

Expectancy of Clear Days in the Central Zone of the Total Eclipse of the Sun June 30, 1954, in Sweden

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Abstract

The occurrence of the total solar eclipse in 1954, visible in southern Sweden, has raised the question regarding the cloudiness conditions which may be expected in this part of the country at the time of the eclipse. A detailed investigation of the average sunshine conditions at Swedish stations situated along the track of the totality has therefore been made. From this is concluded that the coastal regions are decidedly more favourable than the inland. A comparison between the western and eastern coasts leads to the conclusion that the average cloudiness at 14^h, the hour of observation nearest to the totality, is slightly higher on the West coast than at locations on northern Öland and southern Gotland. Regarding the number of clear sky days at different places the coasts are also more favourable than the inland, and of those the northern part of Öland seems to be considerably more favourable even than the outer part of the West coast. The statistics refer to observations at 14^h June 20—July 10 in the years 1931—1950.

It is evident from the maps of average daily cloudiness and sunshine in Scandinavia 1887—1900 by H. E. HAMBERG (1908) as well as from recent maps based on observations 1901—1930 that the coasts and the sea off both the West- and the East coasts of Götaland along the track of the eclipse on June 30, 1954 (GRÖNSTRAND, 1950) are more favourable, or statistically seen, less unfavourable for astronomical observations than the interior of the country.

The reversed daily variation of the cloudiness at inland stations and at coastal stations depending upon orographic effects on cloud genesis over land tends to increase the average cloudiness (isonephs) gradient at the coasts at noon, when the totality of the eclipse occurs. This is seen in fig. 1 which is based upon observations at 14^h M.E.T. in June and July during the period 1901—1930 from which monthly mean values have been computed.

The corresponding distribution of the duration of sunshine (isohels), given in fig. 2, shows similar features. The monthly mean values of sunshine in per cent of the possible amount between 13^h and 14^h S.T. (solar time) have been calculated from the values of cloudiness in fig. 1 by application of the regression function $s = 36 + 0.745 C_p$. This equation was deduced from simultaneous records of duration of sunshine between 13^h and 14^h in per cent (s) and observations of cloudiness N in scale 0—100 at 14^h during the period 1927—1949 at the meteorological station Vinga Lighthouse on the West coast (C_p is per cent of clear sky: $C_p = 100 - N$).

The statistics in table 1 has been prepared in order to establish more clearly whether the West- and East coasts of Götaland differ significantly in their mean cloudiness and sunshine duration and therefore whether any of these two parts of the country would be preferable with regard to cloudiness conditions

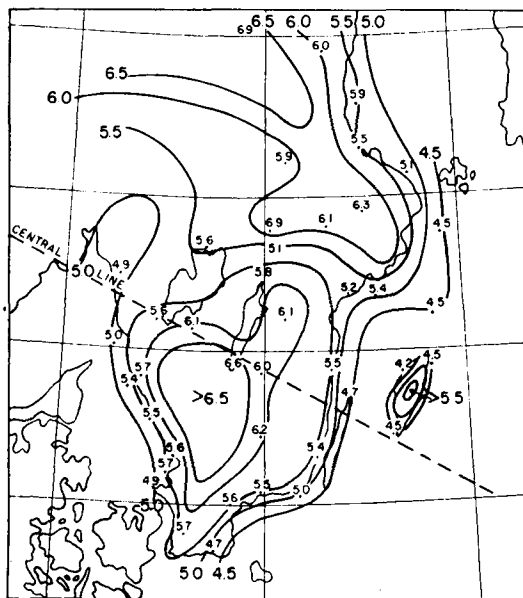


Fig. 1. Isoneph of average cloudiness at 14^h M.E.T. June—July 1901—1920.

