for Lake Michigan-Huron, about 24.7 inches; for Lake Erie, about 30 inches; for the vicinity of Boston, about 28.5 inches; for Lake Tahoe, Calif., (altitude 6,230 feet) about 22 inches; for Great Salt Lake, Utah (altitude 4,200 feet) about 26 inches.

DISCUSSION

By C. F. MARVIN

Perhaps there is no measurement of a meteorological phenomenon concerning which there is greater diversity of view than prevails with reference to evaporation from free water surfaces. The Weather Bureau, in choosing the present so-called standard type of evaporation pan, fully considered practically all the faulty characteristics pointed out by Mr. Grunsky.

In reaching our decision we are compelled to recognize that the observations must be continued, not for a few weeks or months, but over periods of several years of time, and under the care of observers who are often conscientious enough but, nevertheless, lack the highly trained character of engineers or laboratory physicists whose minds are always alert, as to sources of error and fallacious records. In the case of pans floating in water or pans buried deeply in the ground, it is almost surely a question only of time before an insidious leak develops in the seams, or even in the body of the pan itself, out of which water passes in unknown quantities, always measured as so much evaporation. Maintenance of a proper condition of cleanliness is difficult, unless the pan can be thoroughly washed and rinsed, a process much simplified when the water can be poured out.

Mr. Grunsky's criticism that the Weather Bureau type of pan is so freely exposed to the air, even underneath, that its temperature fluctuates widely, is true, but this construction is one that permits of the discovery of leaks and faults of the apparatus that perhaps might otherwise escape the notice of a careful observer.

Moreover, the conditions that surround the standard Weather Bureau pan undoubtedly lead to a larger quantity of evaporation than that representing conditions over large, free surfaces of reservoirs, lakes, etc. However, this larger evaporation admits of a more accurate measurement, and its subsequent correction is a subtractive reduction of the actual observation, involving in principle a greater accuracy than would otherwise be the case; that is, the engineer in using these data is on the safe side, inasmuch as the evaporation may be really less than that estimated from the observations.

While these remarks are applicable to the Weather Bureau practice, there is a full realization of the decided advantage of making evaporation measurements that require no consequential correction of any kind. However, this concept presupposes that the evaporation characteristic of a given climate is a definite and constant thing for all possible utilization, such, for example, as the water losses from open reservoirs, water losses from vegetation by transpiration, forest cover, etc. Each of these uses of the evaporation characteristic of a given locality is contemplated in the data being collected by the Weather Bureau, and while our results may have a limited value for determining the exact evaporation from a free reservoir surface, they may have greater value for other uses.

RELATIVE FREQUENCY OF CENTERS OF CYCLONES AND ANTICYCLONES IN THE UNITED STATES

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Cyclones and anticyclones are difficult to deal with statistically, hence have not received attention in proportion to their importance as climatic elements. This paper attempts what may be called a "census" of the number of centers that appear in each 5° square of latitude and longitude, at the 8 a. m. and 8 p. m. (eastern standard time) observations, per month and per annum.

In order to eliminate the varying lengths of the months, the monthly data have been reduced to the number of occurrences per 1,000 observations. For the year, the number of centers per annum per 5° square are given here.

The monthly and annual statistics have been entered at the center of each square, and lines of equal frequency drawn. Graphs showing the march of frequency through the year have also been drawn for each square, and these have been transferred to maps of the United States on the Mercator projection, so that each square is of the same width in longitude.

Before enumerating the results of this study, it must be pointed out that these statistics differ from those of Garriott (1) and Kullmer (2), which show the number of centers that passed across the individual squares. The present paper counts only those centers that were in the square at the two daily observations.

The charts and graphs accompanying this paper show that—

(1) The number of centers, of both cyclones and anticyclones, is greater in the interior of the continent than around the margins. Mark Twain, in a famous after-dinner speech (3) has called attention to the variability of New England weather. These charts show more than twice as many centers over the Great Lakes and the Plains as in New England. Success in weather forecasting (4) is negatively correlated with the number of centers, and is at a minimum in the Lake region.

(2) A center of maximum frequency of cyclones exists in Saskatchewan at all seasons.

(3) There is a maximum of frequency of cyclones in the Lake region in July and August, in the West Gulf States in January. The intervening States show two maxima, one in spring, another in autumn, corresponding to the popular tradition of the "equinoctial storm," and also to two maxima of rainfall; e. g. in eastern and southern Wisconsin. Whether there is continuous travel of a "polar front," or tendency to steep temperature gradients, back and forth from the 30° parallel to the 50° parallel of latitude, may be worth investigating.

(4) In winter, a loop of maximum frequency of anticyclones extends from Saskatchewan to the southern Appalachians.

(5) Centers of anticyclones have a maximum of frequency in Oregon and Washington in summer, when the semipermanent anticyclone in the Pacific is at its greatest intensity.

(6) Maxima of frequency of anticyclones appear successively in contiguous regions as follows: July to