A.A.V.S.O.

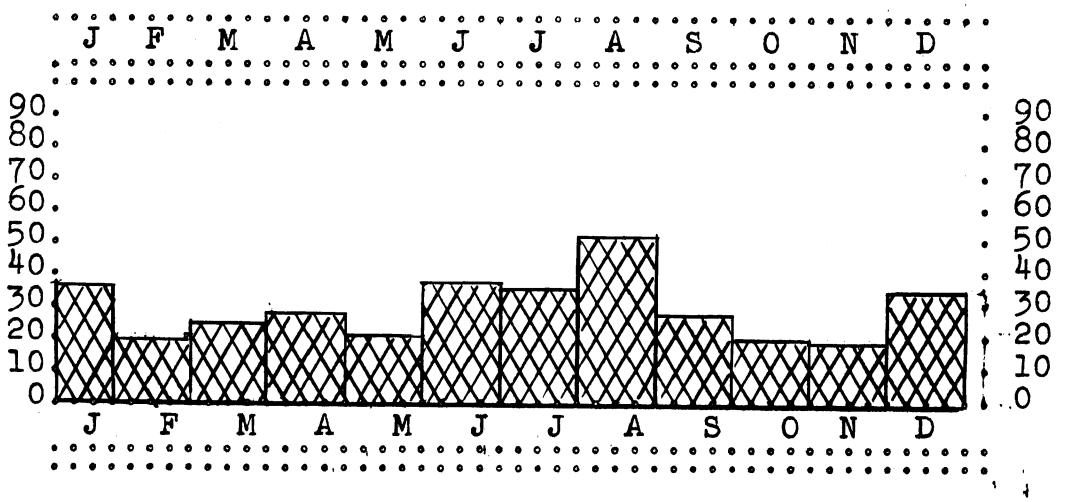
SOLAR DIVISION BULLETIN.

Neal J.Heines,Editor.

February 1953. P.O.Box 2353.
Number 83 -Page 235- Paterson N.J.

THE FORTY SECOND MEETING OF THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS WILL BE HELD AT ANN ARBOR MICHIGAN AT THE KIND INVITATION OF DR.LEO GOLDBERG, ON MAY THE TWENTY SECOND AND TWENTY THIRD 1953.

AMERICAN RELATIVE SUNSPOT NUMBERS 1952.



Jan.	38.6	Jul.	39.4
Feb.	21.8	Aug.	53.2
Mar.	23.3	Sep.	26.6
Apr.	27.3	Oct.	22.6
May.	22.2	Nov.	22.5
Jun.	35.9	Dec.	33.5

Mean For 1952, 30.5

ADDITIONAL STATISTICS FOR 1952.

If we count the sunspot groups, and spots, as new each day, as in the Wolfer method, then for 1952, as observed at Solar Division Headquarters, we have the following;

Number of groups whole disk	631
Number of sunspots whole disk	3939
Number of groups Central Zone	304
Number of sunspots Central Zone	2587
Number of groups north of Solar equator	333
Number of Groups south of Solar equator	295
Number of sunspots north of solar equator	2117
Number of sunspots south of solar equator	2135
Number of days with sunspots	314
Number of days without sunspots	29
Number of doubtful days (with or without spots)	22
Number of solar observations for 1952	594
Number of Observing days for 1952	272
Number of Groups gone	117
Number of New groups	125.

SUNSPOT GROUP HISTORY.

This information differs from that of the Wolfer method in that it counts each group but once, gives its place of origin, as observed, and, its place of disappearance besides the length of life, where it is possible. Solar Division Headquarters observed 125 groups during 1952 as against 240 during the year 1951.

Total of all north groups	67
Total of all south groups	58
Total of all doubtful groups (of above)	8
Combined totals	125

Total of all minus groups; ie, groups having died on the visible solar hemisphere	82
Total of all plus groups; ie; groups that have passed on to the invisible solar hemisphere	42
Total of doubtful cases in the above	8
Combined totals	125

Total of all groups giving their visible period in terms of days, north groups above the line, south below.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	?
*D																
*N	1	7	10	6	3	7	4	3	3	3	1	3	7	7	1	
*S	0	12	5	5	5	3	2	5	1	1	0	6	4	5	0	8
*T	1	19	15	11	8	10	6	8	4	4	1	9	11	12	1	= 125

* D, days; N, North; S, South; T, Combined totals.