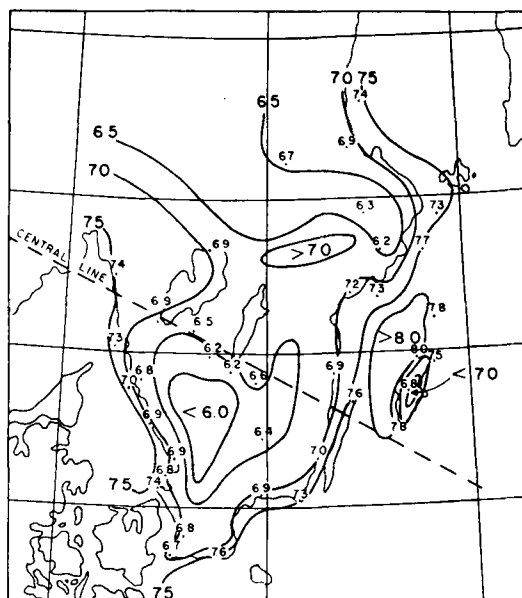


Fig. 2. Isohels of average relative duration of sunshine (%) 13^h—14^h S.T. June—July 1901—1930.

for astronomic observations. The cloud observations at 14^h during the period June 20—Juli 10 1931—1950 have been treated for Väderöbod, Hällö and Måseskär on the Skagerrack coast and Västervik, Ölands Norra Udde and Hoburg on the East coast of Sweden. All these stations are located near the central line of the eclipse. The whole material has been divided in two ten-years groups.

As is seen from table 1 the mean cloudiness at the west coast stations and Hoburg on southern Gotland has increased in the later 10

years period 1941—1950 corresponding to both a reduced number of clear days and an increase of the number of overcast days. On the other hand Västervik and Ölands Norra Udde show a marked decrease of the mean cloudiness during this period chiefly due to a decrease of the number of overcast days. The number of clear days has remained at a constant value at these two stations.

Regarding the whole period 1931—1950 we find the lowest average cloudiness of the 6 stations at Ölands Norra Udde. The difference

Table 1. Average cloudiness ($\bar{N}$, scale 0—10) and frequency of clear or almost clear days and of overcast or near overcast days at 14^h M.E.T.

$\bar{x}_1$ = mean number of days $N = 0-2$, June 20—July 10

$\bar{x}_2$ = mean number of days $N = 8-10$, June 20—July 10

Stations	Long. E	Lat.	1931—1940					1941—1950					1931—1950				
			$\bar{N}$	$\bar{x}_1$	$\varepsilon(\bar{x}_1)$	$\bar{x}_2$	$\varepsilon(\bar{x}_2)$	$\bar{N}$	$\bar{x}_1$	$\varepsilon(\bar{x}_1)$	$\bar{x}_2$	$\varepsilon(\bar{x}_2)$	$\bar{N}$	$\bar{x}_1$	$\varepsilon(\bar{x}_1)$	$\bar{x}_2$	$\varepsilon(\bar{x}_2)$
Väderöbod	11° 2'	58° 31'	4.1	7.7	0.9	4.9	0.5	5.5	4.8	0.5	7.6	0.7	4.8	5.9	0.5	6.3	0.5
Hällö . . .	11° 13'	58° 20'	4.3	6.7	1.0	4.5	0.6	5.2	4.9	0.7	5.8	0.7	4.7	5.8	0.6	5.2	0.5
Måseskär .	11° 21'	58° 6'	4.8	5.9	0.9	5.0	0.6	5.6	5.4	0.8	7.8	0.8	5.2	5.7	0.6	5.7	0.6
Västervik.	16° 36'	57° 47'	5.7	6.3	0.9	9.3	0.8	4.8	6.4	0.9	5.7	0.6	5.2	6.4	0.6	7.5	0.6
Öl. n. udd.	17° 6'	57° 22'	4.6	9.7	1.2	7.5	0.8	4.2	9.8	1.3	5.8	0.9	4.4	9.7	0.9	6.7	0.6
Hoburg . .	18° 9'	56° 55'	4.6	7.8	1.0	6.6	0.9	5.4	5.3	0.7	7.6	1.0	5.0	6.6	0.7	7.1	0.6
Visingsö .	14° 20'	58° 5'	—	—	—	—	—	6.6	1.1	0.5	9.0	1.4	—	—	—	—	—

between Ölands Norra Udde and the other stations is much more pronounced for the number of favourable days with cloudiness 0—2.

The table shows a marked predominance of clear days also at Hoburg and Västervik; thus the eastern stations are more favourable than the western ones, Väderöbod, Hällö and Måseskär.

