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SPACE DISTURBANCES LABORATORY

SOLAR-GEOPHYSICAL DATA

DESCRIPTIVE TEXT AND INDEX

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for

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SOLAR - GEOPHYSICAL DATA

INTRODUCTION

This pamphlet contains the description and explanation of the data contained in the monthly publication "Solar-Geophysical Data"*, issued by the Institute for Telecommunication Sciences and Aeronomy of the Environmental Science Services Administration (ESSA). These data reports continue the series issued by the Central Radio Propagation Laboratory of the National Bureau of Standards, known since 1956 as the CRPL-F series Part B. The CRPL became the ITSA in October 1965. As before the reports are compiled and edited under the supervision of Miss J. Virginia Lincoln; since June 1965, the compilations have been done by Miss H. I. Leighton.

The reports are intended to keep research workers abreast of the major particulars of solar activity and the associated ionospheric, radio propagation and other geophysical effects. This report series is made possible through the cooperation of many observatories, laboratories and agencies as recorded in the detailed description of the tables and graphs which follow. These reports should not be considered as definitive publications because of the rapid publication schedule involved. Errata or revisions are included from time to time. Additions to the descriptive text will appear with the data when new material is added or revision is made.

Preliminary summaries of solar activity, prepared on a fast schedule, are issued Friday of each week from High Altitude Observatory in conjunction with ESSA and include solar activity through the preceding day. These are useful to groups needing information on the current status of activity associated with regions on the visible solar disk, but are not recommended for research uses unless such a prompt schedule of reporting is essential.

I DAILY SOLAR INDICES

Relative Sunspot Numbers -- The tables include (1) the daily American relative sunspot numbers, R_A' as compiled by Richard H. Davis,

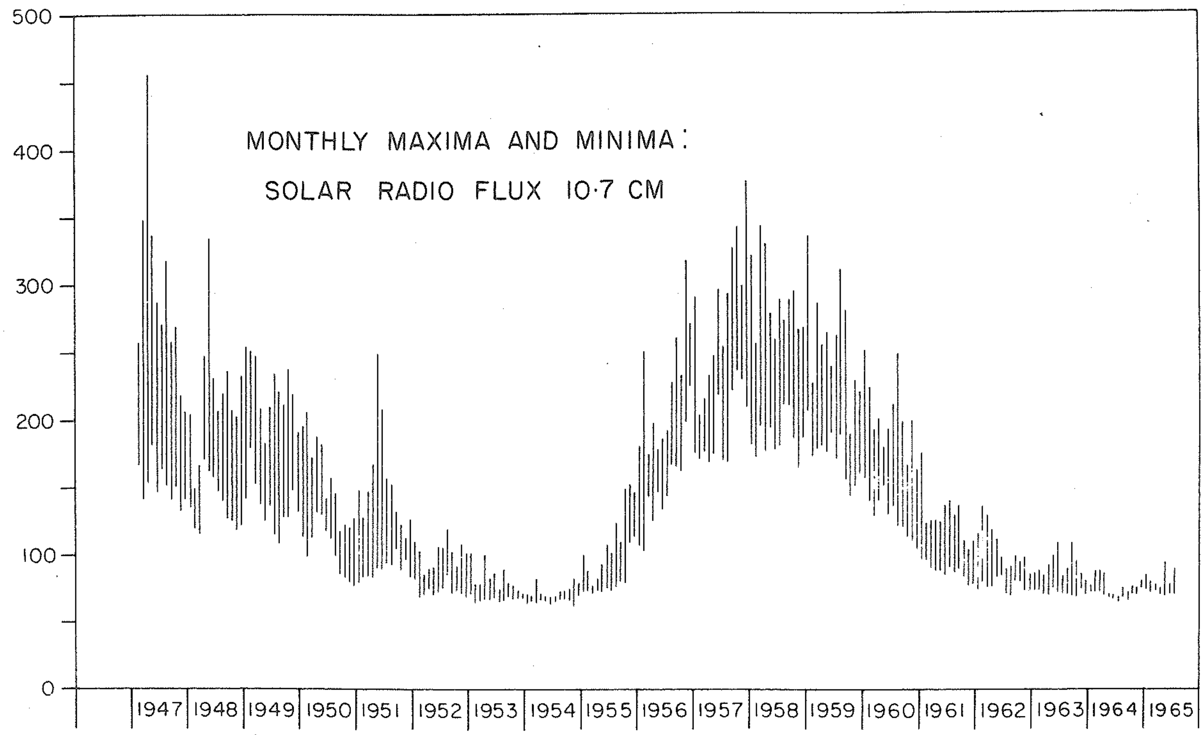
* Contents are also available at cost through the World Data Center-A for Airglow and Ionosphere as "Compilations of Solar-Geophysical Data".

Boston, Massachusetts, for the Solar Division of the American Association of Variable Star Observers, and (2) the provisional daily Zürich relative sunspot numbers, R_Z, based upon observations made at Zürich and its two branch stations in Arosa and Locarno as communicated by M. Waldmeier of the Swiss Federal Observatory.

The relative sunspot number is an index of the activity of the entire visible disk. It is determined each day without reference to preceding days. Each isolated cluster of sunspots is termed a sunspot group and it may consist of one or a large number of distinct spots whose size can range from 10 or more square degrees of the solar surface down to the limit of resolution (e.g. 1/25 square degree). The relative sunspot number is defined as $R = K (10g + s)$, where g is the number of sunspot groups and s is the total number of distinct spots. The scale factor K (usually less than unity) depends on the observer and is intended to effect the conversion to the scale originated by Wolf. The R_A' observations for sunspot numbers are made by a rather small group of extraordinarily faithful observers, many of them amateurs, each with many years of experience. The counts are made visually with small, suitably protected telescopes.

Final values of R_Z appear in the IAU Quarterly Bulletin on Solar Activity, the Journal of Geophysical Research, these reports, and elsewhere. They usually differ slightly from the provisional values. The American numbers, R_A', are not revised.

Daily Solar Flux Values - 2800 Mc/s -- The tables also give daily intensities of the 2800 Mc/s radio emission which originates from the solar disk and from any active regions present. The observations are made at the Algonquin Radio Observatory (ARO) of the National Research Council near Ottawa with a reflector 1.8 meters diameter as a continuation of observations which commenced in Ottawa in 1947. Entries refer to a single calibration made near local noon at 1700 UT. When the flux changes rapidly, or there is a burst in progress, the reported value is the best estimate of the undisturbed level for the whole observing day. The various types of outstanding events are listed separately in another table. The observed flux values have variations resulting from the eccentric orbit of the earth in its annual path around the sun. Although these radio values are suitable to use with observed ionospheric and other data, an adjustment must be introduced when the observations are used in studies of the absolute or intrinsic variation of the solar radio flux. One table shows the observed flux S, and the other flux adjusted to 1 A.U., S_a. A graph showing the monthly highs and lows for the last two sunspot cycles is shown. Relative errors over long periods of time are believed to be about $\pm 2\%$, over a few days may be $\pm 0.5\%$. The spectral difference between 2800 Mc/s and 2700 Mc/s solar emissions will be evaluated in the coming sunspot cycle so that the present series of observations at 2800 Mc/s can be transferred to the ITU allocation of 2690 - 2700 Mc/s.



Commencing in 1966, a correction for atmospheric attenuation due to the variable zenith angle of the sun will be incorporated in the reported daily flux levels. In order to minimize the discontinuity between future tabulations and past tabulation in which the absorption correction was neglected, the correction factor will be separated into two parts: a constant part corresponding to a fixed loss when the sun is at the "zenith distance" of summer solstice and a variable part corresponding to the difference in loss between summer solstice and when the sun is at greater zenith distances during other times of the year. The constant correction given by a multiplier of 1.011 will not be incorporated into the tabulations and so must be considered as an alteration to the absolute values of solar flux. The variable multiplier has values given by the table:

January	1.015	July	1.000
February	1.009	August	1.001
March	1.004	September	1.003
April	1.002	October	1.007
May	1.001	November	1.012
June	1.000	December	1.017

These solar radio noise indices are being published in accordance with a CCIR Recommendation from the Xth Plenary Assembly, Geneva 1963, which states "that the monthly-mean value of solar radio-noise flux at wavelengths near 10 cm should be adopted as the index to be used for predicting monthly median values of foE and foF1, for dates certainly up to 6, and perhaps up to 12 months ahead of the date of the last observed value of solar radio-noise flux". These four daily solar indices (R_Z, R_A', S and Sa) are now being presented in four separate tables giving values for the last twelve months so that trends in solar activity can be readily recognized without recourse to several issues of these reports.

Graph of Sunspot Cycle -- The graph illustrates the recent trend of Cycle 20 of the 11-year sunspot cycle and some predictions of the future level of activity. The customary "12-month" smoothed index, R, is used throughout, the data being final R_Z numbers except for the current year. Predictions shown are those made for one year after the latest available datum by the method of A. G. McNish and J. V. Lincoln (Trans. Am. Geophys. Union, 30, 673-685, 1949) modified by the use of regression coefficients and mean cycle values recomputed for Cycles 8 through 19. Cycle 20 began October 1964, when the minimum $\bar{R}$ of 9.6 was reached. Tabular values of the smoothed index, R, appear regularly in the Ionospheric Telecommunications Laboratory of I.T.S.A. "Ionospheric Data" reports and in the ITSA "Ionospheric Predictions" series and are available upon request.

II SOLAR CENTERS OF ACTIVITY

Calcium Plage and Sunspot Regions -- The table gives particulars of the centers of activity visible on the solar disk during the preceding month. These are based on estimates made and reported on the day of observation and are therefore of limited reliability. The calcium plage region identifications, in particular, should be considered preliminary, subject to change after more detailed scrutiny.