Total of all groups born on the visible	northern hemisphere ---	41
" " " " " " "	southern " ---	36
" " " " " " " invisible	northern " ---	23
" " " " " " " "	southern " ---	17
" " " doubtful cases in the above		8
	Combined totals	125

Total of all groups born on the N. visible hemisphere, and died on the same ----------	33
Total of all groups born on the S. visible hemisphere, and died on the same ----------	25
Total of all groups born on the N. invisible hemisphere, and passed on to the N. invisible hemisphere ----------	7
Total of all groups born on the S. invisible hemisphere, and passed on to the S. invisible hemisphere----------	8
Total of all groups born on the N. invisible hemisphere, and died on the north visible hemisphere ----------	11
Total of all groups born on the S. invisible hemisphere; and died on the S. visible hemisphere ----------	7
Total of all groups born on the N. invisible hemisphere; and passed on to the N. invisible hemisphere again ----------	10
Total af all groups born on the S. invisible hemisphere; and passed on to the S. invisible hemisphere again, ----------	10
Total of all doubtful cases in the above ----------	14
Combined totals	125

STATISTICS FOR DECEMBER 1952.

The total number of sunspot groups for the month of Dec.,was --- 7
Zurich's Provisional sunspot number " " " " " " -- 34.6
The mean monthly sunspot area (US Naval Observatory) Not Released.
* The highest sunspot group number as assigned at Solar Division Headquarters was 125. The group made its appearance on Tuesday, December 30th., it represented a small group in the north belt, about three days east of the central solar meridian.
* Group counting reference for observers.

Predictions of smoothed, monthly, sunspot numbers, for the next six months;

Jan. 23	Apr. 20
Feb. 22	May. 19
Mar. 21	Jun. 18

Released by Prof. M. Waldmeier, Director Federal Observatory at Zurich , Switzerland, and transmitted by the Swiss Broadcasting Corporation on January 4th.,1953, via. Short Wave radio.

Statistics continued.

Naked-Eye Sunspots were observed in December by members of the R.A.S., Montreal Centre,Canada, as follows;

DeKinder,Dec.14, 1; 18th., 2; 19th., 2; 20th., 1.

Venor, Dec.18th., 2; 19th., 2; 20th., 2.

Wright, Dec. 17th., 1; 18th., 1; 19th., 1; 20th., 1.

Naked Eye Spots were seen 41 days by this group during 1952.

PUBLICATIONS.

"Radio Astronomy" ---------- F.J.Kerr
SKY AND TELESCOPE Vol.XII.,No 3,pp.59-62.
Read the portion begining with the last paragraph on the left of page 62 concerning solar items.

"A Simple Spectroscope for Solar Prominence Observations." Leinbach.
Same issue as above. Observers,where possible,should make such an instrument.

"A Simple Ocular Spectroscope"---------- Roger Hayward.
Scientific American. Dec. 1952. pp.86-90.

Details for construction contained in this article.
Designed by Ernst Keil. Cal.Inst. Tech.

"The Differences In The Relationship Between Ionospheric Critical Frequencies And Sunspot-Numbers For Different Sunspot Cycles.

Ostro & PcKemper.
Journal Of Geophysical Research Vol.57 No.4, Dec.52.pp473-480.
Technical.

" Mapping The Magnetic Fields Of The Sun." Babcock & Babcock.
Publications Of The Astronomical Society
Of The Pacific.Vol 64, No.381 Dec.1952.pp.282-287.
Worth Study.

"Preliminary Analysis Of The Turbulance Spectrum Of The Solar Photosphere At Long Wave Lengths"-------- Frenkiel-Schwarzchild.
Technical.

