METEOROLOGY

ON EASTON's PERIOD OF 89 YEARS

BY

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In 1928 C. EASTON published his monumental collection of West European winter data. [1])

This publication was proceeded, already in 1917, by considerations concerning a period of 89 years, deduced from 13 temperature waves of this duration between A.D. 760 and 1916, in these Proceedings. [2]) I arrived at this same period by quite another way and have tested my views by means of EASTON's figures. I give my results in this paper.

Remarkable meteorological extremes, especially of the winter temperature, such as we are experiencing nowadays, appear to have occurred in historical times repeatedly. Instrumental observations during 2½ centuries [3]) reveal the occurrence of time intervals during which extremes accumulate, alternating with intervals during which excessive values are rare.

The investigation showed that, quite in the same manner as nowadays, such accumulations of extreme winters occur when the 11-years sun spot period obtained exceptionally high maxima.

CLAYTON [4]) has remarked that the sunspot activity is characterized by a sequence of 4 strong 11-years periods followed by three faint ones and he supposed therefore a long period of seven 11-years periods or 77,7 years. This regularity, however, is nowadays no longer present and my investigations led me to surmising that we have to do with a long period of eight 11-yearlies, exactly EASTON's period. EASTON himself had seen this connection between his period and the 11-years solar period. He had divided his period in 4 parts, each of 22¼ years, suiting two sunspot periods, each part with its own characteristic temperature averages.

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[1]) C. EASTON. Les hivers dans l'Europe occidentale, Leyde (1928).

[2]) C. EASTON. Periodicity of winter temperatures in Western Europe since A.D. 760. Proc. Kon. Akad. v. Wetensch. Amsterdam **20**, 1092—1107 (1917).

C. EASTON. Afwijkingen en periodiciteit der wintertemperaturen in West-Europa sedert het jaar 760. Versl. Kon. Ak. v. Wet. Amsterdam **25**, 1119—1134 (1917).

[3]) A. LABRIJN. Het klimaat van Nederland gedurende de laatste twee en een halve eeuw. Med. en Verh. Kon. Ned. Met. Inst. De Bilt **49**, (1945).

[4]) H. H. CLAYTON. Solar cycles. SMITHS. Misc. Coll. Washington, **106**, nr. 22 (1947).

In order to investigate the accumulations of extremes I have characterized them by means of the standard deviation [5]).

Intervals with large standard deviations must alternate with intervals with small ones. The results arrived at were hopeful, but the interval with instrumental observations was too short. To test the surmized period it is necessary to investigate EASTON's data. His character figures have by no means the same evidence as those of thermometer observations. Yet, EASTON having spent much care on his character figures, it seemed to be the wrong way to neglect his work because they do not suit modern claims. Moreover, is it not the task of the statistician to draw the best conclusions from insufficient data?

My research started with the year A.D. 1205, the first year of EASTON's uninterrupted series, containing up to 1917 eight periods of 89 years.

Yearly overlapping 11-years average values of EASTON's character figures were calculated. Each average was inscribed at the central year (the sixth) of the group of 11. The deviations of the observed values and these averages were calculated and from these deviations, again for overlapping 11-years groups standard deviations were determined. These standard deviations are not wholly identical with those of theoretical statistics, because the averages are changing continually, but confusion is impossible.

The results are represented in the figure by 8 curves, each of 89 years. The starting year of each period is indicated at the left hand side of each curve. The beginning of the 9th period (1917—1949), calculated by LABRIJN [6]) for De Bilt, has been added. Moreover the average range of the 89-years period for 1205—1916 has been represented in the figure (curve *m*). The average value of the standard deviation for the whole interval (15,5) has been drawn as a straight line in each curve.

The average curve (*m*) shows a fairly regular shape. It may divided without objection in 4 equal parts, each of two 11-years periods.