The table gives the heliographic coordinates of each center (taken as the calcium plage unless two or more significantly and individually active sunspot groups are included in an extended plage) in terms of the Greenwich date of passage of the sun's central meridian (CMP) and the latitude; the serial number of the plage as assigned by McMath-Hulbert Observatory; the serial number of the center in the previous solar rotation, if it is a persisting region, or an otherwise appropriate statement; particulars of the plage at CMP: area, central intensity; a summary of the development of the plage during the current transit of the disk, where b = born on disk, ℓ = passed to or from invisible hemisphere, d = died on disk, and / = increasing, - = stable, \ = decreasing; age in solar rotations; date first seen, month/day; and duration of plage on disk given in days: particulars of the associated sunspot group, if any, at CMP: area and spot count and the summary of development during the current disk transit, similar to the above. The unit of area is a millionth of the area of a solar hemisphere: the central intensity of the calcium plages is roughly estimated on a scale of 1 = faint to 5 = very bright and refers to the brightest part of the plage. Parentheses indicate region was not observed on CMP date; values are those nearest CMP date.

Calcium plage data are available through the cooperation of the McMath-Hulbert Observatory of the University of Michigan under ESSA contract. The sunspot data are compiled from reports from the U. S. Naval Observatory, Sacramento Peak Observatory and from reports from Europe, Asia and Japan received through the network of the International Ursigram and World Days Service.

Mount Wilson Magnetic Classifications of Sunspots -- This table lists the date and time (UT) of the observations, the approximate heliocentric coordinates, and the magnetic classification of the sunspot groups, as observed at the Mt. Wilson Observatory. Starting with March 1965 the Mount Wilson group number has been given for each group. This is the group number of the series which used to be published in the Publications of the Astronomical Society of the Pacific. Only the groups for which magnetic measures are available are listed.

The classification system gives the maximum magnetic information. The classifications are defined as follows:

αp All the magnetic measures in the group are of the same polarity which is that corresponding to the preceding spots in that hemisphere for that cycle.

αf All the magnetic measures in the group are of the same polarity which is that corresponding to the following spots in that hemisphere for that cycle.

βp A bipolar group in which the magnetic measures indicate that the preceding spots are dominant.

β A bipolar group in which the magnetic measures indicate a balance between the preceding and following spots.

βf A bipolar group in which the magnetic measures indicate that the following spots are dominant.

βγ A group which has general β characteristics but in which one or more spots are out of place as far as the polarities are concerned.

γ A group in which the polarities are completely mixed.

A parenthetical statement will be added to the above classifications if the group is also of the "δ-configuration": spots of opposite polarity within 2° of one another and in the same penumbra.

Coronal Line Emission Indices -- Emission intensity indices for each quadrant of the limit for the λ5303 (FeXIV) and λ6374 (FeX) coronal lines are listed in the table entitled Provisional Coronal Line Emission Indices. The indices are based on measurements made at 5° intervals around the periphery of the solar disk by the High Altitude Observatory at Climax, Colorado and by Harvard University observers at Sacramento Peak (the USAF Sacramento Peak Observatory at Sunspot, New Mexico, under contract AF 19(628)-3322). The measurements are expressed in millionths of an angstrom of the continuum of the center of the solar disk (at the same wavelength as the line) that would contain the same energy as the observed coronal line. The indices are:

G_6 = mean of six highest line intensities in quadrant for λ5303.

G_1 = highest value of line intensity in quadrant for λ5303.

R_6 = mean of six highest line intensities in quadrant for λ6374.

R_1 = highest value of line intensity in quadrant for λ6374.

The dates given in the table correspond to the approximate time of CMP of the longitude zone represented by the indices. The actual observations were made for the northeast and southeast quadrants 7 days before; for the southwest and northwest quadrants 7 days after the CMP date given.

Once every three months Final Coronal Line Emission Indices are printed. These tables contain data from Pic du Midi and Kislovodsk as well as Sacramento Peak and Climax. The indices are computed in the same manner as for the provisional table.

<u>Notes</u>: 1. From calibrations in February - March 1960 it was determined that all intensities from the Climax and Sacramento Peak Observatories during the years 1956-1959, inclusive, if multiplied by the factor 0.60, will be expressed in millionths of equivalent Angstroms to a somewhat lower precision. Intensities prior to 1956 cannot be compared precisely with those obtained later because of changes in observing and reduction techniques. They may be converted roughly to millionths of equivalent Angstroms by the use of the table given by Billings and Varsavsky, 1955, Zs.f Ap. <u>38</u>, 160. In FB185 several corrections were made to October and November 1959 coronal line emission indices published in FB183 and FB184, respectively.

2. The October 1962 through March 1963 final coronal line emission indices were revised and the correct data appear in CRPL-FB 226, issued June 1963.

To obtain rough measures of the integrated emission of the entire solar disk in either of the lines, assuming the coronal changes to be small in a half solar rotation, it is satisfactory to perform the following type of summation given in example for 15 October:

$$\left(\begin{matrix}\text{MEAN DISK EMISSION} \\ \text{IN } \lambda 5303\end{matrix}\right)_{15\ \text{OCT}} = \frac{1}{N}\left[\sum_{15\ \text{OCT}}^{22\ \text{OCT}}\left\{(G_6)_{NE}+(G_6)_{SE}\right\} + \sum_{8\ \text{OCT}}^{14\ \text{OCT}}\left\{(G_6)_{SW}+(G_6)_{NW}\right\}\right]$$

where N is the number of indices entering the summation.

Such integrated disk indices as well as integrated whole-sun indices are computed for each day and are published by the High Altitude Observatory at Boulder, Colorado.

III SOLAR FLARES

Optical Observations -- The table presents the preliminary record of solar flares as reported to ESSA on a rapid schedule at the sacrifice of detailed accuracy. Definitive data are published later in the IAU Quarterly Bulletin on Solar Activity, in various observatory publications and elsewhere. The present listing serves to identify and describe the phenomena observed without time to verify questionable values.

Reporting directly to ESSA are the following observatories: Haleakala (Maui, Hawaii), Huancayo Geophysical Institute, Lockheed, McMath-Hulbert, Sacramento Peak, Swedish Astrophysical Station on Capri, C.S.I.R.O. Culgoora, Manila, and Wendelstein. The remainder report through the Ursigram centers or are available through the World Data Center A for Solar Activity, High Altitude Observatory, Boulder, Colorado. Observations are made in the light of the center of the Hα line unless noted otherwise. The reports from Sacramento Peak, New Mexico are from observations at the USAF Sacramento Peak Observatory at Sunspot, New Mexico, by Harvard University observers, under contract AF 19 (628)-3322.

National Aeronautics and Space Administration funds assist the Lockheed and C.S.I.R.O. Culgoora flare patrols. ESSA contracts support the flare patrols at Haleakala, Huancayo, Manila, McMath-Hulbert and the Swedish Astrophysical Station on Capri.

For each flare or subflare are listed the reporting observatory using IAU Quarterly Bulletin on Solar Activity designations: the date; beginning and ending times; time of maximum phase; the heliographic coordinates in degrees for the "center of gravity" of the emission region, corresponding to the time of maximum intensity; McMath serial number of the region; duration; the flare importance on the IAU scale of Sf to 4b (see below); nature and completeness of available observations where C* = a complete, or quasi complete, sequence of photographs was obtained, P* = one or a few photographs of the event were obtained resulting in incomplete time coverage, V = all (or most of) the development of the flare was visually observed, or S = flare was seen visually for a small part of its probable duration; observing conditions where 1 means poor, 2 fair and 3 good; time of measurement for tabulated width of Hα to nearest 1/10A or tabulated

* Circumstances C and P can occur with any type of photographic patrol, whether automatic or not. Combinations of two symbols can be used for intermediate circumstances, example: VP = continuous visual watch plus a few photographs.

area; measured (i.e. projected) maximum area in square degrees (reported in millionths of disk by observatory); corrected maximum area in square degrees (see below); maximum effective line-width in Hα expressed in percent of the local continuum; and remarks in the IAU system of notes where a = eruptive prominence for which the base has a heliocentric distance of at least 90°, b = probably the end of a more important flare, c = invisible 10 minutes before, d = brilliant point, e = two or more brilliant points, f = several eruptive centers, g = no spots visible in the neighborhood, h = the flare is accompanied by a dark filament (surge) of high sightline velocity, i = very extensive active region, j = marked variations in the intensity of the plage area, also before and (or) after the real flare event, k = several intensity maxima, l = filaments already existing in the neighborhood show effects of sudden activation, m = the flare has a strong continuous spectrum (is visible in white light), n = the continuous spectrum shows effects of polarization, o = the observations have been made in the calcium II lines H or K, p = the flare shows helium D_3 in emission, q = the flare shows the Balmer continuum in emission, r = the Hα line shows a marked asymmetry suggesting outgoing matter of high velocity, s = brightening follows disappearance of filament, occurs in position of former filament, t = region active all day, u = formation of two relatively close and somewhat parallel bright filaments (II or Y shape), v = occurrence of an explosive phase (very sudden expansion and/or intensity increase within about one minute) -- give the corresponding time, w = great increase in area after time of maximum intensity -- give the corresponding time and area, x = unusually wide Hα emission, y = onset of a system of loop-type prominences, and z = major sunspot umbra covered by flare. The following symbols are used in the table:

D = greater than U = approximate
E = less than □ = not reported
(In older lists & = plus)

All times are Universal Time (UT or GCT).

The flares alone will be given in the table for the immediately preceding month, and the no-flare patrol observations for that month will be given only in graphical form. All of the flares available for the month four months before date of publication will be presented together with the no-flare patrol entries in tabular form. The no-flare patrol observations for that month's data will also be given graphically. Because some observatories report flares, but not the periods covered by their observations, flares may be included in the table during hours of reported no patrol.