"A STUDY OF SOLAR INDICES"

Like most amateur sunspot observers I wanted to know more about the physical meaning of sunspots. Do their numbers reflect a corresponding degree of solar activity?. How does the Relative Sunspot Number -R- compare with other indices? Are the so-called Solar-Terrestrial correlations mere numerical creations - a case of coincident,but unrelated cycles? Is there an actual physical carrier emanating the sun and, upon reaching the earth, causing relative geophysical changes?

Unfortunately no ready ready made clear cut answer to these and similar questions could be found. I therefore decided to find the answers in various publications, periodicals, books, and fit together at least some of the pieces of this puzzle. I gathered solar data pertaining to sunspots,faculae,floculli,flares,prominences,the corona, solar Rdaio-Noise", as well as gephysical data pertaining to geomagnetic activity,aurorae and the ionosphere. I have particularly sought data for the present cycle, since 1944, bringing wherever possible,indices up to 1952. This, I feel,will bring some of the results right into our own observations,showing them in their true perspective. No "pet" theories, will be proposed here, the readers may draw their own conclusions. Without entering into detailed descriptions of the various phenomena, I shall try to keep to the indices as such,presenting only the necessary background, where I believe it necessary.

SUNSPOTS.

Sunspots are the most apparent features of the sun.They appear dark because they are the coolest phenomena,being as much as 2000°K cooler than the surrounding photosphere.With their tremendous magnetic fields they are the largest electromagnets and "refrigerators" known to man.Occasionally they are visible to the naked-eye, at sunset, through haze or clouds, and were observed,in this manner by ancient people.Telescopically,they were discovered by Galileo,Fabricius and Scheiner in 1610. However, not until two centuries later,were they observed with any degree of regularity. Like so many instances in astronomy,the greatest impetus came after an amateur, Samuel Heinrich Schwabe,of Dessau,Germany,1789-a875,discovered the so-called "Solar Cycle",the periodicity of sunspots.(1) The importance of this discovery began to be appreciated when Sabine, Gautier and Wolf, independantly of each other,discovered that the magnetic needle performed variations similar to those of the sunspots.(More about this later). This fact attracted the attention of another great amateur, Richrad Christopher Carrington of England,1826-1875. Carrington's precise observations still serve as standards today. His solar coordinates, and the solar rotation periods, were counted since, November 3,1853. He discovered the zonal distribution of spots;the motion of these zones during a cycle towards the equator and the increase in the period of rotation with solar latitude.

Gustav Spoerer subsequently proved the law of the zonal movement, which is one of the most fundemental ones. The next great step in the study of sunspots,after Warren de la Rue (another Amatuer) built the first photo-heliograph, came in 1908. when Dr,George Ellery Hale

1868-1938, proved spectroscopically the magnetic fields in sunspots, the Zeeman effect, and later on showed another fundamental characteristic of sunspots, namely, that the polarities of sunspot-groups change with each cycle.(Thus during the current cycle,the so-called, 18th., the preceeding -p- spots on the Northern solar hemisphere have an S polarity, while the following -f- spots, have a N polarity. The opposite holds for the southern solar hemisphere. This was reversed in 1933-44 cycle and will also serve as proof of the commencement of the next cycle, the 19th. The problem of motion in sunspots, discovered by Dr.John Evershed,is still not resolved to the full satisfaction of the astrophysicists. The true nature and origin of sunspots is still unknown. Presently,the most accepted theories are those of Hale, Bjerkness and Alfven, and Wallen.

SUNSPOTS AS A SOLAR INDEX.

