single measurements can be made within two or three minutes; summation for longer periods, such as, morning, afternoon and night, is obtainable by a single reading of the clock and a simple multiplication.

B. *The skin thermometer*

This never gives such precise values as those obtained by the thermo-electric method, and in a powerful wind it is unreliable. A thermo-element has been employed at Davos consisting of copper and constantan of which one soldered joint is immersed in a thermos bottle filled with oil (air is also sufficient, but not water) and is in direct connection with the mercury bulb of a sensitive thermometer, which projects from the mouth of the bottle and may be read off there, while the other soldered joint is movable and can be transferred to the surface of the body to be measured. A simple but important provision is that this second narrow and thin soldered joint is extended over a tiny, narrow piece of cork, which hinders radiation and owing to its low conductivity does not remove any heat. Mounted on the same board and in connection with the thermos bottle is a galvanometer with a resistance of 1 Ohm only and a sensitiveness of 10^5, rendering the whole very transportable. With this outfit it is possible to measure on an average to a tenth of a degree centigrade with precision.

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SIXTEEN YEARS OF SNOW-SURVEYING IN THE CENTRAL SIERRA AND ITS RESULTS

551.578.46 (57)

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Snow-surveying under the percentage system as conducted by the Mount Rose Observatory is based upon two fundamental facts: (1) The approximate uniformity of the snow cover over wide areas and (2) the intimate relationship in the western mountains between winter snow fall and the spring-summer flow.

During the 16 years of field work, only two disturbing factors of major importance have been found, viz, (1) premature melting of the snow cover at lower levels and (2) deficiency in normal precipitation during April–July. The former can be determined and measured by means of low level snow courses at the time of the annual snow survey April 1. The probability of the latter and its results can usually be determined by May 1 or at the latest by May 15.

The maximum shrinkage in stream flow due to lack of April–July precipitation is 25 per cent of normal for rivers and 50 per cent for Lake Tahoe. However, the usual revision for precipitation has not exceeded 10 per cent for streams and 20 per cent for Tahoe. A few revisions have been made after the season was over. However, these were based upon principles noticed then for the first time but applicable at the beginning of the season. These revisions are distinguished from those for April–July precipitation by being placed in parentheses.

Six basins are included in the series and are situated on both sides of the range. One of these, the Tahoe, consisting mainly of a lake, is greatly affected by precipitation upon its surface. Another, the Carson, has large diversions above its point of gaging. A third, the Mokelumne, possesses only crest snow survey stations and depends for its outpost estimates upon measurements in the South Yuba Basin, which is separated from it by the wide American Basin. Yet out of 54 forecasts for the entire six basins, 29 forecasts were within 10 per cent of the actual run-off while 14 were within 20 per cent. In the remaining 11, the maximum divergence between snow cover and run-off was only 30.4 per cent.

The following table on comparison of snow cover and run-off will give details and serve as a record of seasonal net snow cover and run-off in the Central Sierra since the snow surveys were established in 1909–10:

Comparison of snow cover April 1 or revised forecast May 1–15 and run-off April–July (per cent of normal)

N. B. Until 1918–19 unrevised snow cover April 1 is used as a forecast. Those revised May 1–15 marked by an R placed before number. Those revised on basis of new data after season was over are followed by Rev., and new estimate in parentheses.

Season	East slope of Sierra								West slope of Sierra			
	Truckee (exclusive of Tahoe), 351,200 A. F.		Lake Tahoe, rise 1.66 feet, 204,180 A. F.		Carson (but subject to heavy diversions), 251,476 A. F. (N. B.—Courses few)		West Walker, 199,366 A. F. (N. B.—Snow courses mostly in East Walker)		South Yuba, 205,442 A. F. (Heads against Truckee)		Mokelumne, 461,486 A. F. (Heads against Carson)	
	Forecast	Run-off	Forecast	Run-off	Forecast	Run-off	Forecast	Run-off	Forecast	Run-off	Forecast	Run-off
1909–10	No forecast until 1921–22 except that for adjoining basin of Lake Tahoe.	65.9	82.7	61.5	No forecast until 1917–18, but compare adjoining Tahoe for similarity.	64.1	No forecast until 1918–19, but notice usual similarity to Tahoe and Carson, adjoining basins to north.	96.6	No snow survey until 1915–16. Then only one wind-swept course until 1918–19.	68.4	Only survey course at Blue Lakes at Crest and interpolation from S. Yuba. Note close correspondence between run-off S. Yuba and Mokelumne though the American intervenes.	68.1
1910–11		190.9	170.4	172.3		176.7		150.6		119.3		120.6
1911–12		52.2	49.7	64.5		42.4		56.2		68.3		50.2
1912–13		56.2	58.2	69.3		57.2		50.9		70.1		65.2
1913–14		144.2	153.8	150.6		162.9		-------		99.5		129.3
1914–15	------------------	92.7	88.2	89.8	------------------	93.3		-------		109.8		122.9
1915–16	------------------	130.9	151.9 (101.9 Rev.)	99.4	------------------	125.7	------------------	119.9	168.4 (148.4 Rev.)	122.2		123.9
1916–17	------------------	101.5	117.4	125.9	------------------	128.7	------------------	106.9	120.7	106.0		115.1
1917–18	------------------	57.6	96.2 (56.2 Rev.)	53.6	100.2 (80.2 Rev.)	55.8	------------------	81.9	85.4 (65.4 Rev.)	69.0	100.2 estimated (80.2 Rev.)	76.2
1918–19	------------------	77.1	R 80.8	72.9	R 83.9	66.6	R 83.0	69.9	R 99.2	80.8	R 83.9	81.6
1919–20	------------------	51.2	R 51.3	56.0	R 70.0	39.6	R 74.8	70.0	R 67.5	57.1	R 68.0	72.4
1920–21	R 96.0	73.7	R 80.0	90.4	R 103.0	78.6	R 102.0	92.4	R 109.0	101.9	R 103.6	98.4
1921–22	R 135.0	117.6	R 121.3	124.1	R 124.8	121.2	R 149.3	121.2	R 141.8	121.3	R 130.0	126.9
1922–23	R 99.4	82.0	R 95.1	94.0	R 85.9	80.2	R 92.0 approximately.	85.3	R 98.6	[1] 99.2	R 81.0 approximately.	[1] 74.7
1923–24	R 15.4	15.0	R −1.9	−3.0	R 26.0	8.9	R 32.6	23.9	R 25.1	28.5	R 32.5	24.1
1924–25	64.2	55.4	80.2	101.2	77.9	75.2	85.1	88.7	62.9 (75.7 Rev.)	104.0	62.9 (83.0 Rev.)	95.7

