sented. This shows annual precipitation data for six long-record stations, geographically distributed from east to west across the country. They include data for New Bedford, Mass.; Marietta, Ohio; Oregon, Mo.; Manhattan, Kans.; Boise, Idaho; and Sacramento, Calif. The record for New Bedford covers a period of 100 years, for Marietta 92 years, and for the other stations 50 years each. The heavy horizontal lines shows the average for the entire period in each case, while the vertical bars indicate the respective annual falls. The superposed curves have been smoothed by the formula,

$$(a+4b+6c+4d+e)/16=c',$$

where c' is an adjusted average for the middle year of the series. This serves to reduce factors purely temporary and emphasizes tendencies extending over several years. It will be noted that in each of these records there is a pronounced tendency to periods of varying lengths of heavier and lighter rainfall, but no evidence of a permanent increase or decrease appears. Had the records covered several hundred years, however, more definite conclusions could be drawn.—*J. B. Kincer.*

ANNUAL PRECIPITATION - LONG RECORD STATIONS

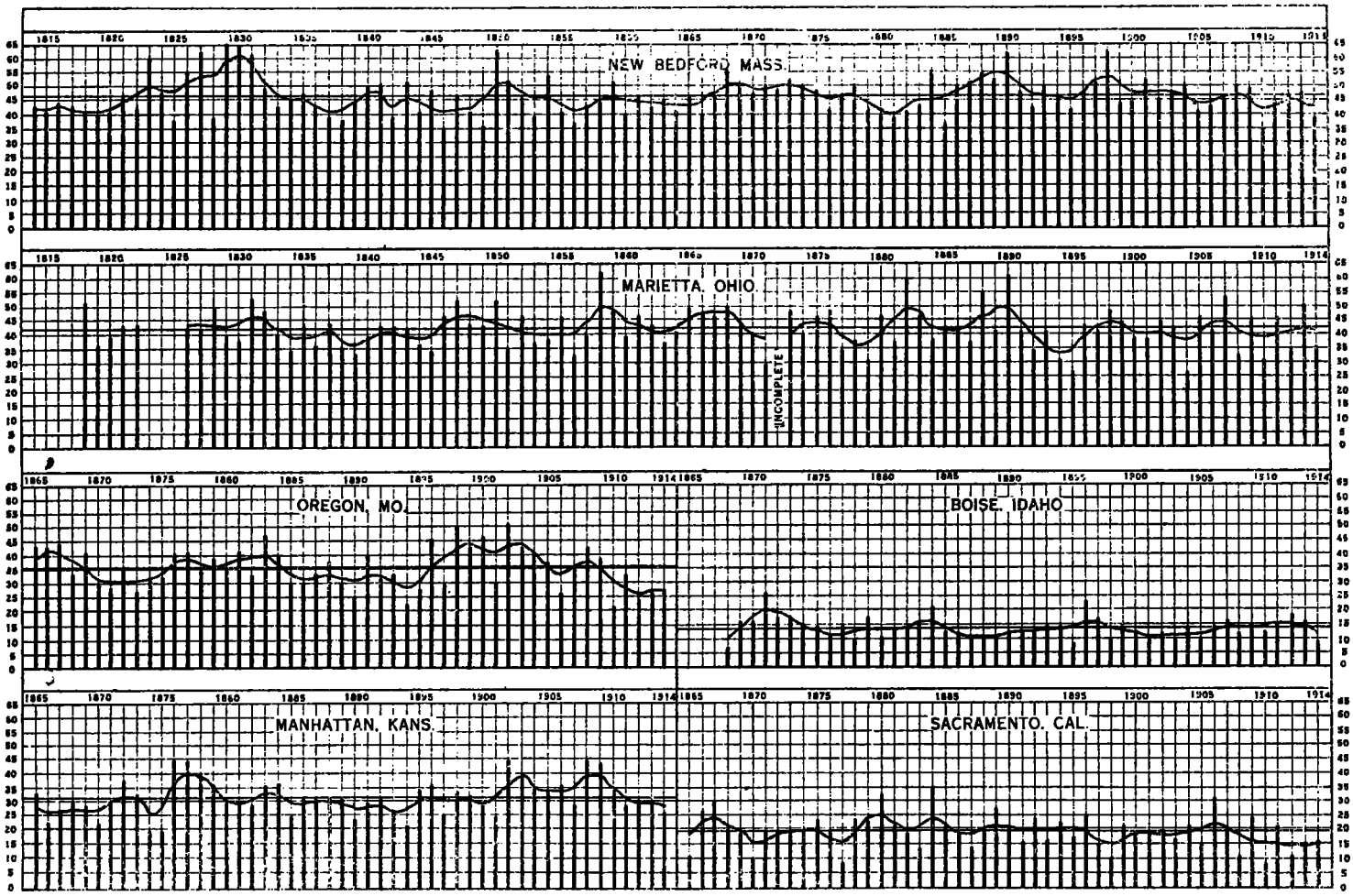

FIG. 1.

A NEW SEASONAL PRECIPITATION FACTOR OF INTEREST TO GEOGRAPHERS AND AGRICULTURISTS.

By ROLAND M. HARPER.

(Abstracted from *Science*, Aug. 30, 1918, pp. 208-211.)

Instead of resorting to the usual methods of correlating rainfall with soils and vegetation, the author has compared the precipitation April to June, inclusive, with that from August to October, inclusive. These data were prepared for several hundred stations, over a considerable period of time. A map was prepared showing the line of equal rainfall in the two periods, and the departures from this equality. The borders of the United States generally fall in the region of late summer excess, while about three-fourths of the country, including the Mississippi Valley, has an early summer excess. The greatest late summer excess is on the east coast of Florida; the greatest early summer excess occurs in the Black Hills.

There are several interesting correlations suggested by such a map. First, the region of greatest tornado frequency is the region of early summer excess, and that of greatest hurricane frequency is the region of late summer

