and below the normal in Asia and rising and above the normal over Bering Sea, and, incidentally, falling over the Azores and rising over Iceland, indicate a period of cold weather over the country generally east of the Rocky Mountains.

The above are but two indications of the many that are afforded by a study of the great "centers of action." Others equally applicable are available for all of the seasons and possess an equal degree of merit.

The main "center of action" in the winter season is the Asiatic area of high pressure, and the character and movements of this great mass appear to control in a measure not only the interrelated actions of the lesser "centers of action," but also periods of weather that persist for days, and the character and movements of areas of high and low barometer that cause the daily changes shown on our weather maps. Furthermore it is believed that a study of the Asiatic high, and the employment of telegraphic reports from the region it occupies, will permit accurate forecasts of the monsoons in southern and southeastern Asia.

FORECASTS AND VERIFICATIONS IN WESTERN AUSTRALIA.

By W. ERNEST COOKE, Government Astronomer. Dated Perth, W. A., January 8, 1906.

From the commencement of 1905 I have adopted a new method in connection with the issue of weather forecasts, and the following statement will probably interest some of your readers.

All those whose duty it is to issue regular daily forecasts know that there are times when they feel very confident and other times when they are doubtful as to the coming weather. It seems to me that the condition of confidence or otherwise forms a very important part of the prediction, and ought to find expression. It is not fair to the forecaster that equal weight should be assigned to all his predictions and the usual method tends to retard that public confidence which all practical meteorologists desire to foster. It is more scientific and honest to be allowed occasionally to say "I feel very doubtful about the weather for to-morrow, but to the best of my belief it will be so-and-so;" and it must be satisfactory to the official and useful to the public if one is allowed occasionally to say "It is practically certain that the weather will be so-and-so to-morrow."

With a view of expressing various states of doubt or certainty, as simply as possible, I now assign weights to each item of the forecast. The signification of the weights was stated as follows, with their first issue:

5. We may rely upon this with almost absolute certainty.

4. We may rely upon this with tolerable certainty, but may be wrong about once in ten times.

3. Very doubtful. More likely right than wrong, but probably wrong about four times out of ten.

2. Just possible, but not likely. If showers are indicated, for example, they will not be heavy even if they occur at all.

1. The barest possibility. Not at all likely.

In order to familiarize the public with the new departure a number of these explanatory slips were printed and attached to the forecasts wherever they were publicly exhibited. Thus a forecast might read as follows:

Southwest district (Geraldton to Esperance.) Fine weather throughout (5) except in the extreme southwest where a few light coastal showers are possible (2). Warm or sultry for the

present inland (4), but a cool change is expected on the west and southwest coast (4), which will gradually extend throughout (4).

The figures (1) and (2) are very seldom used, and then only as above, to indicate just a bare possibility. The figure (3) is occasionally employed for the main forecast, but the general practise is to use either (4) or (5) for the principal weather feature whenever possible, and this has been found practicable on most days. Whenever there is any serious doubt the figure (3) is used.

Great care is taken as to the figure (5). We wish to establish the utmost confidence in predictions followed by this figure and are therefore inclined to be rather conservative in its use. It has, however, been found possible to issue 685 such confident predictions for the two principal districts during the year, and of these 675 were justified by subsequent events.

As our weather comes mainly from the westward, where there are no observing stations, the period for which the prediction is issued is limited to 24 hours.

Two forecasts are issued daily (except Saturday and Sunday) for the Southwest and Goldfields districts, and the following shows the success or otherwise of the new system.

	Southwest district.			Goldfields district.	
	Right.	Wrong.		Right.	Wrong.
Weight 5	435	5	Weight 5	240	5
Weight 4	573	38	Weight 4	337	22
Weight 3	131	38	Weight 3	102	25
Weight 2	24	18	Weight 2	13	11
Weight 1	6	5	Weight 1	5	3

NOTE BY PROF. E. B. GARRIOTT.

For the limited areas covered by our forecasts by States this scheme would be impracticable, (1) for telegraphing our forecasts, owing in part to the great number of words and consequent expense that would be involved in transmitting them; (2) for forecast cards, that would not contain them; (3) for maps, that have not sufficient space to print them; (4) for the reason that the bewildering complication of uncertainties it involves would confuse even the patient interpolator; and (5) because our public insist upon having our forecasts expressed concisely and in unequivocal terms. For general forecasts, that apply to the country as a whole, our present vocabulary can, if properly employed, be made to cover all necessary modifications.