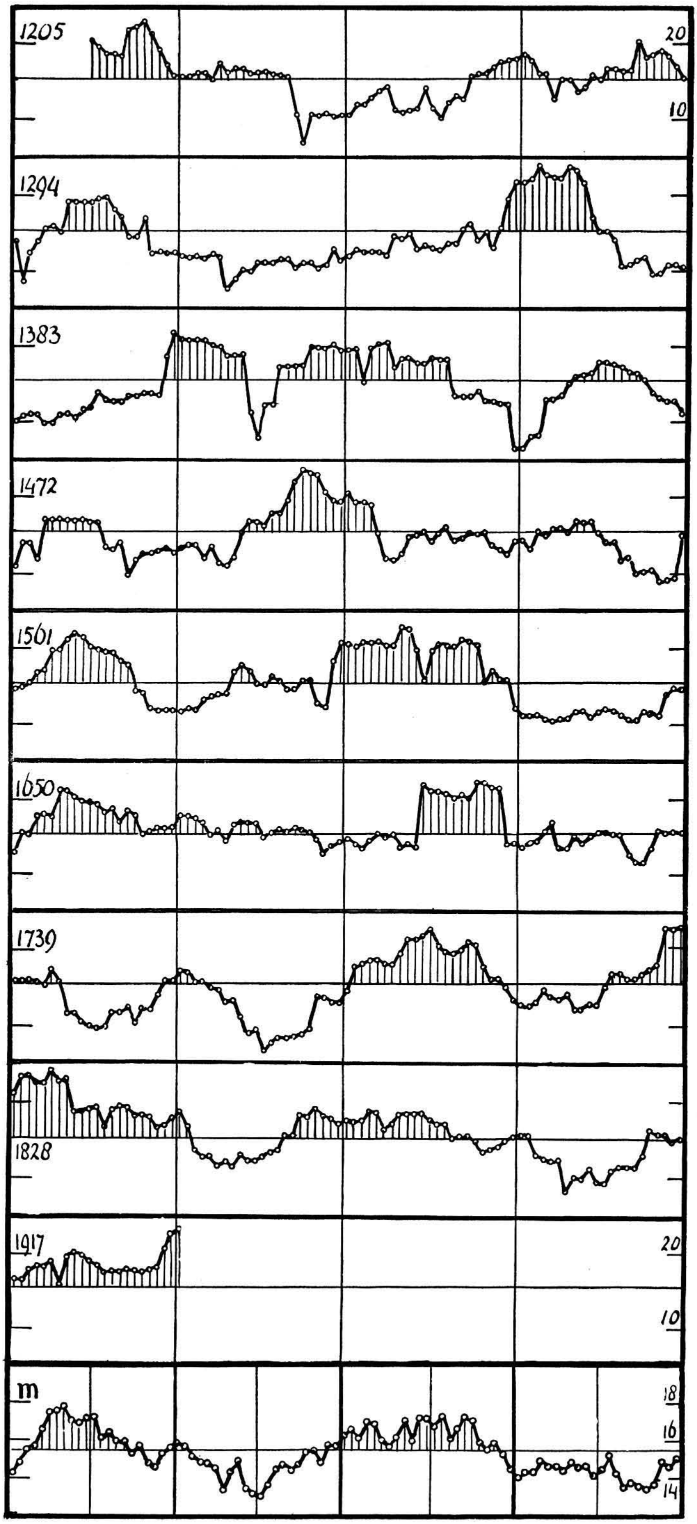
The first and the third parts are characterized by high standard deviations, the second and the fourth parts by low ones. The limits between high and low values coincide fairly well with the limits between the four parts; only at the end of the first part a small irregularity is present. The amplitude of the first half of the whole period is distinctly larger than that of the second half.

Though these features in each of the eight curves are not as clearly developed as in the average curve, yet they show obviously common traits, especially since A.D. 1561.

[5]) S. W. VISSER. Les taches solaires et la météorologie, III Les hivers extrêmes. Ann. de Géoph. Paris, **5**, 74—82 (1949).

S. W. VISSER. Een verband tussen zonnevlekken en strenge winters, Statistica **3**, 92—100 (1949).

[6]) A. LABRIJN. Ts K.N.A.G. **64**, 307 (1947). The years 1948 and 1949 have been added with the aid of data, received from the Roy. Neth. Met. Inst. at De Bilt.


1205
20
10
1294
1383
1472
1561
1650
1739
1828
1917
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10
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14

Probably the tops may advance or retard in the same manner as f.i. the meteorological seasons may deviate from their average epochs.

The strongest argument for the physical reality of the period of 89 years is its concordancy with the 11-years sunspot period.

The first year of the long period was since the beginning of the 18th century a sunspot maximum year: 1739, 1829, 1917. We may surely accept that the same has been the case before and so we can fix the sunspot maxima since 1205.

For the years with instrumental observations a high correlation has been revealed between the standard deviations of the winter temperature and the deviations of the long solar period (for the years 1831—1937 I found for Prague a correlation coefficient + 0,74, for De Bilt + 0,82).

Now finding periodically shaped standard deviations of winter temperatures since A.D. 1205, pointing to periodical accumulations of extreme winters, it is allowed to ascribe these accumulations to a solar-activity period with a duration of 89 years or eight 11-years periods.

Concerning the occurrence of extreme winters, the 11-years maxima behave differently according to their situation in the 89-years period; they coincide resp. with normal, high, normal and low standard deviations (see the m-curve in which the 8 maxima are indicated by vertical lines). The same applies for the sunspot minima; here, however, the succession of standard deviations is high, high, low, low. This conclusion is important; two succeeding 11-years sunspot minima may occur during high intensity of the long solar period. The consequence is extreme winters coinciding with sunspot minima and this means a solar influence on atmospheric phenomena independent of the common 11-years period. Recently BURGAUD [7]) has arrived at a similar conclusion when investigating solar influences on disturbances of terrestrial magnetism.

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[7]) M. BURGAUD S. J. Eruptions chromosphériques, crochets et perturbations magnétiques à début brusque. Ann. de Géoph. Paris, 3, 264—281 (1947).