excess. In the regions where the precipitation is about equal there is little damage from wind. Late summer rains generally come as daytime showers, while early summer rains fall more gently and at night. Thus, while the total seasonal precipitation may be equal in two given regions, the economic effects of the difference in amount between early and late summer [or winter and summer] may be considerable. "A warm rain presumably has a greater leaching effect than cold rain or snow, and regions subject to heavy summer rains, like most of Florida, generally have poorer soils and more swamps than where the summers are dry, as in California." Soil appears to be most fertile where the excess comes in early summer, as is evidenced by the fertility of the Mississippi Valley as contrasted with the less fertile soil of Florida.

"The same precipitation factor seems to control indirectly several economic features. For example, most of the developed water powers in the United States are within two or three hundred miles of the line of equilibrium between early and late summer rains, though this may be chiefly because the same topographic factors that make the water power possible also influence the seasonal rainfall in some way. Some correlations between seasonal rainfall and crops are easily made. Alfalfa, wheat, figs, and upland cotton are not raised much where the late summer rainfall exceeds that of early summer by more than three inches, while sugar cane, pineapples, grapefruit, and sea-island cotton thrive where late summer rains prevail. But, of course, the soil [and temperature] have a great deal to do with this, too."

The further correlation of this precipitation distribution with soil, vegetation, etc., in the other parts of the world on such a basis as this would be of interest. Thus, this line of investigation opens a new and a large field, and it is possible "that by shifting, a little, the periods compared, more significant results can be obtained."—*C. L. M.*

NORMAL PRECIPITATION IN UTAH.

By J. CECIL ALTER, Meteorologist.

[Dated; Weather Bureau, Salt Lake City, Utah, Sept. 13, 1919.]