THE RELATION OF FORESTS TO RAINFALL.[1]

By the late W. F. HUBBARD.

[Communicated by Mr. Geo. B. Sudworth, Chief of the Division of Dendrology.]

The relation between forests and rainfall is very complex. It is claimed that the presence or absence of forests may increase or diminish precipitation to some extent, especially in semiarid regions.

On the other hand, forests are dependent upon moisture, and, other things being equal, the densest forests are found in regions of greatest rainfall. It is not the total precipitation of the year that favors vegetation (field crops as well as forests), but the amount that falls during the growing season. Thus a locality may have thirty-five inches of rain annually, but if most of it falls in heavy showers or during the winter, some trees and crops will flourish less than where an annual average of but twenty inches is made up largely of moderate spring and summer rains. Trees are more dependent upon uniformity in the rainfall than the field crops, for if a severe drought comes but once in five years the trees may be killed. It is also true that a crop of grain may be destroyed by the drought, but that is a loss of only one season's growth whereas in the case of the trees it is a loss of the growth of many years. In general it is found that a region having less than fifteen inches of rain during the six growing months, April–September, does not support flourishing forests; trees may grow along the streams and where they are cultivated, but the real forest will be absent.

As rainfall determines the presence or absence of forests, so the configuration of the land and its relation to water bodies and constant winds determine the rainfall. These relations and their effects can be traced in all forest regions of the United States, but they are so clear in the western half of the country that that section may be taken as a type. It should be remembered that moisture is carried in the atmosphere, and that when an air current is forced to rise, as when it meets a mountain range, the air expands, is cooled, and precipitates its moisture first as cloud and then as rain. When a current descends, as from the crest of a mountain, the process is reversed; that is, the air is compressed, warmed, and made retentive of moisture or even capable of absorbing more water from any available source. The western coast line of the United States includes a great curve with the crown of the arc at Cape Mendocino. The rain bearing winds are the west or northwest winter winds. They are also much more constant over the northern half of the coast line than over the lower or southern half, since the latter falls within the region of subtropical calms. All these conditions combine to determine the character of the forests throughout the West and explain why they are dense on the Pacific coast, and on the western slopes of the Sierras and the Rocky Mountains, and why they dwindle on the eastern slopes and fail entirely on the plains.

The accompanying map and profile of California illustrate this subject very thoroughly, because every feature of forest distribution is to be found within this State. The westerly winds striking the Coast Range have their moisture condensed as fog in summer and rain or snow in winter; here are the heavy redwood forests. Passing the summit of this range the winds descend and become drier and drier, finally reaching the great interior valley where no trees grow. Then mounting the western slope of the Sierras the winds expand and cool and rain falls. The increase of moisture is marked by the transition from chaparral to open pine forests, then to denser forests of fir, spruce, sugar pine, and the great sequoia. The upper timber line is at about 10,000 feet; for various reasons no trees grow on the higher summits, but not because of deficient moisture. Passing the summits, the winds again descend to the plains, but they have lost so much of their moisture[2] in crossing two mountain ranges that on the

[1] This paper consists essentially of a large chart of California, showing in detail the distribution of rain and forests in that State. The chart and accompanying text were prepared by the late William F. Hubbard, of the Bureau of Forestry, for exhibition at the Lewis and Clark Exposition held at Portland, Oreg., in 1905. Unfortunately Mr. Hubbard was drowned on July 17, and the text must, therefore, be published without his final revision. The chart represents the work of a very enthusiastic student, and we regret that, owing to the limitation of our space, we are unable to publish the whole of the chart, which is based upon all available reliable data, and affords a basis for many generalizations that the author would doubtless have elaborated had his life been spared.

[2] The air does not lose much moisture in coming over the California mountains, probably not one per cent; but it does lose many per cent in relative humidity.

From another point of view, however, one may say that, on the windward side of our Coast and Sierras ranges, there are more clouds than on the leeward side, consequently the soil and roots do not become so hot at midday, and especially does foggy weather keep them cool; this coolness is quite as important to the growth of a forest as high relative humidity or abundance of rain. In fact if one follows along the course of any one of the belts of forest growth he will find it running over various elevations and rainfall areas in such a way as to show that these two are not alone the controlling factors.

It would increase the value of such charts of the distribution of forests if something could be added as to the species of trees characteristic of the forests. It seems hardly sufficient to say that a dense forest prevails in a certain rainfall region, but a light forest in another rainfall region. Is not the species of tree as important as the density of the forest?—EDITOR.