PAPERS ON THE REALITY OF METEROLOGICAL PERIODICITIES

I. INTRODUCTORY NOTE

By C. F. MARVIN

It is interesting to present in the accompanying articles the opposing views of two prominent hydrologic engineers concerning periodicities in rainfall and stream flow.

The perplexing question of the underlying laws controlling meteorological sequences can not be disposed of by simple theories. Deductions must follow observational data and be consistent with known physical laws.

Constancy in consecutive values of meteorological data is an unknown characteristic, whether we examine individual values of such groups as monthly, seasonal, annual, or lustrum means, etc. The same is true with data treated by smoothing formulæ. Ceaseless fluctuations in consecutive values is the outstanding feature of the time function of meteorological data. We can not, in advance of suitable summaries of actual observations, safely proceed on the theory that more or less striking fluctuations will not be found in data, even for the entire globe, if appropriate units and summaries are employed.

Every investigation of meteorological sequences encounters at the outset the question: Is the order of succession of values fortuitous and lawless, or is it systematic and controlled, in some slight degree at least?

Mr. Clough[1] has summarized the greater part of what is known of the mathematical characteristics of purely fortuitous data as compared with those displayed by meteorological statistics. The latter, when tested by one or more criteria, rarely fail to show that the order of succession of the natural data differs more or less from a perfectly fortuitous one. This would doubtless prove to be the case with most of the sequences shown by Mr. Streiff, as well as those of Mr. Grunsky. Such being the case, the data call for appropriate interpretation. However, statistical evidence that the order of succession in California rainfall is controlled does not imply that Mr. Streiff's paricular interpretation is necessarily confirmed. If we say the features are periodic, the word period must be very liberally defined to signify recurrences at intervals which may differ in length at least 100% in extreme cases and with variations in amplitude also. No better appellation than "periodicity" has yet been proposed for these irregular recurrences, and a good deal of skepticism about meteorological periodicities is aroused when the sense in which this word is necessarily used is narrowly construed.

The recurrent features develop with greater or less regularity in all classes of data and undoubtedly call for segregation, study, and interpretation.

The Brückner period (25 to 35 years) is so long and so obscure that observations for 150 to 200 years are absolutely necessary to even fairly demonstrate its reality. Nevertheless, evidence of its presence in shorter records can not be entirely disregarded.

A partial harmonic analysis of the California rainfall percentages from 1851 to 1926 gives for the San Francisco and Sacramento values a large, well-defined secular trend, characterized by moderate values after 1850, rising to sustained maximum ratios during the eighties, followed by low minimum values about 1916 and tending to higher values at the present time. This secular trend is quite accurately represented by a 70 or 80 year period, but it would be folly to claim that such a period is real; it is simply a secular trend. The amplitude of any short period around 30 to 35 years is quite insignificant in the central California data, but a period of 20 to 26 years has a relatively larger amplitude of about 15 per cent above or below normal.

The San Diego values are in close accord with those of central California up to 1907, but remained generally above normal thereafter. The secular trend is, therefore, missing. The amplitude of a 36-year period comes out below 15% with crests at 1881 and 1917, whereas the 24-year period has about the same amplitude, the two periods in this short record being mathematically independent.

These results indicate how different and uncertain conclusions are when they are drawn from records of inadequate length.

[1] MONTHLY WEATHER REVIEW, March, 1921, 49: 124-132.

II. THE IMPROBABILITY OF RAINFALL CYCLES

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There has just come to the writer's attention the article by Mr. A. Streiff "On the investigation of cycles and the relation of the Brückner and the solar cycle," published in the MONTHLY WEATHER REVIEW of July, 1926. His conclusions are by no means convincing. The fact is so well known that the annual precipitation on the surface of the earth, taken in its full extent, may be accepted as equal to annual evaporation—if transpiration be included in evaporation in the sense as here used—and that the amount of heat which reaches the earth from the sun year by year varies within such narrow limits, that aggregate annual evaporation, and consequently precipitation, on the entire surface of land and water, when one year is compared with another, may be accepted as constant in amount. There must, therefore, be a more or less complementary relation between those regions in which there is a deficiency of rain in any year (compared with normal) and those other regions in which there is an excess. Moreover, the complementary regions are not persistent in location or area. There is never-ending change, much more likely to be caused by slight variation in ocean currents and ocean temperatures than by activity in the solar chromosphere. Rainfall for this reason is not at all likely to respond to or to harmonize with cycles of solar or planetary influence. This is partially true also of tree rings when they are used as indices to climatic conditions. The growth of the tree is only occasionally, as in parts of California and only when suitably located, an index to droughts and to wet years.

An illustration or two may suffice to show how little dependence can be placed on rainfall and stream-flow records for the deducing of cycles and to show that careless use thereof must always throw doubt upon resultant conclusions. In noting average rainfall conditions throughout California the United States Weather Bureau