The new dual importance scheme, adopted January 1, 1966 by IAU Commission 10, is summarized in the following table:

"Corrected" area in square degrees	Relative Intensity Evaluation Faint (f)	Normal (n)	Brilliant (b)
≤2.0	Sf	Sn	Sb
2.1 - 5.1	1f	1n	1b
5.2 - 12.4	2f	2n	2b
12.5 - 24.7	3f	3n	3b
>24.7	4f	4n	4b

The area to be used in assigning the first figure of the dual importance, is the area of the flaring region at the time of maximum brightness. The observatory measures apparent area in millionths of the solar disk. For flares less than 65° from the center of the solar disk, the formula relating apparent and corrected area is:

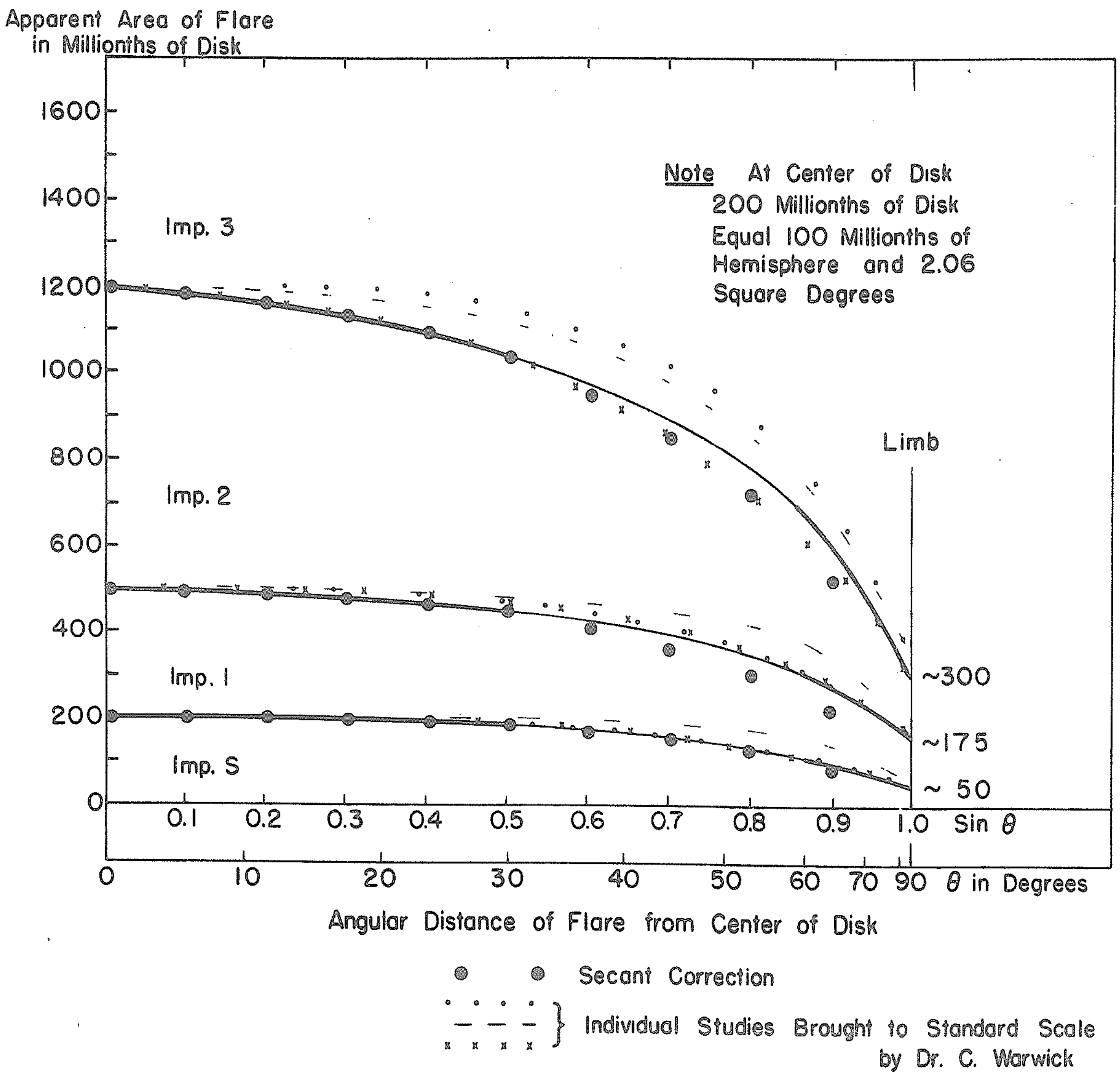
$$\text{"corrected" area} = \frac{\text{apparent area}}{97\,\theta} \times \sec\theta$$

For flares more than 65° from the center, the "sec θ law" becomes unsatisfactory. The first importance figure can be estimated from the graph given below or from the table below where areas are given in millionths of the disk.

Angle	0°	------		65°	70°	80°	90°
Limit S-1	200	sec θ	law	90	75	50	45
Limit 1-2	500	sec θ	law	280	240	180	170
Limit 2-3	1200	sec θ	law	600	500	350	300

The intensity scale shown as the second importance figure is only a qualitative one where each observatory uses its experience to decide if a flare is rather faint (f), normal (n), or rather bright (b).

At the time all flares are available it is intended to present the solar flare reports by the normalized solar flare data method developed by C. S. Warwick. The flare importance reported by each observatory is corrected by an amount that depends on the reported importance, the reporting observatory, and the position of the flare on the solar disk. Then the various reports are grouped together, and average values are computed for times of beginning, maximum and end, and for position and importance. For each grouped report are given a serial number; date; mean beginning, end and maximum phase times in UT; mean heliographic coordinates of the flare


Apparent Area of Flare
in Millionths of Disk
1600
1400
1200
1000
800
600
400
200
0
Note At Center of Disk
200 Millionths of Disk
Equal 100 Millionths of
Hemisphere and 2.06
Square Degrees
Imp. 3
Imp. 2
Imp. 1
Imp. S
Limb
~300
~175
~ 50
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 Sin θ
0 10 20 30 40 50 60 70 90 θ in Degrees
Angular Distance of Flare from Center of Disk
Secant Correction
Individual Studies Brought to Standard Scale
by Dr. C. Warwick

followed by month, day and tenth of day of central meridian passage of the flare position; central distance in units of a solar radius; mean corrected importance; and (in remarks column) number of flare reports and number of valid reports of importance. Reports of importance from an observatory that saw the maximum phase of the flare are considered valid. Under each grouped report, the individual observatory reports will be listed.

The table on page 13 gives the code number on the punch cards and IAU abbreviations for the solar flare observatory names as presented in the published tables, together with former CRPL designations.

Notes: 1. All the flare data are recorded on punched cards. As errata are received the punched cards are corrected. These errata are not always published in these reports. Copies of the cards or tabulations from them are available at cost through the World Data Center A for Ionosphere and Airglow, ESSA, Boulder, Colorado 80302, U.S.A.

2. Major errors occurred in the area listing in this report series for the Russian flares until 1960 data. We misunderstood some of the original entries. The Simeiz flares in FB156 for example, were for June 1957, not July 1957. Revised flare lists as well, were received for IGY-IGC flares from the following observatories: Abastumani, Alma-Ata, Moscow Gaish, Kiev University, Pirculi, Simeiz, Tachkent, and Voroshilov and are available as described above.

3. The flare position reports from Hawaii have been corrected from July 1, 1957 to December 10, 1960. Flare coordinates reported since December 10, 1960 have been computed correctly. The measured and corrected areas for flares from Hawaii as published for July 1957 through November 1959 should be divided by two to make the entries correct.

4. The flares incorrectly labelled "Boulder" in FB178 and FB179 are those for Greenwich Royal Observatory, Herstmonceux. As stated above, the corrected data are available on punched cards.

5. From October 1, 1960 through December 31, 1965 the following observatories: Climax, Haleakala (formerly called Hawaii when patrol at Makapuu Point, Oahu), Lockheed, Sacramento Peak, and Ottawa, Canada

