Huygens Institute - Royal Netherlands Academy of Arts and Sciences (KNAW)

Starting from 4-bromo-2-amido-*m*-xylene prepared according to Nolting[1]), we obtained 4-5-dibromo-2-amido-*m*-xylene by bromination and from this 2-4-5-tribromo-*m*-xylene was prepared according to Sandmeyer.

6. Finally, tribromo-*p*-xylene was prepared according to the subjoined scheme.
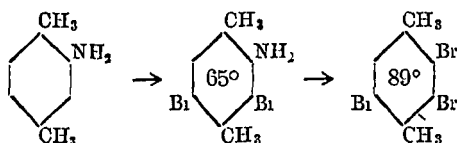
Consequently all six tribromoxylenes had been obtained.
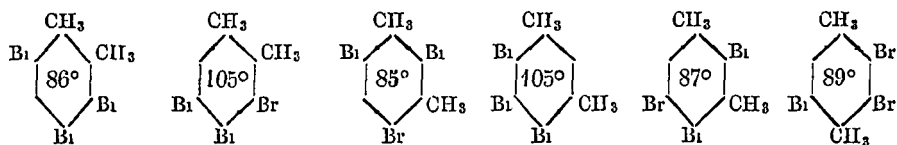
We wish here to express our thanks to Prof. Franchimont, who kindly presented us with the specimens for this research.

Zaandam,
Amsterdam, Juni 1905.

Meteorology. — *"Oscillations of the solar activity and the climate".* (Second communication[2]). By Dr. C. Easton. (Communicated by Prof. C. H. Wind.)

(Communicated in the meeting of May 27, 1905).

At the end of the first communication on this subject the supposition was started, that the 11-year oscillation of temperature with regard to the eleven-year cycle of the sun's activity generally was accelerated in the cold, retarded in the warm part of the larger oscillation. In order to investigate this matter more thoroughly, I proceeded as follows:

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[1]) Ber. 34, 2261.

[2]) See for the First Communication: Proceedings of Nov. 26, 1904, p. 368. In that paper p. 372 read 89-years instead of 178-years. Furthermore strike out what has been said on p. 369 about the experiment of Savélief.

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The *observed* maxima of the eleven-year cycle were placed one beneath the other, beginning with the greatest positive deviation of the observed Maximum and ending with the greatest negative one.

Afterwards the cold-factors found for these periods were put in their places on both sides of that line of the Maxima, the dates being recorded accurate within a quarter of a year. Of the series thus obtained those before 1750 were provisionally left out of consideration: they are much less reliable, according to WOLF and NEWCOMB. The rest was divided into three groups (taking as limits the deviations + 0.4 and — 0.4 years): group A showing as a rule a strongly positive deviation from the maximum, group B containing small deviations in both directions, in group C the deviation being on the whole strongly negative. The mean deviation in group A (3 eleven-year cycles) is + 1.5 years, that in group B (3 cycles) 0, that in group C (6 cycles) — 1.7 years. For each group the cold-periods which fell in the same vertical column, were combined and the three rows of numbers thus obtained were smoothed.

The following rows (Table I) show the result; M means the place of the observed maximum, m and m_1 the calculated normal minima on both sides.

TABLE I.

Acceleration or retardation of the cold wave with regard to the sun wave.

A	8	10	4	0	0	3	7	5	2	6	9	5	3	5	7	6	2	4	10
B		8	3	6	9	7	6	3	0	1	2	0	0	5	10	5	3	6	6	8
C		4	7	9	10	21	26	15	6	5	13	17	7	3	11	19	17	8	7	12

<div align="center">

m M m_1

</div>

No conclusions can be derived with any certainty from this table. Here again we find some indication of a distribution of the winter-cold, within the 11-year cycle, different for the warmer and the colder periods. Still however the curves B and C rather suggest a correlation of the minimum of the sun wave with the Maximum of the cold-wave. An other investigation seems to point in the same direction. It was made by the method explained on p. 372 of our First Communication[1]); it merely differs in so far that only the cold-factors since 1615 were included. We thus obtain the following table as a counterpart of Table II of the First Communication:

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[1]) Table II of the First Communication is based on a 356-year period; of such periods, 3 are available. Each value given in that table represents therefore a frequency for 3 years. The values that follow hereafter represent a yearly frequency.

TABLE II.

Wintercold and phases of the 11-year suncycle since 1615.
(Groups from cold to warm).