[1] Data for July lacking, making thus only a 3-month run-off. The inclusion of July would decrease the divergence in the case of the Mokelumne.

AN EXAMINATION BY MEANS OF SCHUSTER'S PERIODOGRAM OF RAINFALL DATA FROM LONG RECORDS IN TYPICAL SECTIONS OF THE WORLD

[This paper supplements that by the same author in Monthly Weather Review, Oct. 1924]

By DINSMORE ALTER

[University of Kansas, Lawrence, Kans., Dec. 18, 1925 [1]]

SYNOPSIS

This is the ninth of a series of papers on the rainfall of the world, and the second on the application of Schuster's Periodogram. In the last application of this method, published in the Monthly Weather Review of October, 1924, periods longer than nine years were investigated. In this one, periods are examined between nine and two and one-sixth years. In the next paper, which is already mostly computed, still shorter periods will be considered. The aim of these investigations is to examine typical sections systematically, so that all facts concerning rainfall periodicities, which are inherently possible in data at the present time, may be established. It is believed by the author that this question requires such a method as the periodogram, through which periodicities and probabilities are shown, entirely free from the personal bias which must affect the judgment when almost any other method is used. At present, it is his belief, the great need is for such a careful examination of data, rather than for theorizing regarding causes. It is only through thus establishing accurate quantitative relationships that the theories regarding causes can be given the sound footing which they require. Naturally a knowledge of causes is the final goal of all research, but any short cut to theories regarding them is too dangerous to use.

The following summarizes the principal results obtained so far.

(*a*) Rainfall periods certainly do exist.

(*b*) There is, in all sections of the world examined, a very marked bias toward harmonics of the sun-spot period, too much so to be merely accidental.

(*c*) It is impossible to say at present whether these periods are constant or varying in length, however, the bulk of the evidence favors the former.

(*d*) It would be too unsafe to make agricultural predictions on the basis of results so far obtained. However, some sections of the world indicate quite strongly that this may be possible in the future.

(*e*) The more nearly a climate approaches a pure marine the more nearly does its periodogram give us definite results.

[1] Since sending the manuscript for publication, an excellent article by Sir Gilbert T. Walker on the periodogram has appeared in No. 216 of the Quarterly Journal of the Royal Meteorological Society. Our conclusions regarding the strength and limitations of the method parallel each other very closely although in general his treatment is the more elegant.—*D. A.*

SCHUSTER'S PERIODOGRAM METHOD OF FINDING HIDDEN PERIODICITIES

Schuster's method is the most careful analytical net which has been devised to investigate the existence of periodicities, hidden from casual inspection by means of accidental errors or by the presence of multiple periodicities. Various attempts have been made to use shorter methods of analysis but all these seem unsafe to the writer, some because real periods may be overlooked, others because they permit accidental periodicities to appear real.

Little summary of the method is necessary here, merely a statement of the equations being sufficient. Given data $q_1 \ldots q_n$, assume any period P_j times the datum interval. Let φ_i be the phase angle for the datum q_i, so that $\varphi_{i+1} - \varphi_i = \frac{2\pi}{P}$. $(\varphi_1 = 0)$

Define:

$$A_j \equiv \sum_1^n q_i \cos \varphi_i; \quad B_j \equiv \sum_1^n q_i \sin \varphi_i$$

$$I_j \equiv \frac{A_j^2 + B_j^2}{n}; \quad \tan \Phi_j \equiv \frac{B_j}{A_j}$$

where Φ_j is the phase of the best sine curve of period P_j at the instant of observation of q_1, and I_j is proportional to the square of the amplitude of this curve. Periods P_j are chosen of lengths such that there is little phase divergence between adjoining ones during the stretch of data, and I_j is computed for each. A curve is then drawn with P's as abscissæ and I's as ordinates.