For over twenty years Schwabe counted the number of sunspot groups and the number of "spotless days" and thus discovered the solar cycle. After Rudolph Wolf (1816-1893) began his solar observations in 1847, he instigated an extensive study of all the previous records then available, and was able to obtain fair monthly data back to 1749 and the periods of maxima and minima back to 1610. From his own observations and those of Schwabe and others, he chose a sunspot index, the so-called "Relative Sunspot Number". (2) To obtain a continous index it was necessary to integrate observations of different people and instruments. Wolf learned from experience, that a single factor, the so-called "k factor" was able to reduce different observations to a common scale. The k factors of experienced observers remain fairly constant. (plus or minus 10%) This k factor has been criticised severely, and in part, rightly so. It is useful, as has been proven by more than 100 years of the Zurich statistics, because a certain smoothing-out of the various differences occurs, when the means of a large number of observations are computed. Only in this quantitative statistical sense, not in a limited,localized qualitative sense, may this factor be used satisfactorily. (A seperate study of this "k" factor is intended for a later date). Wolf's decision to give a group (even a single isolated spot) a tenfold significance over individual spots within a group, was a most fortunate choice as comparison with other indices will show. His arbitrary formula is ; $R=k(10g+f)$; where R is the Relative Sunspot Number; g the number of groups; f the number of spots;. Wolf's qwm k factor was equal to 1, when he used the 8 cm Frauenhofer Refractor of 110 cm focal length with a 64x magnification at the Eidgenoessische Sternwarte on Zurich , Switzerland.(This telescope is still used as their standard instrument.) Later on, when traveling, he used a smaller instrument and used a k factor of 1.5. When Wolfer succeeded Wolf as head of the Zurich Observatory in 1894, he had to make certain, that his factor could continue the sunspot statistic without a change in the scale. This he was able to do from comparison observations of 17 years with Wolf. He obtained a k factor of 0.60, which to this day is used by the regular observer at Zurich. The large difference was due to a change in the method of spot counting. R.Wolf considered only those spots,which were readily visible even under just fair conditions of seeing and counted as one spot even seperate umbrae within a common penumbra.

Wolfer and all his succesors, Brunner and Waldmeier consider even the smallest spots visible under the best seeing conditions (but not the pores) and count each seperate umbra, even though there be several of them in a joint penumbra, just as do the observers of the A.A.V.S.O. Solar Division. (3). However,and this is less known, an additional factor is assigned to the largest spots according to the existing size. (The maximum being 5). Only Zurich uses this size factor. (I beleive the large discrepencies between RZ and RA for May and June 1951, during the lifetime of a very large group, were at least partly due to this"size" factor at Zurich).
Some sixty observatories and many more individuals contributed at one time or another to the Zurich statistics. Three sets of distinct Relative Sunspot Numbers are published by Zurich.1) the PROVISIONAL SUNSPOT NUMBERS, PUBLISHED MONTHLY, ARE BASED SOLELY ON THE SWISS OBSERVATORIES AT ZURICH: AROSA and LOCARNO and thus necessarily include occasionally observations made under unfavorable conditions of seeing. 11) the Definitive or Final Sunspot Numbers consist of unaltered Zurich observations made under good observing conditions plus the mean daily sunspot number derived from contributing observers. The complete Definitive Numbers serve as a basis for Zurich's computations of yearly k factors for all observers, contributing. III) The SMOOTHED SUNSPOT NUMBERS are monthly numbers computed from 13 months, including the 6 preceeding, the actual month, and 6 following months (e.g. add all monthly means from Jan.to Dec.and obtain the mean (1/12-); then do the same for the 12 months from Feb. to Jan. of the next year, and obtain their mean; one half of the sum of these two 12 monthly means is the smoothed number for July). The three sets of Numbers serve distinct purposes. The Provisional Numbers are of course the basis for immediate study and limited"predictions". The Definitive Numbers are the basis for accurate studies of Correlations,; and the Smoothed Numbers are the basis for long period predictions as well as the basis for determining the period of sunspot Maximum and Minimum. They are more indicative of the over all total solar activity, since they do not show short period fluctuations; (E.g. for Jan.1951; Provisional Zurich Sunspot Number was : 56.3; the Definitive Number was 59.9 and the Smoothed Number was 71.1;(much higher, because of the higher activity during 1950).

AMERICAN SUNSPOT NUMBERS.