SOLAR FLARE OBSERVATORIES

CODE NO.	I.A.U. ABREV.	NAME, PLACE AND COUNTRY	FORMER CRPL DESIGNATION
824	ABST	ABASTUMANI,GEORGIAN,SSR	ABASTUMANI
825	ALMA	MTN OBS,ALMA-ATA,KAZAK,SSR	ALMA-ATA
512	ARCE	ARCETRI,FLORENCE,ITALY	ARCETRI
521	AROS	AROSA,SWITZERLAND	AROSA
508	ATHN	NATL OBS,ATHENS,GREECE	ATHENES
832	BAKO	BAKOU,PIRCULI,USSR	PIRCULI
560	BUCA	NATL OBS,BUCHAREST,ROMANIA	BUCHAREST
151	CAPE	R.O.CAPETOWN,CAPE OF GOOD HOPE SOUTH AFRICA	CAPETOWN,GOOD HOPE
506	CAPF	ANACAPRI,ITALY(GERMAN)	CAPRI-G
519	CAPS	ANACAPRI,ITALY(SWEDISH)	CAPRI-S
466	CART	CARTER OBS,WELLINGTON,NEW ZEALAND	CARTER
570	CATA	CATANIA,SICILY,ITALY	CATANIA
450	CHRI	CHRISTCHURCH,NEW ZEALAND	CHRISTCHURCH
639	CLMX	HIGH ALTITUDE OBS,CLIMAX,COLORADO,USA	CLIMAX
826	CRIM	SIMEIS,CRIMEA,RSFSR	CRIMEE,SIMEIZ
402	CULG	CULGOORA,AUSTRALIA	NONE
511	DUNS	DUNSINK OBS,DUBLIN,IRELAND	DUNSINK
536	EDIN	R.O.EDINBURGH,SCOTLAND	R.O.EDINBURGH
564	FRIB	FRANHOFER INST.FREIBURG,GFR	NEW SCHAUINSLAND
478	HALE	HALEAKALA,MAUI,HAWAII,USA	HALEAKALA
563	HTPR	HAUTE-PROVENCE,FRANCE	HAUTE-PROVENCE
537	HERS	R.GREENWICH OBS,HERSTMONCEUX,ENGLAND	HERSTMONCEUX,RO.HERST
440	HONO	HONOLULU,HAWAII,USA	HAWAII
718	HUAN	GEOPHYSICAL INST,HUANCAYO,PERU	HUANCAYO
313	IKOM	IKOMASAN OBS,KYOTO,JAPAN	KYOTO
358	ISTA	UNIV.OBS,ISTANBOUL,TURKEY	ISTANBUL
831	IZMI	IZMIRAN,KRASNAYA PAKHRA,USSR	NIZMIR,KRASNAYA PAKHRA
382	KAND	KANDILLI OBS.,ISTANBOUL,TURKEY	NONE
547	KANZ	GRAZ OBS,KANZELHOHE,AUSTRIA	KANZELHOHE
827	KHAR	KHARKOV,UKRANIAN,SSR	KHARKOV
828	KIEV	KIEV,GAO,UKRANIAN,SSR	KIEV,KO
829	KIKY	KIEV UNIV,UKRANIAN,SSR	KIEV KY
309	KODA	KODAIKANAL,INDIA	KODAIKANAL
522	LOCA	LOCARNO,SWITZERLAND	LOCARNO
659	LOCK	LOCKHEED,LOS ANGELES,CALIFORNIA,USA	LOCKHEED
876	LVOV	LVOV,UKRANIAN,SSR	LVOV
468	MANI	MANILA,PHILIPPINE ISLANDS	MANILA
642	MCMA	MCMATH-HULBERT,PONTIAC,MICHIGAN,USA	MCMATH
505	MEUD	MEUDON,FRANCE	MEUDON
314	MITK	MITAKA,TOKYO,JAPAN	MITAKA
555	MONT	MONTE MARIO OBS,ROME,ITALY	ROME
830	MOSC	MOSCOU,MOSCOW-GAISH,RSFSR	MOSCOW-G
643	MWIL	MT.WILSON,CALIFORNIA,USA	MT.WILSON
515	NERA	NEDERHORST DEN BERG,NETHERLANDS	NERA,NEDERHORST
310	NIZH	NIZAMIAH,HYDERABAD,INDIA	NIZAMIAH
504	ONDR	ONDREJOV,PRAGUE,CZECHOSLOVIA	ONDREJOV
603	OTTA	OTTAWA,ONTARIO,CANADA	OTTAWA
548	POTS	POTSDAM,GDR	POTSDAM
359	PURP	PURPLE MTN,NANKING,CHINA	PURPLE MT
645	SACP	SACRAMENTO PEAK,SUNSPOT,NEW MEXICO,USA	SACRAMENTO PEAK
572	SALO	SALONIQUE(THESSALONIKA)GREECE	THESSALONIKA
520	SALT	SALTSJOBADEN,STOCKHOLM,SWEDEN	STOCKHOLM
758	SANM	SAN MIGUEL,ARGENTINA	SAN MIGUEL
507	SCHA	SCHAUINSLAND MT,GFR	SCHAUINSLAND
880	SHEM	SHEMAKHA,AZERBAIJAN SSR	NONE
862	SIBE	SIBERIE(SIBERIAN IZMIR)IRKUTSK,RSFSR	IRKUTSK
401	SYDN	C.S.I.R.O.SYDNEY,AUSTRALIA	SYDNEY
833	TACH	TACHKENT,UZBECK,SSR	TASHKENT
661	TONA	TONANTZINTLA,MEXICO	TONANTZINTLA
556	TORT	TORTOSA,SPAIN	TORTOSA
502	UCCL	UCCLE,R.O.BRUSSELS,BELGIUM	UCCLE
644	USNR	USNRL,WASHINGTON,DC,USA	USNRL
516	UTRE	SONNENBORGH OBS,UTRECHT,NETHERLANDS	UTRECHT
834	VORO	VOROSHILOV,USSR	VOROSHILOV,USSURISK
546	WEND	WENDELSTEIN,GFR	WENDELSTEIN
574	WROC	WROCLAW,POLAND	WROCLAW
523	ZURI	EIDGENOSSISCHE STERNWARTE,ZURICH,SWITZERLAND	ZURICH

reported maximum area in square degrees corrected according to a method proposed by C. S. Warwick of the National Bureau of Standards (now ESSA). As of August 1964 the Huancayo, Peru Geophysical Institute used the same method. These observatories based their flare importances on this corrected area in accordance with IAU rules. Previously they had based their importances on the measured areas. The formula used was:

$$\text{Corrected area} = \frac{\text{measured area}}{\cos \phi + 0.2 \sin \phi}$$ where ϕ is

the central distance. This factor represents the variation in apparent area that depends only on central distance, and avoids an infinity at the limb. A graph was published in CRPL-F 197 Part B, January 1961 and in the descriptive text of November 1964.

Solar x-ray radiation -- The NRL X-Ray Monitoring Satellite has provided numerous measurements of solar x-ray emissions during 1964. The data published consist of tables of observing times and daily averages of the solar x-ray flux. Outstanding events are also listed. This program is under the direction of Robert W. Kreplin of the U. S. Naval Research Laboratory.

Instrumentation for the experiment consisted of five photometers sensitive in different but overlapping regions of the soft x-ray spectrum. These photometers are gas filled ionization chambers whose wavelength sensitivity is determined by the window material and the gas filling. Initially the bands covered included 2-8A, 8-14A, 8-16A, 44-55A and 44-60A. Failure of the 8-16A and 44-55A photometer about one month after launch reduced the number of bands monitored but did not seriously effect the wavelength coverage of the experiment. Reference (3) describes the experiment in some detail giving the actual wavelength response curves of the photometers, as well as a discussion of preliminary results.

The column entries in the table following the date are explained below:

1. Times of Observation -- These are the intervals of time (UT) when the satellite was in range of a telemetry station. Intervals have not been included when x-ray flux could not be reduced from the records due to noise or other interference.

2. Average X-ray Flux

a. 44-60A -- The average flux is calculated from the records reduced for the listed intervals. This reduction is made assuming that the solar x-ray spectrum can be approximated by a $0.5x10^6$ °K "gray" body (ref. 1). This assumption is used only for convenience. Austin, Purcell, and Tousey (ref. 2) have photographed a line spectrum in the region 44-60A. Calculation of the flux values using this spectrum does not yield a value greatly different from that calculated here. The probable limit of error in each flux value is approximately ±10%.

b. 8-12A -- The 8-12A flux is calculated on the assumption that this region of the spectrum may be approximated by a $2x10^6$ °K "gray" body. Earlier published results have given the flux in band 8-20A. Measurement of the solar spectrum between 13 and 26 Angstroms by R. L. Blake (Ap.J., 142, 1, 1965) has revealed a number of emission lines. Therefore, it seems advisable to limit the calculations to the region of sensitivity of the photometer (ref. 3).

Normally the 8-12A flux is below the threshold of the measurement system. The numbers listed in this column preceded by < indicate the nominal threshold value for the day.

c. 0-8A -- The flux in this spectral range is calculated using a $2x10^6$ °K "gray" body assumption. Here also the flux is normally below the threshold of the measurement system and the column entry represents the threshold value.

All flux values are in ergs cm^{-2} sec^{-1}. The probable limit of error for the 8-12A and 0-8A measurements are ±10% for purposes of comparison.

3. Outstanding Events -- In this table are listed those intervals in which the x-ray flux was significantly greater than the average for the day.

REFERENCES

1. Kreplin, R. W., Solar X-rays, Ann. Geophys. 17, 151-161, 1961.

2. Austin, W. E., J. D. Purcell and R. Tousey, Astron. J. 69, 133, 1964.

3. Kreplin, R. W., NRL Solar Radiation Monitoring Satellite, Description of Instrumentation and Preliminary Results, Presented at the COSPAR Symposium (Working Group 2) at Florence, Italy, 11 May 1964, SPACE Research V, 951-965, 1965.

Ionospheric Effects -- SID, sudden ionospheric disturbances (and GID, gradual ionospheric disturbances) may be detected in a number of ways: shortwave fadeouts (SWF), increases in cosmic absorption (SCNA), enhancement of low frequency atmospherics (SEA), sudden phase anomalies at VLF (SPA), sudden enhancements at VLF (SES) and sudden frequency deviations (SFD).

SWF

The SWF events are listed in first columns and have been recognized on field-strength recordings of distant high-frequency radio transmissions. Under a coordinated program, the staffs at the following ionospheric sounding stations contribute reports that are screened and synthesized at ESSA-Boulder: Ft. Belvoir, Va., Boulder, Colo. and Anchorage, Alaska (ESSA Stations: BE, BO, AN); Huancayo, Peru; (ESSA-Associated Station: HU); Ft. Monmouth, N.J., White Sands, N. Mex., Adak, Alaska, and Okinawa (U. S. Army Radio Propagation Agency stations: FM, WS, AD, OK). McMath-Hulbert Observatory (MC), Hiraiso Radio Wave Observatory, Japan (TO), and University of West Indies, Trinidad (TR) also contribute such reports. In addition, reports are volunteered by Cable and Wireless (CW+ = Hong Kong, CW++ = Singapore, CW+++ = Accra, CW* = Barbadoes, CW** = Somerton, England, CW*** = Brentwood, England); Netherlands Postal and Telecommunications Services at NERA (NE) and Paramaribo (PA); Swedish Telecommunications, Enköping, Sweden (SW); New Zealand Post and Telegraph Department (NZ) and others: these usually specify times of SWF and the radio paths involved. Through the Ursigrams, reports are available from still other stations: such as Breisach, GFR (BR), Canberra, Australia (CA), Darmstadt, GFR (DA), Juhlesruh, GDR (JU), Kuhlungsborn, GDR (KU), Lindau, GFR (LI), Predigstuhl, GFR (PS), Prague, Czechoslovakia (PU).