	A	B	C	D
m	1.33	0.14	0 21	—
ap	0.77	0.25	0.44	0.26
M	0 42	0.36	0 21	—
dp_1	0.27	0.46	0.21	0.20
dp_2	0.32	0.53	0.21	0.13

There is, it is true, a strong elevation about the time of the minimum in the coldest group and a small elevation at ap in the warm one, but nothing is left of a curve corresponding with the 11-year one. This table does not confirm Table II of the First Communication. For the rest its value is only small, because the material, though purer, is so scanty : in 26 eleven-year cycles only 51 observed cases of severe or very severe winters are available.

The telluric perturbations thus seem to be so strong that, though they cannot cause the disappearance of the greater fluctuation, they practically abolish here the 11-year cycle, such at least is the case for the data at present under discussion. With regard to the supposition at the end of the First Communication, our conclusion therefore must be that the result of a more thorough investigation of all the available data is negative.

We have already remarked that there appears only a very incomplete correlation between the frequency of the sun spots and the oscillation of the temperature. The correspondence became only somewhat more apparent if, for the cold winters, we combined four 89-y. periods in one of 356 years. However the indication of parallelism obtained between the periodicity of the severe winters and that of the quantity M—m of the sun's oscillation, leads us to consider more closely the other elements of the sun's oscillation. For a long time it has been well known that the maximum of an eleven-year cycle as a rule succeeds the minimum the faster, the higher the wave.

As the amplitude of the sun's period must be restricted within certain limits, this might be supposed to mean that the steepness of the ascending phase represents the only variable element in the sun's oscillation and that the minimum thus would remain constant, at

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least would not be displaced systematically. In that case indeed a very high wave of the sun spot curve would have to coincide with an abbreviation of the normal ascending - phase. When we examine the oscillation more closely, however, it soon appears that the place of the minimum varies systematically. We are thus led to inquire, whether for a comparison with telluric oscillations just this acceleration and retardation do not present real advantages over the other elements of the sun's activity. As by no means the observed deviations of the maxima and minima always agree in amount and direction, I investigated separately :

1. the deviations of the maximum,
2. those of the minimum,
3. those cases in which the deviations of M and m have the same sign. Where such is not the case, we should not attribute it to errors of observation without additional proof. However, case 3 will show the most pronounced deviations of the oscillations. The investigation was made *first* using the whole of the available materials; *second* excluding all periods before 1750 (that is of the least reliable observations). As the result did not deviate very strongly, only those of the last mentioned investigation are here communicated.

Meanwhile it seemed desirable to use not only NEWCOMB's list, but also the data as given by Prof. A. WOLFER [1]), because relatively small deviations in the observed values may already have an appreciable influence. In this case also the difference of the results was fairly small.

For the following tables I used WOLFER's data as a basis ; only in the IVth it was deemed necessary to communicate also (in parentheses) the result obtained from NEWCOMB's data.

In the tables III and IV, column 1 shows the groups of the periods, arranged according to the amount of the deviations beginning with those that are largest positive; column 2 contains the numbers of 11-year cycles ; 3 the mean amount of the deviations; 4 the quantity $M-m$; 5 the length of the period ; 6 the mean of the Relativ-Zahlen (according to the smoothed table of WOLFER), in parentheses I placed the means of the highest elevations of the curve ; 7 the cold-factors (yearly frequency). Table V column 3 shows the mean deviation as computed from the two phases.

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[1]) A. WOLFER, *Astron. Mitteilungen*, XCIII, 1902.

TABLE III.

11-year periods, arranged according to the deviat. of the max.

1	2	3 M	4 M—m	5 L	6 R.-Z.	7 Cf.
A	4	+ 1 4	5.9	11.3	32 8 (64)	0.33
B	4	— 0.4	4 4	11.2	47.7 (103)	0.31
C	4	— 3 2	3.5	11 1	60 3 (128)	0 59

TABLE IV.

11-year periods, arranged according to the deviat. of the min.

1	2	3 m	4 M—m	5 L	6 R.-Z.	7 Cf.
A	4	+ 0.8 (+ 0 7)	4.7 (4 5)	10 5 (10 9)	46 5 (91) [43 2 (90)]	0.27 (0 29)
B	4	— 0.1 (0)	4.7 (4 3)	11 2 (10.7)	41.8 (90) [54 1 (111)]	0.38 (0.40)
C	4	— 2.2 (— 2.0)	4.4 (4.9)	11 9 (11 8)	52 5 (114) [43.6 (94)]	0.57 (0.51)

TABLE V.

11-year periods, arranged according to mean deviat. of both min. and max.