Since December 1944 under the guidance of Mr.Alan H.Shapley of the Central Radio Propagation Laboratory at Washington D.C., and Mr. Neal J.Heines, of Paterson N.J., head of the Solar Division of the AAVSO, a group of sunspot observers was organized.Their observations are reduced by A.H.Shapley's formula to give what is known as the American Sunspot Number. (4). Originally these reductions were coupled directly to the Zurich scale for ten (10) months. It was thought,that after this period, the American Number -RA- could be independent of Zurich. Un fortunately, unforseen and rather complex factors entered this process to such an extant,that by 1949 it became all too clear ,that the RA scale was systematically higher,than its origin permitted (Without any signs that the Zurich scale had deviated systematically). (I intend to write a detailed study of the possible causes why RA changed together with the study of k factors.

In 1951 new steps were taken to eliminate a number of ill effects, permitting a more homogeneous statistic. (5). RA was again coupled with Zurich by means of k factors from 1949-1950. RA is computed as a mean product ofits standard observers, whose reports are combined with their k factors, here called -Ki-,and an additional factor expressing a statistical weight -Wi-. which is an indicator of the homogeneous nature of an individuals observations. The actual Formula is $RA' = \sum_{i=1}^{n} WiKiRi / \sum_{i=1}^{n} Wi$ - where RA' is the new series of American Numbers ---------- since 1951: wi, and ki are factors and Ri is the individual's reported sunspot number. Graph A shows clearly that RA followed Zurich in every fluctuation, having deviated only in its scale. The Maximum of the present cycle according to my computations of the American Smoothed Numbers was reached in October 1948 (Smoothed RA was 185.2 : while the accepted maximum of Zurich came in May 1947. (RZ smoothed was 151.8) (Other indices confirm Zurich, as will be shown later on). Mean while the New RA' shows close agreement with Zurich over 1951-1952.

THE FRAUENHOFER INSTITUTE Sunspot Numbers.

This institution in Freiburg I.B. Germany, publishes under K.O. Kiepenheuer a quarterly called "Sonnen-Zirkular". This excellent publication carries detailed reports on sunspots, faculae, flares, the corona data of the Wendelstein and Kanzelhoehe Observatories as well as Ionospheric and Geomagnetic-Kp- data,cosmic radiation measurements plus ynoptic charts of solar phenomena. In addition they have computed their own sunspot Numbers since March 1945, RF-, which are the mean number of all its contributing observers (8 Observatories and 8 individuals) by means of the k factors RF is coupled to the Zurich scale. (see Graph A).

GREENWICH SUNSPOT AREAS.

Since 1873 the Royal Observatory of Greenwich, Now at Herstmonceux Castle,England, has measure Sunspot and Faculae areas from photographs made there, at Cape of Good Hope South Africa,or at Kodaikanal India. The Sun's diameter on these photographs is about $7\frac{1}{2}$ inches. First the apparent sizes of umbra,total spots and faculae are measured in millionths of the sun's visible hemisphere by means of a "graticule". This is asort of "reticule -net", whose lines form perfect squares,proportional to a certain number of millionths of the suns disc. This measurement forms one set of indices,giving the areas of spots as they actually face the earth, and are used for specific correlation studies. When the apparent areas of spots are corrected for their relative position on the sun-globe, the Foreshortening effect of the solar sphere being thus eliminated , a new index is formed giving the"true" sunspot areas as they are on the sun in millionths of the solar hemisphere. I say "true" areas, because they can never be the actual areas since a mere trigonometric function cannot substitute reality. These corrected areas serve of course best as a measure of solar activity from the astrophysical point.

U.S.Naval Observatory

This observatory has measured sunspot areas since 1927, from photographs,where the sun's image however measures $4\frac{1}{4}$ inches. When the Naval Observatory cannot photograph the sun , then photos from the Mount Wilson Observatory are used for this index. However a different method from that used at Greenwich is applied here. The areas

are measured, corrected for the foreshortening effect by means of transparent discs. These are a sort of "Stonyhurst Disc" showing the solar coordinates, latitude and longitude, as they would appear, were they marked on the sun itself. This method of "reading-off" directly the actual sunspot areas is much simpler, however the danger of including errors is greater. Thus, contrary to all expectations, when one compares Greenwich data with those of the U.S. Naval Observatory, the absolute objectivity of area measurements is found lacking. There are actual differences between the indices of these two observatories, reaching limits of plus and minus 10%.