In the coordinated program, the abnormal fades of field strength not obviously ascribable to other causes, are described as shortwave fadeouts with the following further classification:

- S-SWF (S) : sudden drop-out and gradual recovery
- Slow S-SWF (SL): drop-out taking 5 to 15 minutes and gradual recovery
- G-SWF (G) : gradual disturbance: fade irregular in either drop-out or recovery or both.

When there is agreement among the various reporting stations on the time (UT) of an event, it is accepted as a widespread phenomenon and listed in the table.

The degree of confidence in identifying the event, a subjective estimate, is reported by the stations and this is summarized in an index of certainty that the event is geographically widespread, ranging from 1 (possible - single station) to 5 (definite - many stations). The times given in the table for the event are from the report of a station (listed first in the group of stations) that identified it with high confidence. The criteria for the subjective importance rating assigned by such station on a scale of 1- to 3+ include amplitude of the fade, duration of event and confidence of reality of event. The published summary importance rating is also subjective with greater consideration given to reports on paths near the subsolar point for the particular event.

Note: The table of SID observed at Washington included in these reports prior to FB-135 were restricted to events classed here as S-SWF.

SCNA-SEA-bursts

Sudden ionospheric disturbances are next listed in the table which have been recognized on recorders for detecting cosmic absorption at about 18 Mc/s (SCNA) or on recorders for detecting enhancements of low frequency atmospherics at about 27 kc/s (SEA). Solar radio bursts at 18 Mc/s as identified on the SCNA records are also given in the table.

Reports are received either directly or through the World Data Center A for Solar Activity at the High Altitude Observatory, Boulder, Colo. The following observatories report SCNA: McMath-Hulbert Observatory (MC); High Altitude Observatory, Boulder, Colo. (BO); University of Hawaii, Haleakala, Maui, Hawaii (HA); Manila Observatory (MA); and Osservatorio Astronomico su Monte Mario, Rome, Italy (RO). These five stations also report solar noise bursts observed at 18 Mc/s. The SEA reports come from the following: Osservatorio Astrofisico di Arcetri, Florence, Italy (AR); Research Institute of Atmospherics, Toyokawa, Japan (TY); Dunsink Observatory, Ireland (DU); Observatorio del Ebro, Tortosa, Spain (TS); two stations operated by the Netherlands PTT at Nederhorst den Berg, Netherlands (NE), and Paramaribo, Dutch West Indies (PA); Panska Ves Observatory near Prague, Czech. (PU); High Altitude Observatory, Boulder, Colo. (BO); McMath-Hulbert Observatory (MC); University of Hawaii (HA); Manila Observatory (MA); Osservatorio Astronomico su Monte Mario, Rome, Italy (RO); Willard Hall, Preston, England (LO); Neustrelitz, GDR (NU); Kuhlungsborn, GDR (KU); Observatoire Royal de Belgique, Uccle, Belgium (UC); and a group of American Association of Variable Star Observers located at Brooklyn, N.Y. (A1), Paterson, N.J. (A3),

SL = Slough, Eng. bursts & SPA
ZI = Ziliniec, Czech bursts SCNA SEA
UM = Umuarama Radio Observatory, Mackenzie Univ., Brazil
AN = Anchorage SCNA SES, SPA, burst.
BI = Baiter Island SCNA
GS = Goddard Space Flight Center SWF
BN = Brentwood, England (CW***) SWF
SO = Somerton, England (CW**) "
BA = Barbadoes (CW*) "
HK = Hong Kong (CW+) "
GH = Godley Head SWF July '66

A-17 - Durban, So. Africa

Ramsey, N.J. (A5), Oshkosh, Wis. (A6), Haddam, Conn. (A8), Vlauvelt, N.Y. (A10), Beverly Hills, Calif. (A14), Vermont (A15), Sao Paulo, Brazil (A16), and Scituate, Mass. (A18); and an amateur astronomer in Hobart, Tasmania (TA). The AAVSO reporters are given ESSA contract support.

These reports are coordinated at ESSA Boulder. When there is agreement among the various reporting stations on the time (UT) of an event, it is accepted as a widespread phenomenon and listed in the table. Some phenomena are listed, if noted at only one location, if there has been a flare or another type of flare-associated effect reported for that time.

In the table under the type of event the subjective importance of the event is given on a scale of 1 minus to 3 plus. Next there is the index of geographic widespread certainty ranging from 1 (possible) to 5 (definite). The times of beginning, end and maximum phase of the event in UT are given as reported by the station listed first in the group of observing stations. If the event is an SCNA, a percent absorption figure is given. This absorption is calculated by the formula: (ABS)

$$\text{SCNA } \% = \frac{I_n - I_f}{I_n} \times 100$$

where I_n = noise diode current required to give a recorder deflection equal to that which would have occurred in the absence of a flare, i.e. a value extrapolated from cosmic noise level trend before and after a flare. The previous day's record may be considered if necessary.

and I_f = noise diode current required to give a recorder deflection equal to the level at the time of maximum absorption.

SPA

Sudden phase anomalies (SPA) are observed as a phase advance of the downcoming skywave on VLF recordings. An estimate of the intensity can be obtained in terms of the degree of phase shift (see Chilton, C.J. et al, Jour. Geophys. Res. 68, 5421-5436, October 1, 1963). The length of path and amount of sunlight on the path must of course be considered.

Reports are received from ESSA, Boulder, Colo. (BO) recording regularly Maui, Hawaii, U.S.A. (NPM 26.1 kc/s); Jim Creek, Wash., U.S.A. (NPG 18.6 kc/s); Annapolis, Md., U.S.A. (NSS 21.4 and 88 kc/s); and Cutler, Maine, U.S.A. (NAA 17.8 kc/s). Other reports are from NBS Maui, Hawaii, U.S.A. (HA) recording WWVL 20 kc/s; from Battelle

Institute, Frankfurt, G.F.R. (FR) recording NAA, NSS, NPM and NPG alternately; and from Tucuman, Argentina (TU) recording NPG. The ITSA Space Disturbance Monitoring Station at Anchorage, Alaska records NPM, NSS and WWVL and is planning to record GBZ, England at a later date. When Balboa, Canal Zone, NBA, returns to the air it will be recorded at Boulder and Tucuman.

In the table under SPA column the degrees of phase change are given for the path reporting maximum phase change while under the station column the parenthetical remark gives the call letters with the degrees of phase change for each transmitter recorded at the observing station. For each event the time of beginning, time of maximum phase advance, and time of ending in UT are given.

SES

Sudden enhancements of signal strength (SES) are observed on field strength recordings of extremely stable VLF transmissions. The times of beginning, ending and maximum are given in UT, as well as a subjective importance rating from 1-to 3+ as in the column headed SES and a widespread index as described under SWF above. The reporting stations are the AAVSO observers A1, A3, A5, and A14.

SFD

An SFD, sudden frequency deviation, is defined as a rapid change in the received frequency of an ionospherically propagated signal observed during a solar flare. SFD's are detected by comparing the signal received from a highly stable transmitter with a locally generated signal of comparable stability which is offset from the transmitted frequency by a few cycles per second. This produces a frequency difference of a few cycles per second, and any sudden changes in the phase path of the ionospherically propagated signal are indicated by rapid changes in this difference frequency. A typical SFD consists of a rapid positive frequency shift followed by a negative shift and a gradual return to the pre-flare conditions. However, there is great variation observed from one event to another. The maximum positive frequency deviation observed varies with the operating frequency and the path length involved. SFD's as small as a tenth of a cycle per second and as large as forty cycles per second have been observed. A more complete discussion of this technique and the related theory, and additional references, can be found in "Doppler Studies of the Ionospheric Effects of Solar Flares" by K. Davies (Proceedings of the International Conference on the Ionosphere, London, July 1962, Institute of Physics and the Physical Society, London, 1963).

The time column gives the times of the start, end and maximum frequency deviation of the sudden frequency deviation in UT. The SFD column gives the largest frequency deviation observed, for the various paths and frequencies used, during a given event in tenths of a cycle per second (i.e. 014 = 1.4 cycles per second). The station column gives the maximum positive frequency deviations (in cycles per second) observed on the different frequencies and paths being used. The receiver location (BO = Boulder, Colorado; AC = Accra, Ghana; NA = Natal, Brazil; FR = Frankfurt, GFR) is given followed by a parenthetical remark giving the transmitter location (WWV = Beltsville, Maryland; WWVH = Maui, Hawaii; KKE = Sunset, Colorado; MN = Monrovia, Liberia), the carrier frequency to the nearest Mc/s, and the frequency deviation in cycles per second. For example, BO(KKE 4-1.2) indicates that a frequency deviation of 1.2 cycles per second was observed at Boulder on the 4 Mc/s transmission from Sunset, Colorado.

A table lists these phenomena jointly giving: date, beginning, ending and maximum phase in UT; type and importance rating if SWF; percent absorption and importance if SCNA; importance if SEA; or degrees of phase change if SPA with path designated; importance if SES; cycle per second frequency deviation if SFD and frequencies on which observed; importance of solar noise burst observed at 18 Mc/s; a geographically widespread index for type of event; stations observing event; and associated solar flare, if known (asterisk if no patrol). In the tables D = greater than, E = less than and U = approximate.

Riometer Absorption Events

Beginning with data for June 1965, the periods of absorption have been reported from Great Whale River, Canada (N55.33°, W77.83°). The equipment operates at 30 Mc/s and uses a zenithal antenna with 34° half-width to 3 db power points.