1	2	3 m. and M.	4 M—m.	5 L	6 R.-Z.	7 Cf.
A	2	+ 1.6	5 8	10.6	35.4 (66)	0 35
B	2	— 1.0	3 9	10.7	54 2 (114)	0.50
C	2	— 4 0	3 1	11 4	66.3 (142)	0.70

These tables show that the variation is least apparent in the length of the period, ·furthermore that the deviations in the position of the maximum of the period (as was to be expected) agree well with those of the Relativ-Zahlen and of the quantity M—m; finally that this correspondence is less satisfactory for the deviations in the position of the minimum, which however agree well with the modification in the cold. factors. In Table III, it is true, the largest cold factors coincide with the largest deviations of the other elements of the

sun's activity, but the course is irregular (the list which also contains the periods before 1750 shows the same peculiarity).

It appears from Table IV that the correlation of the course of the coldfactors with the deviations of the minima is evident according to Newcomb's data as well as to those of Wolfer.

When we consider only those periods however, where the deviations of m and M are of the same sign, we find correlation between *all* the elements of the sun's activity and the cold factors. (That the extension is so small, proves that the acceleration of M and m is rather to be explained as an acceleration of the whole period). Unfortunately, if we leave out of consideration, as in Table V, the data which must be considered insufficiently reliable, the materials becomes so limited that the result can prove but little, and can only be considered as a strong indication.

In the preceding investigation the periods have not been chronologically arranged; it was not possible therefore to find any evidence of a periodic modification in the deviations of the sun's oscillation. According to our former results, however, we may expect that these deviations will generally correspond with the great periodic wave. To test this point the 11-year cycles have been arranged according to the adopted 89-year period; the deviations have been compared with the cold factors found for each period. An arrangement corresponding with the computed maxima seemed preferable to an arrangement corresponding with the minima, because of the previously indicated acceleration of the strong cold waves, beyond the observed solar minimum.

In Table VI*A* the vertical columns represent the eight 11-year cycles contained in the 89-year period; the first begins in 1648; in the 23$^{\text{d}}$ and 24$^{\text{th}}$ square however I placed the periods 1626—1637 and 1637—1648, the periods since 1894 being of course not yet available. In each square the uppermost number represents the deviation of the maximum, the second the deviation of the following minimum according to Newcomb. Where the sign $+$ or $-$ follows the number, the deviation amounts to at least half a year, either in the positive or the negative direction. A 0 indicates a smaller deviation. The lower number gives the total of the cold factors between two consecutive maxima. Those phases to which Newcomb assigned a weight smaller than 3, have been placed in parentheses.

Table VI*B* contains the same data according to Wolfer; however, in the last square but one I have here written down the observed phases 1894 and 1900.

TABLE VI.

Deviations of M and m and cold factors in the 11-year cycles, arranged according to the 89-year period.

A. Newcomb.

I	II	III	IV	V	VI	VII	VIII
(+0 2)0 (—0 3)0 4	(+0.1)0 (—0 4)0 10	(+4 0)+ (+1 9)+ 2	(+2 9)+ (+0 8)+ 3	(—0 3)0 —1.8— 4	+1 1 + +1 0 + 3	+2 7 + +1 4 + 4	+0 8 + +0 8 + 1
+0 9 + +0 6 + 4	+1.1 + 0 0 3	+1 4 + —0.1 0 7	—1 3 — —1.9 — 3	—2 8 — —4.1 — 9	—4 4 — —1.5 — 5	—0 6 — —0 6 — 6	+1 1 + +0.9 + 1
+1.9 + +0 4 0 4	—0.8 — —0 5 — 5	—0 5 — +0.6 + 4	0 0 +0 4 0 3	+0 2 0 +0.1 0 6	+0.2 0 +0.2 0 3	—0.5 — +1 0 + 1	+1 9 + +0.8 + 1

B. Wolfer.

I	II	III	IV	V	VI	VII	VIII
(—0 6)— (—0 1)0	(—0 6)— (—0.2)0	(+3.3)+ (+2 1)+	(+2 2)+ (+1 0)+	(—0 9)— (—1.7)—	+0.5 + +1 2 +	+2 1 + (+1 6)+	+0 3 0 (+0.9)+
(+0 4)0 (+0.8)+	+0.9 + —0 2 0	+1.0 + 0 0	—1 9 — —2.1 —	—4 2 — —4.1 —	—5.6 — —1 6 —	+0 4 0 —0 5 —	+0 5 + +1.1 +
+2.9 + +0 6 +	—0 9 — —1 0 —	—1 1 — +0.4 0	—0.2 0 +0.4 0	—0 8 — +1 0 +	+1 4 + +0 5 +	+0 5 + +1 3 +	(+1 0)+ +1.0 +

In order to bring into greater evidence those cases, in which the deviations are most decidedly indicated, I give in table VIIa, for the whole of the three last 89-year periods, the numbers of + or — (following the amounts) which remain, when I take together the signs of the same vertical column.