SYNOPSIS.—The precipitation in Utah as shown by about 180 records of 5 to 49 years' length is least in the depressions and greatest on the higher windward slopes of the mountains generally, the amount being about 10 times greater on the higher mountains than on the depressions to windward. The increase with altitude is about 4 inches per thousand feet on the windward or western slopes and about 5.50 inches per thousand feet on the opposite side of the mountain ranges which intercept storm tracks. A slight decrease is shown near the crests, and the increase begins some distance to windward of the mountains. An important nonconformity appears on slopes which are interrupted by important initial barriers, beyond which there is sometimes a decrease and always a change in the rate of increase. The windward sides of intermediate valleys are drier usually than the leeward sides.

Secular variations in annual and monthly amounts are shown to be without uniformity or reliability. Decade means for every consecutive 10 years in several groups of stations show variations amounting to from 15 per cent to 19 per cent of the 26-year means. The stability of 26-year and longer means is shown to be within 3 per cent the addition of any 10 years' record changing the mean no more than this amount. Certain supposedly wet or dry cycles are shown to be of opposite value or absent from a number of months and stations, and the January to May precipitation is shown to be comparatively stable and subject to less fluctuation. Types of monthly distribution are presented.

INTRODUCTION.

The accompanying chart of average annual precipitation in Utah (chart J.C.A. I) has been prepared from all authentic data available at the close of the year 1918, the records having been adjusted as nearly as possible to the 26-year period, 1893–1918, and the interstation interpolations having been made with every practicable consideration for topographic influences.[1]

The records used have been made principally in the settled communities where cooperative observers were available, at an average altitude of about 5,250 feet above sea level, a figure that has not varied materially through any period of years. The number of stations reporting regularly has been about as follows: 1890, 12; 1895, 25; 1900, 45; 1905, 60; 1910, 75; 1915, 110, and 1918, 125. About 180 localities are represented in all, or nearly one-half the number of post offices in the State. The general average annual precipitation is about one-third as much as in Illinois, the dearth being due to distance from the Pacific Ocean, which is the principal moisture source, and to the interception of the moisture-bearing winds by the coast ranges and Sierra-Cascades. The Wasatch Mountain range forms the principal topographic control of precipitation within the State as it intercepts most of the storm tracks at about right angles; its westerly slopes therefore, as well as the northerly slopes of the Uinta Mountains, receive the State's heaviest precipitation. A comparatively heavy precipitation is also wrested from passing storms by the La Sal and Elk Mountains and their surrounding plateau lands in southeastern Utah.

Contrariwise, the depressions over western Utah which formed the bottom of the prehistoric Lake Bonneville (the Great Salt Lake Desert) is the State's most arid region. The slightly higher plains regions of western Utah generally, from which rise numerous ranges of hills and minor mountains, and the broad basins of the Green and the Colorado Rivers in eastern Utah, are also relatively arid, as a rule.

INCREASE WITH ALTITUDE.

The transition from arid to moist conditions is noticeably more gradual on the windward slopes of the major topographical barriers than on the leeward slopes; the 10-to-15-inch zone (chart J.C.A. I) for instance, being much narrower along the east slope than along the west slope of the Wasatch Mountains. This condition is also rather well-defined in the minor intermediate valleys the western portions of which are usually drier than the eastern portions. These valleys as a whole are successively drier to leeward (eastward) than similar valleys located in the more westerly parts of the broad mountain range in general.

The precipitation increase with altitude begins at a considerable distance to windward of the mountain base, and is progressive at a fairly regular rate on the long gradual uninterrupted slopes, until near the summit where it decreases slightly. The geographical area of diminished precipitation, however, is naturally limited and of reduced consequence. The precipitation on the western slope of the Wasatch Mountains at from 7,500 to 8,750 feet altitude is about ten times the amount over the salt deserts 60 to 75 miles to windward.

Compilations of data depicting the increase of precipitation with altitude on the western slope of the Wasatch Mountains for practically all groups of adjacent stations

[1] The author acknowledges the valuable assistance of Mr. C. F. Korstian, forest examiner, in charge of Research, District No. 4, U. S. Forest Service, Ogden, Utah.