Great Whale River is located in the zone of maximum auroral activity. Therefore, it may be expected that the riometer will record less polar cap absorption and more auroral type absorption than Frobisher Bay which is no longer in operation and whose data were published until June 1965.

The columns show date, time of start of event, time of maximum absorption, time of end of event, absorption in tenths of a decibel at the maximum, number of major absorption peaks in the event (i.e., those exceeding half the largest). All dates and times are in UT. The report is confined to those events having at least 0.3 db of absorption at the maximum. Groups of short events separated by less than two hours are normally reported as a single event.

IV SOLAR RADIO WAVES

2800 Mc/s Solar Burst Observations -- Burst phenomena are measured above the quiet sun level on the basis of the classification described by Covington, Jour. Astro. Soc. Can. 45, 1951, and Paper 28, Paris Symposium on Radio Astronomy, 1959. These terms have also been found to be of significance over large bands in the microwave region. The tabulation includes events not only from ARO at Lake Traverse (Lat. 45°57'N Long. 78°03'W) but also from the Dominion Radio Astrophysical Observatory at Penticton, B.C. (Lat. 49°19'N Long. 119°37'W). The latter observations are on the frequency of 2700 Mc/s which has been allocated to the radio astronomy service.

Tabulations of the bursts for the combined observing day of ARO and DRAO include the URANE code type as reported telegraphically, descriptive type, the time of commencement in UT, duration in hours and minutes, mean flux, UT of maximum flux and value of peak flux. Many of the microwave bursts show a rise to a single maximum and subsequent decay. Three types of these "Simple" bursts are designated by the regions occupied in a scatter diagram of Burst Intensity versus Duration. These are shown in the figure and are described numerically in the table. Consideration of the rate of flux increase leads to further descriptions of the Simple bursts 2 as "Impulsive" and to the Simple bursts 3 as "Long Enduring" or as "Gradual Rise and Fall". Simple bursts 1 may be either Impulsive or Non-impulsive. Further description of these and other bursts requires a numerical measure of the degree of impulsiveness.

Varying degrees of complexity are noticed in the microwave bursts. Bursts with two or more peaks are termed "Complex" bursts. If the minimum flux between peaks reaches that of the quiet sun for a short interval, the composite event is termed a "Group", and individual listings of the components are provided. When the complexity is such that it is difficult to tabulate individual parts, the event is termed a "Period of Irregular Activity" or "Fluctuations". If this appears as a separate event, it is given a separate type-number in the URANE code, but if superimposed upon a Simple or Complex burst as a secondary feature, it is not given a URANE code number and is only recorded by the letter "f" added to the basic descriptive term.

A gradual increase in flux which precedes the Impulsive burst is designated as a "Precursor".

Many bursts, both Simple and Complex, are followed by an enhanced level of great duration and designated as a "Post Burst Increase". If these two features, the Precursor and the Post Burst occur together and are simply connected, they are combined into a Simple 3A burst.

A decrease in the quiet sun level observed after an Impulsive event is designated as "Post Burst Decrease" or "Absorption". A "Rise Only" in flux, likewise a "Fall Only", are occasionally observed.

Microwave bursts of great intensity, with peak intensity equal to or greater than 750 flux units are of special geophysical interest and are generally very complex. The secondary fluctuations are comparable to the average bursts so that these events have been placed in a group designated "Great Bursts". In the URANE code they are listed as Complex bursts. The unit of intensity for burst classifications, 7.5 flux units, has been adopted since it is approximately 1/10 of the quiet solar flux at sunspot minimum. The error intensity of the small bursts is similar to the error in the daily flux level, for the more intense bursts the error may be as high as ±15%.

The commencement of a burst is taken when the enhancement of the daily flux shows a departure from the daily level by an amount of approximately 1 flux unit. For the impulsive bursts this may be determined certainly to within a minute while for the Gradual Rise and Fall burst, the uncertainty in the time of commencement may be as great as 5 minutes. The letter "E" appearing after the time of start, indicates that the burst was already in progress at this time. Profiles of typical bursts are produced on page 23.

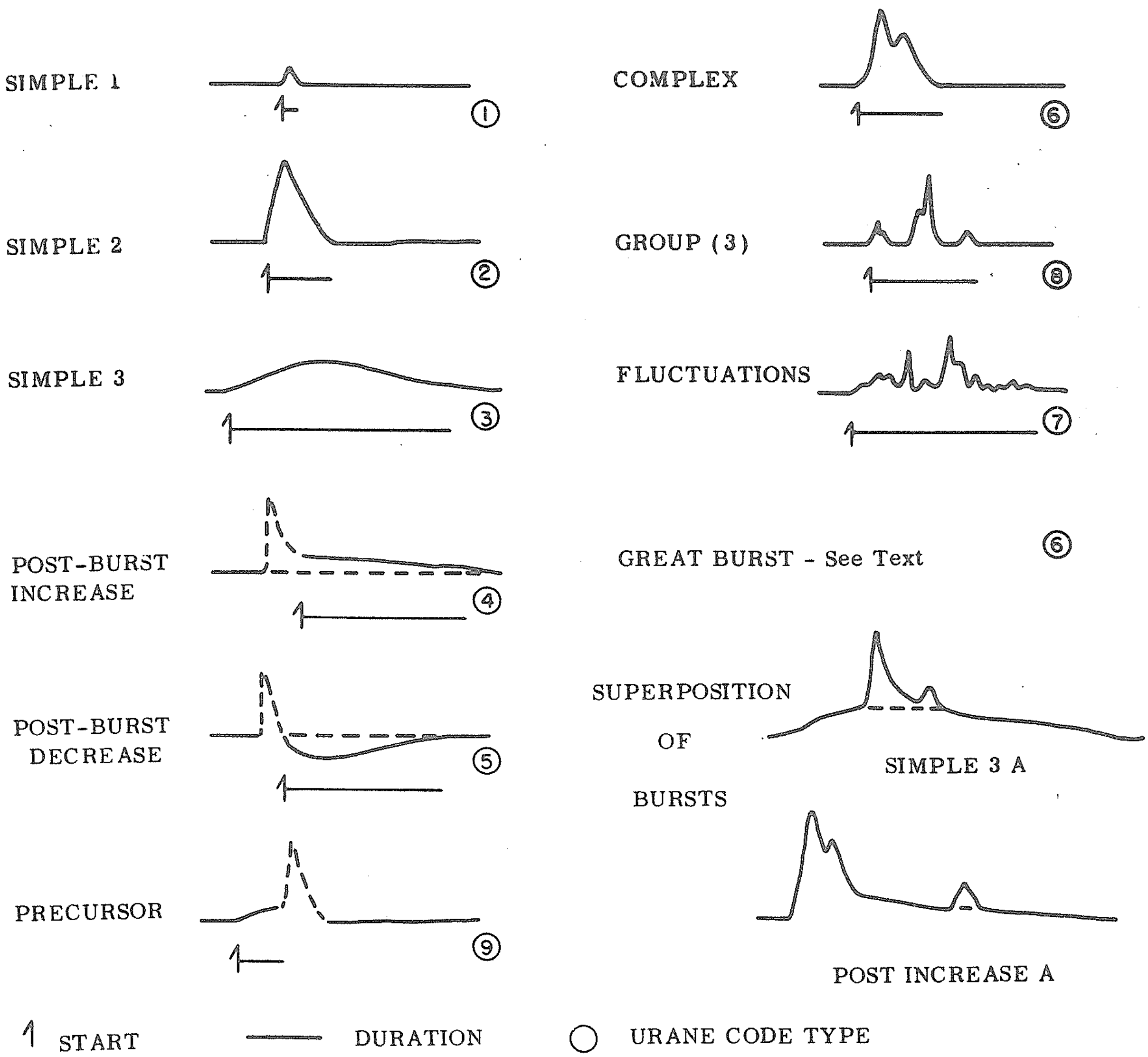
From time to time photographic copies or tracings of the more interesting outstanding occurrences are published.

<u>10,700 Mc/s, 2,700 Mc/s, 960 Mc/s and 328 Mc/s Solar Noise Observations</u>:

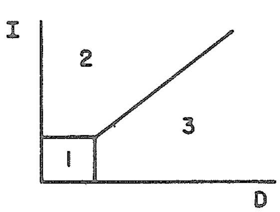
The Radio Astronomy Observatory at the Pennsylvania State University is conducting a daily solar patrol at 10,700 Mc/s, 2,700 Mc/s, 960 Mc/s and 328 Mc/s. An interferometer operating at approximately 80 Mc/s is under construction. The purpose of this patrol is to obtain correlated flux measurements with emphasis on solar bursts. The patrol operates from 1200-2400 UT.

The antennas for the four radiometers now operating are all mounted on a single polar tracking mount located on the roof of the Radio Astronomy Observatory. The 10,700 Mc/s and 2,700 Mc/s radiometers use 4-foot and 6-foot waveguide fed, parabolic reflecting antennas, respectively. The 960 Mc/s uses a dipole fed, 6-foot parabolic reflecting antenna, while the 328 Mc/s radiometer uses a pair of stacked Yagi antennas.