Furthermore I computed the sum of the amounts in each vertical column, both excluding and including the values in parentheses, taking then the mean amount for each phase (VII, b^a and b^b).

Table VIIc gives the elevations of the Relativ-Zahlen-curve computed from WOLFER's table in the following way : the mean was taken of the three highest yearly means on both sides of the Maximum ; the series of numbers thus obtained (nearly two complete series since 1750) were placed one beneath the other; then the means of these values were again computed.

The curve c^1 was then obtained by placing against the rotation

number of the period the means of the last mentioned numbers taken in pairs (viz. the means of the maximum at the beginning and at the end). For the curve c^b the preceding maximum value was written down in the same place.

In table VIId have been inserted cold factors as combined in each column for the three last 89-year periods.

Table VIIe^a shows the sum of the cold factors between the computed maxima of the 11-year cycles, obtained by addition of all the 89-year periods elapsed since 848. They are nothing else than the totals of Table I in my first communication about this subject (in e^b I gave a greater weight to the most recent data, see p. 163).

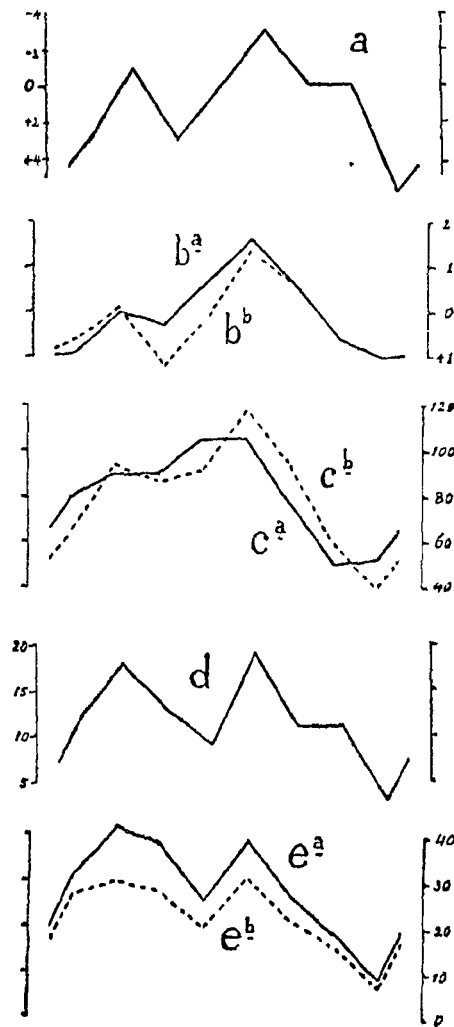Figure I is a graphical representation of the curves of Table VII.

Fig. I. 89-year period.
a—c : Sun's activity.
d—e : Climate.

TABLE VII.

Deviation in the elements of the sun's activity, and 89-year oscillation of the climate.

	I	II	III	IV	V	VI	VII	VIII
a Direction of deviation.	3 +	1 —	3 +	0	3 —	0	0	6 +
b_b^a Amount of deviation.	{ + 0.9 + 0 6	0 — 0.1	+ 0.3 + 1 2	— 0 7 + 0 1	— 1 6 — 1 4	— 0.6 — 0 6	+ 0.6 + 0.6	+ 1.0 + 1 0
c_b^a Rel. Zahlen.	{ 79 65	90 94	89 87	105 92	106 118	77 94	50 61	52 40
d Cold factors 3 Per of 89 years.	12	18	13	9	19	11	11	3?
e_b^a Cold factors All the 89-year Per.	{ 31 27	41⁵ 30	38 28	26 20	39 31	27 22	19 16	9? 7?

All the curves show a corresponding course; the correspondence of the curve of the cold factors with that of the deviations *in time* of the sun waves is certainly as well indicated as that with the deviations in height. As was to be expected the correspondence does not extend to details, but the strong depression in an interval of 8 eleven-year sun cycles is apparent in all the curves.

In conclusion a few words on the apparent general increase of the coldfactors during the last centuries, which might be inferred from table I in my First Communication. Does it justify us in assuming a secular refrigeration?