The frequency of clear days is 46 % at Ölands Norra Udde, about 30 % at Hoburg and Västervik; at Väderöbod, Hällö and Måseskär clear days occur in 27 à 28 per cent of the total number of days in the period June 20—July 10.

The frequency of overcast days, cloudiness 8—10, is of the same order of magnitude as that of clear days. We find that overcast days occur in 32 to 36 per cent at the eastern stations and 25 to 30 per cent at the stations on the West coast.

From the calculated standard errors $\varepsilon(\bar{x}) = \frac{\sigma}{\sqrt{n-1}}$, σ being the standard deviation and n the number of years, we conclude that only the mean for clear days at Ölands Norra Udde differs significantly from those of the other stations. If we divide the stations according to their means in three groups; Ölands Norra Udde $\bar{x} = 9.7 \pm 0.9$, the westernmost stations $\bar{x} = 5.8 \pm 0.6$ and the easternmost stations except Ölands Norra Udde $\bar{x} = 6.5 \pm 0.7$ clear days of a total number of 21 days, we obtain the following values of the differences of these mean values $\bar{x}_1 - \bar{x}_2$ and their standard errors $\varepsilon(\bar{x}_1 - \bar{x}_2) = \sqrt{\varepsilon^2(x_1) + \varepsilon^2(x_2)}$ (table 2).

The differences between the mean at Ölands Norra Udde and the means of the westernmost and also of the other easternmost stations are three times as great as the standard error of the differences. The excess of clear days at Ölands Norra Udde is thus statistically significant. One cannot, however, exclude the

Table 2

Stations	$\bar{x}_1 - \bar{x}_2$	$\varepsilon(\bar{x}_1 - \bar{x}_2)$
Ölands Norra Udde—westernmost station.....	3.9	1.08
Ölands Norra Udde—easternmost station.....	3.2	1.11
Easternmost—westernmost station	0.7	0.88
Easternmost stations—Visingsö	5.5	0.86

possibility that this predominance partly or completely may be due to the personal equation in the daily estimation of the cloud amount at this station.

Nothing can be said about the reality of the difference of the means between the eastern stations Västervik and Hoburg on one side and the western station on the other side, the standard errors being as large as the difference itself.

Professor T. Bergeron has suggested that the convection over the island of Visingsö in the lake of Vättern ought to show similar characteristics as over the islands of Öland and Gotland. Ten years of observations at Visingsö 1941—1950 do not support this idea. The frequency of clear days at Visingsö only amounts to 5 % which should be compared with 30 % at the East coast. The average cloudiness of 6.6 is high and the frequency of cloudy days amounts to 43 %.

Records of duration of sunshine using the Campbell Stokes autographs give a more objective estimation of the cloudiness. Unfortunately there is only one station with records available in the interesting eastern part of the track, viz. Ölands Södra Udde to the south of the central line and these observations cover only the last ten years. The values taken from the records at Ölands Södra Udde and at Vinga at the West coast are summarized

Table 3. Average duration of sunshine and frequency of clear days, duration 0.8—1.0 hours and of overcast days, duration 0.2—0.0 hours between 13^h—14^h S.T. June 20—July 10

Stations	Long E	Lat.	Average duration %	Mean number of days duration 0.8—1.0 hours	Mean number of days duration 0.2—0.0 hours
Vinga	11° 36'	57° 38'	73.8	14.2 ± 0.9	3.9 ± 0.5
Ölands Södra Udde ..	16° 24'	56° 12'	76.5	14.7 ± 0.7	3.2 ± 0.5

in table 3 for the same 21 days period of nine years between 1940 and 1952.

The means 74 % at Vinga and 77 % at Ölands Södra Udde in the table agree well with the values on the map (fig. 2) showing the relative duration of sunshine between 13^h—14^h S.T. calculated for the period 1901—1930.

The mean number of days with sunshine for 0.8—1.0 hours is somewhat greater at Ölands Södra Udde than at Vinga as well as the average duration; the frequencies being 70 per cent of the total number of days at Ölands Södra Udde against 67.8 per cent at Vinga. The mean number of overcast days, 0.0—0.2 hours of sunshine, is also somewhat greater at Vinga than at the station in the

eastern part. But, the differences between the means of these two stations are too small compared with their standard error for securing a statistically certainty both with regard to clear and overcast days.

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