MICROWAVE BURST TYPES – 2800 MC/S – OTTAWA, CANADA



RELATION OF SIMPLE BURSTS TO DIAGRAM OF INTENSITY VERSUS DURATION

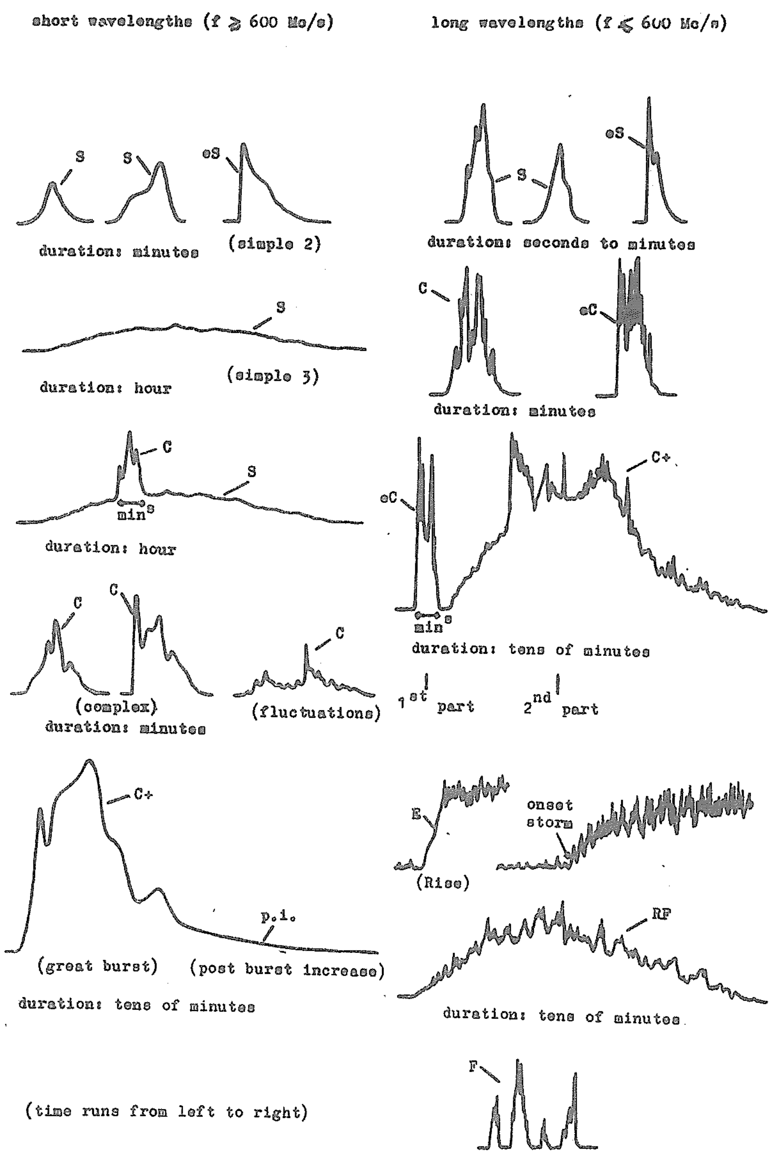


Region 1 - SIMPLE 1 : Intensity ≤ 7.5 flux units
Duration ≤ 7.5 minutes
May be impulsive

Region 2 - SIMPLE 2 : Intensity > 7.5 flux units
Impulsive

Region 3 - SIMPLE 3 : Duration > 7.5 minutes
Long Enduring (Gradual Rise and Fall)

FLUX UNIT 10^{-22} watts/m^2/c/s



Classification of distinctive events.

The receivers operating at 10,700 Mc/s, 2,700 Mc/s and 960 Mc/s are essentially similar switched receivers. The 328 Mc/s receiver is a total power receiver with a band-width of 80 kc/s. The band-width of each of the other three receivers is 8 Mc/s.

The sensitivities of the two receivers for which data are being reported are approximately $6.0 \times 10^{-22} Wm^{-2} (c/s)^{-1}$ for the 10,700 Mc/s system and approximately $1.0 \times 10^{-22} Wm^{-2} (c/s)^{-1}$ for the 2,700 Mc/s system.

The outstanding occurrences are presented in accordance with the classification scheme on page 19 of IQSY Instruction Manual No. 2 Solar Activity. The type, time of beginning in UT, time of maximum in UT, duration in minutes, peak and mean flux densities are tabulated. (See figure on page 24.)

223 Mc/s Interferometer System -- The Geo-Astrophysics Laboratory of Boeing Scientific Research Laboratories operates a swept-lobe interferometer as part of its program of research in solar physics. The nominal frequency of operation is 223 Mc/s. Small occasional frequency shifts in the operating frequency are made to minimize interference problems. Each of the two antenna arrays consists of eight 10-element Yagi antennas, equatorially mounted to track the sun.

The data presentation is in the form of amplitude and phase recordings. The phase recording consists of an analog representation of the phase difference between the receiving antennas and has a saw-tooth appearance. Two quasi-logarithmic amplitude recorders are used. Of these the higher sensitivity one reaches full scale deflection at a flux level of approximately 65×10^{-22} watts/m^2/c/s. Full scale deflection on the other corresponds to a flux of about $81{,}000 \times 10^{-22}$ watts/m^2/c/s.

The solar data are reported in accordance with the classification criteria reported by Dodson, Hedeman and Owren (Ap. J. 118, 169, 1953). The bursts are reported by a description of the type of event, i.e., rise in base level, series of bursts, etc. Distinctive bursts of ten flux units or greater are usually reported and the maximum received flux density is reported wherever possible.

This equipment is not operated routinely on the sun, but whenever it is, reports will be provided.

<u>408 Mc/s and 169 Mc/s Solar Interferometric Observations</u> -- The 408 Mc/s interferometric observations are recorded around local noon at Nançay, France (N47°23', E8^{m}47^{s}), the field station of the Meudon Observatory. The main lobes are parallel to the meridian plane: the half-power width is 1.7 minutes of arc in the East-West direction. The main lobes are about 25' apart (B. Clavelier, Comptes Rendus Acad. Science, Paris, in press).

The records give the position and the intensity of centers observed at this frequency. These daily data are plotted on the same chart. The intensity is given in 10^{-22}W/m^2/c/s and clearly indicated for the centers whose flux density is more than 0.20 x 10^{-22}W/m^2/c/s. The distance between the main lobes being smaller than the radioelectrical diameter of the sun, there is sometimes an ambiguity about the position East or West of the center of activity. In this case, the two possible positions are indicated on the chart by a circle.

The 169 Mc/s interferometric observations are also recorded around local noon at Nançay, France (N47°23', E8^{m}47^{s}), the field station of the Meudon Observatory. The main lobes are parallel to the meridian plane: the half-power width is 3.8 minutes of arc in the East-West direction. The main lobes are about 1° apart (Ann. Astroph. <u>20</u>, 155, 1957). The records give the strip intensity distribution from the center of the disk to 30' to the West and East.

These daily distributions are plotted on the same chart giving diagrams of evolution. Points of equal intensity given in relative units are joined day after day in the form of isophotes. Four equal intensity levels have been chosen to draw the isophotes. These intensities are proportional to 0.6, 1, 1.5 and 2. The first level corresponds to the sun without any radio storm center.

In each noisy radio region the smoothed intensity around noon is given in 10^{-22}W/m^2/c/s.

Beginning with the chart for October 1965 the flux density for the storm centers is no longer given on an arbitrary scale. Therefore, the indicated numbers are not comparable to those of preceding years.

108 Mc/s Solar Noise Observations -- Data on solar radio emission at the nominal frequency of 108 Mc/s recorded at the Table Mountain (Boulder) station of the Institute for Telecommunication Sciences and Aeronomy of Environmental Science Services Administration are presented. The antenna is equatorially mounted and linearily polarized. The plane of polarization is parallel to the solar rotation axis.

> Note: Data on solar radio emission at 167 Mc/s recorded at the Gunbarrel Hill (Boulder) station of the National Bureau of Standards were terminated September 30, 1960. (See earlier reports for details.) The 108 Mc/s equipment started October 1, 1960.

Only the outstanding occurrences are reported. A scale of 1 to 3 is now used for the estimate of smoothed maximum flux where:

1 signifies <10 x quiet sun
2 signifies >10 <100 x quiet sun
3 signifies >100 x quiet sun

Starting and maximum times in UT are read to the nearest 1/10 minute if they are very definite and otherwise to the nearest minute. If the duration is less than five minutes, it is given to the nearest 1/10 minute: otherwise to the nearest minute. The following qualifying symbols are used:

E = Event in progress before observations began.
D = Event continues after observations cease.
S = Measurement may be influenced by interference or atmospherics.

The types of the outstanding occurrences follow the classification originally described for 200 Mc/s observations by Dodson, Hedeman and Owren (Ap. J. 118, 169, 1953). The types are identified by numbers which describe the character of the trace, but not the magnitude of the event, as follows:

0 - Rise in base level -- A temporary increase in the continuum with duration of the order of tens of minutes to an hour.

1 - Series of bursts -- Burst or groups of bursts, occurring intermittently over an interval of time of the order of minutes or hours. Such series of bursts are assigned as distinctive events only when they occur on a smooth record or show as a distinct change in the activity.

2 - Groups of bursts -- A cluster of bursts occurring in an interval of time of the order of minutes.

3 - Minor burst -- A burst of moderate or small amplitude, and duration of the order of one or two minutes.

4 - Minor burst and second part -- A double rise in flux in which the early rise is a minor burst.

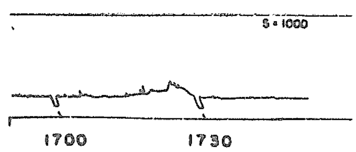
6 - Noise storm -- A temporary increase in radiation characterized by numerous closely spaced bursts, by an increase in the continuum, or by both. Duration is of the order of hours or days.

7 - Noise storm begins -- The onset of a noise storm occurs at some time during the observing period.

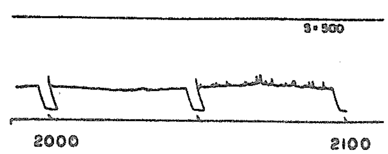
8 - Major burst -- An outburst, or other burst of large amplitude and more than average duration. A major burst is usually complex, with a duration of the order of one to ten minutes.

9A, 9B or 9 - Major burst and second part or large event without distinct first and second parts -- If there is a double rise in flux, the first part, a major burst, is listed as 9A and the second part as 9B. The second part may consist of a rise in base level, a group or series of bursts, a noise storm. A major increase in flux with duration greater than ten minutes but without distinct first and second parts, is listed simply as 9.