In my opinion there is no reason for such a conclusion; it seems more probable that it must be explained provisionally at least by the incompleteness of the data for the earlier centuries. The numbers of winters which have a weight 5 according to KÖPPEN are distributed as follows over the different centuries (the material for the XIXth century is not homogeneous with that for the preceding ones).

Before the year 800	4	winters.
In the	IX century. . . .	7	,,
,, ,,	X ,, ...	5	,,
,, ,,	XI ,, ...	7	,,
,, ,,	XII ,, ...	7	,,
,, ,,	XIII ,, ...	10	,,
,, ,,	XIV ,, ...	6	,,
,, ,,	XV ,, ...	15	,,
,, ,,	XVI ,, ...	16	,,
,, ,,	XVII ,, ...	21	,,
,, ,,	XVIII ,, ...	19	,,
,, ,,	(XIX) ,, ...	(16)	,,

There is no evidence of a smooth course, but rather a sudden increase about the XIVth or XVth century. If there was any question of slowly increasing refrigeration, this would appear most clearly between the XVth and XIXth century, the material being more complete during this time.

For the three 356-year periods treated in Table I, First Communication, the numbers are: 25, 37 and 66. When treating this table with the weights 4, 6, 10 for the 1st, 2nd and 3rd "great period" we obtain for the totals (see Table VII and fig. 1, f b):

I (848—1203)	1.6	4.8	2.0	2.4	2.8	2.0	0	0.8
II (1204—1560)	1.8	6.9	10.8	3.6	5.4	3.6	4.8	1.8
III (1561—1916)	24.0	18.0	15.0	14.0	23.0	16.0	11.0	4.0
Total	27	30	28	20	31	22	16	7

In the recent material the depression about the middle of the 89-year period is pretty evident; we must remark however that it is not to be found in the even 89-year periods of Table I; the totals for the even periods separately become:

$$14, 17, 11, 12, 11, 10, 4, 3.$$

This may be attributed of course to a 356-year period, in which, as appears from the table, the third 89-year subperiod is strongly anomalous.

I will now try to summarise the main results of the investigation contained in these two communications.

We have seen — particularly when investigating the 11-year cycles, leaving out of account their connection with any longer period — that the purer our data the more evident the correlation between modifications of the sun's activity and the deviations of the climate. In the same degree however these data become more scanty and the accidental deviations might perhaps have a predominant influence for this reason.

' In these circumstances the first of our final conclusions must be this : our data are insufficient for any rigid proof. In regard to each several part of the investigation, we can at most qualify them as strong indications.

For some points, however, these indications *taken together* are so strong that they may be considered convincing. Such is to my opinion first, the existence of a fluctuation, both in the activity of the sun and in the climate, larger than the well known 11-year cycle of the sun spots.

This conclusion, though very probable, would not seem to be demon-

strated, if it rested exclusively on the data about cold winters. (Table I First Communication).

A purely accidental coincidence becomes inadmissible however, now that we have found a similar fluctuation in different elements of the sun's activity, the more so, where the possibility — nay probability — of a causal connection between the two phenomena is obvious. This conclusion is strengthened by the correlation between the sun's activity and the temperature in tropical regions, found by Köppen and Nordmann.

On the other hand the exact nature of these fluctuations cannot yet be established.

The parallelism of the frequency of cold winters and the Relativ-Zahlen is most strongly marked, if we take as a basis the period of 356 years=32 eleven-year cycles (see fig. I of our First Communication).

Moreover we find both in the sun's activity and in the climate indications of a shorter period. Meanwhile it is only the 89-year periodicity which appears clearly in our data.

The matter may perhaps be cleared up by hypotheses about the physical cause of the oscillations (hypotheses into which I have not entered here). Therefore, what may be considered sufficiently demonstrated about the nature and the length of the periodicity, comes to this: Retardation and weakening of the 11-year suns' oscillation together with a diminution of the number of cold winters every 89 years.

Moreover it seems sufficiently certain that strong deviations from the "normal" 89-year oscillation occur at the same time in the sun's activity and in the climate. They are perhaps caused by the existence of a still longer period (see for instance the considerable acceleration and increase of the sun's oscillation in the latter half of the 11th 89-year period — second half of the 18th century — and the exceptionally high cold factors of that time).

Finally we may conclude from the whole of our investigation, and this is perhaps the most important conclusion: that in connection with meteorological phenomena, not only the frequency of the sun spots, but also other elements of the sun's activity curve deserve our attention.

Of course the possibility of a prediction of certain characteristics of the weather, long in advance, with a considerable degree of probability, is contained in our result.

Also its importance for explaining geographical and geological phenomena is obvious. I do not now wish to enter into details about these matters.