E.g. : monthly means:

March 1946, Greenwich (6) ..1551x10$^{-6}\odot$ ...US Nav.Obs.: 1762x10$^{-6}\odot$ (8)
July 1946 " " ..2912x10" " " " 2586x10"

or yearly means:
(7) 1938 " 2019 " " 1962 "
1939 " 1579 " " 1723 "
1942 " 423 " " 478 "

According to Sir.H.Spencer Jones, Royal Astronomer, systematic differences between Greenwhich and US Naval Observatorie's data may be due to : a) difference in method, b) difference in size of solar image, c) difference in graticule size, d) U,S.Nav.Obs. repeats some data for two or even three days. This explains the intricacies of measuring areas and partly also why the Geenwich data are five years behind, while the U.S. Naval Observatory are only a few months behind the actual events.

SUNSPOT GROUP COUNTS. (as an index).
The Publication Of The Astronomical Society Of The Pacific (PSAP) publishes regularly Mount Wilson Solar Data pertaining to magnetic fields of sunspot groups, and the number of these groups. Similarly the Kodaikanal Obs. of the RA.S. England, and Zurich, publish the "Number Of Graoups". which may serve as a basis for an index. All these -g- indices agree satisfactorily, however, for reasons, which will be stated later on, this index, though simpler, is not necessarily superior to the Relative Numbers as correlations with other indicies indicate.

References: (1) "Shapley-Howarth: Source Book In Astronomy" 1925 .p221
(2) "Astronomische Mitteilungen(Zurich) No. 145&152, 1948.
(3) N.J.Heines: "Instructions For Reporting Visual Sunspot Observations" 1950.
(4) A.H.Shapley: "Reduction Of Sunspot Number Observations, PASP vol.61#358, Feb.1949.
(5) AAVSO Solar Division Bulletin, N064, Jun., 1951, also "Revised Proceedures For Reducing Sunspot Number Observations" by A.H.Shapley. Sep, 1951.
(6) "Monthly Notices"; RAS, VolIII No 4-1951 p.422.
(7) Sir H.Spencer Jones, RA, "General Astronomy", 1951, p.156.
(8) Special Supplement to the AAVSO Bulletin, Solar Division, for September 1948.

YOUR COMMENTS AND CRITICISM OF THIS PAPER WILL BE APPRECIATED.

1945 1946 1947 1948 1949 1950 1951 1952

J M M J S N J M M J S N J M M J S N J M M J S N J M M J S N J M M J S N J M M J S N J M M J S N

GRAPH A.

SUNSPOT NUMBERS

R

RA

RZ

RF

AMERICAN SUNSPOT NUMBERS RA

ZURICH DEFINITIVE NUMBERS RZ

FRAUNHOFER NUMBERS RF

NEW AMERICAN NUMBERS

RA'

SMOOTHED NUMBERS RA, RZ

1945 1946 1947 1948 1949 1950 1957 1952

SUNSPOT AREAS

U.S.NAV.OBS. AREAS

GREENWICH AREAS

U.S.NAVAL OBS. SUNSPOT AREAS

GREENWICH SUNSPOT AREAS (CORRECTED FOR FORESHORTENING - IN 10^{-6} ⊙ HEMISPHERE)

1945 1946 1947 1948 1949 1950 1951 1952

SUNSPOT-GROUP COUNT "g"

Mt Wilson-g

ZURICH-g

KODAIKANAL-g

Mt WILSON-g'

ZURICH-g'

KODAIKANAL-g'

MT. WILSON SUNSPOT-GROUP COUNT

ZURICH AND KODAIKANAL GROUP COUNT

1945 1946 1947 1948 1949 1950 1951

HARRY BONDY