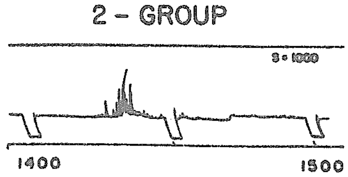
1
0-RISE IN BASE LEVEL



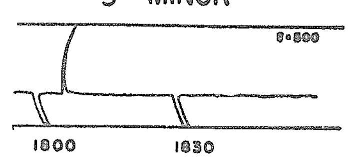
2
1-SERIES

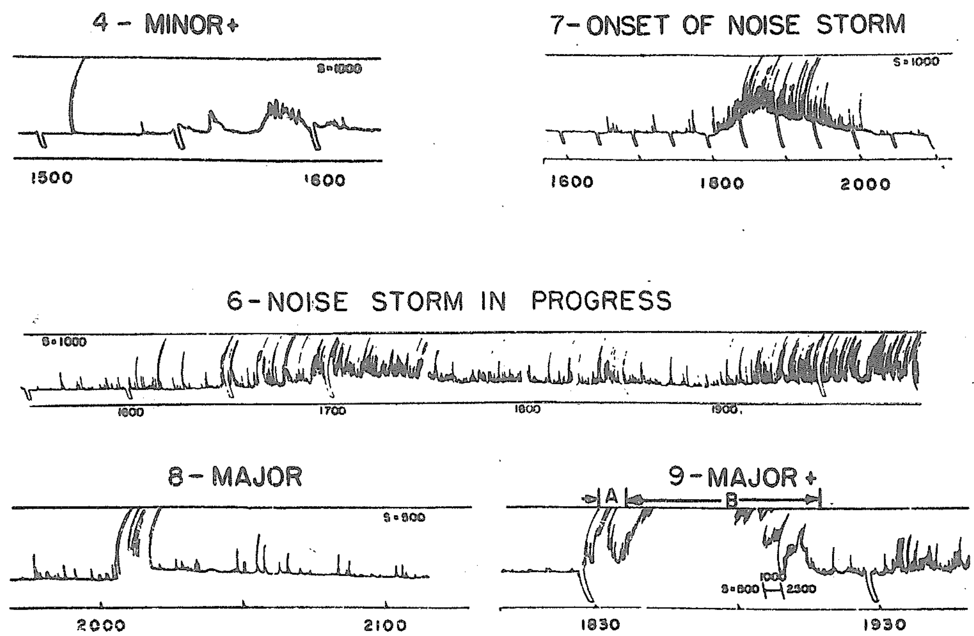


3
2 - GROUP



4
3 - MINOR





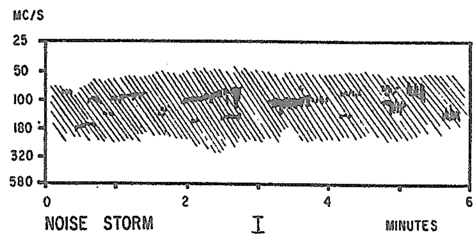
Notes: In the present tables, the type classification 0 is not used: it has been included above only for information.

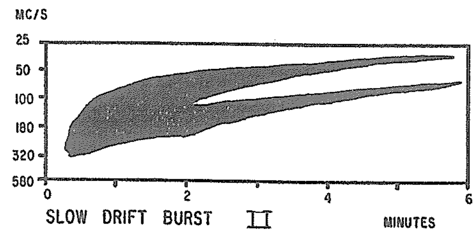
In the nominal times of observation table, the times preceded by I signify periods of interference that could mask solar events.

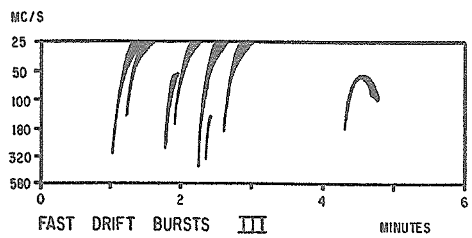
From time to time photographic copies of the more interesting outstanding occurrences are published.

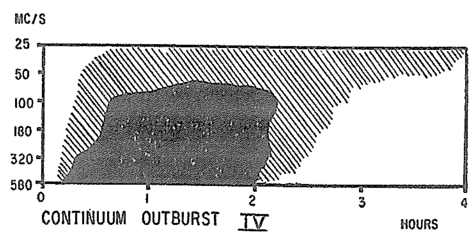
107 Mc/s Solar Noise Observations -- Beginning with June 1965 outstanding occurrences of solar radio emission are presented at the nominal frequency of 107 Mc/s as recorded by the Hawaii Institute of Geophysics of the University of Hawaii at the Haleakala Observatory on Maui under the direction of Dr. John L. Jefferies. This program is supported by contract with ESSA. The antenna is identical with the one used at the Table Mountain Boulder station on 108 Mc/s. The outstanding occurrences are reported in the same manner as for 108 Mc/s described above.

<u>Solar Spectral Observation - Fort Davis</u> -- Data are presented on solar radio emission in the spectral range 25-320 Mc/s recorded at the Radio Astronomy Station of Harvard College Observatory, Fort Davis, Texas. The research program is supported by financial assistance from the Air Force Cambridge Research Laboratories and the Sacramento Peak Observatory. The equipment used at the Station has been described elsewhere (Thompson, Astrophys. J. <u>133</u>, 643, 1961). The following activity is listed: limited information on noise storms (type I); slow-drift bursts (type II); groups of fast-drift bursts with more than 10 individual bursts (type IIIG); continuum bursts (type IV). Idealized examples of the bursts are shown below:









Observations are made for ten hours daily (see UT times listed in column 1 of the table). Entries in the tables are given in Universal Time (UT), and the accuracy is to the nearest half minute, except in the case of major outbursts which are specified to the nearest 0.1 minute. Three classes of intensity are listed: 1 (faint), 2 (moderate), and 3 (strong). At 100 Mc/s these correspond to 5-40, 40-200, and >200 x 10^{-22} watts/m^2/c/s, respectively. The frequency range in Mc/s for the burst is given, as well as additional remarks when appropriate.

Solar Spectral Observations - Astrogeophysics Department, University of Colorado -- Data are presented on solar radio emission in the spectral range 7.6 to 41 Mc/s scanned in 0.65 seconds, recorded by the Astrogeophysics Department of the University of Colorado, Boulder, Colorado. The research program is supported by ESSA and the National Science Foundation.

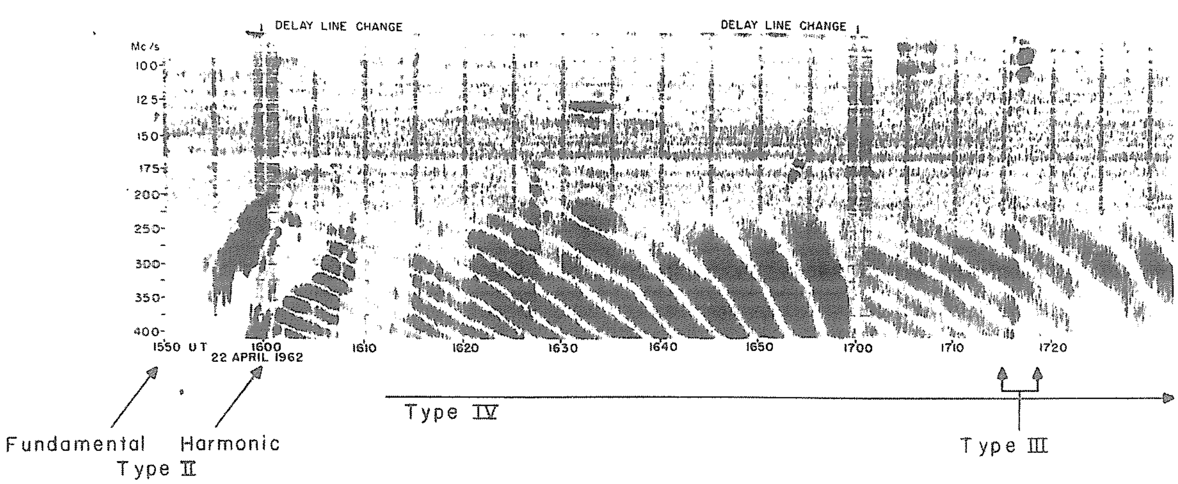
The collecting area of the antennas is approximately 1000 square meters, in two corner reflectors forming an interferometer pair. Observations are taken routinely throughout the Boulder observing day from about 1400 UT to 2400 UT. On the low-frequency side, bursts are frequently limited by an external reflection of the waves above the ionosphere. Examples of Type III (fast drift) and continuum records taken with this equipment are published in A. Boischot, R. H. Lee, and J. W. Warwick, Ap. J. 131, 61 (1960). An example of Type II (slow drift) and Type IV burst is included herewith; the Type II is detected not only by means of the (relatively small) enhancement it produces against a background of continuum, but also by means of the fast fluctuations of fringe position produced as the burst drifts through the low-frequency range. Continuum of two kinds is reported: (a) in close association with Type III burst storms, and often also with reverse drift bursts. This is described simply as "continuum" and is often, but not always, associated with noise storms on metric wave lengths; (b) following major outbursts of Type III or Type II associated with flares. These latter cases of continuum are labelled Type IV in the tables; the attached photograph illustrates an outstanding example. Intensities are on a rough scale from 1- to 3+, crudely convertible to flux densities as follows:

1- to 1+; $5 \times 10^{-22} < S < 2 \times 10^{-21}$

2 to 2+; $2 \times 10^{-21} < S < 8 \times 10^{-21}$

3 to 3+; $8 \times 10^{-21} < S \leq 3 \times 10^{-20}$

Above about 3×10^{-20} watts m^{-2} $(cps)^{-1}$, the equipment saturates and does not indicate relative intensities satisfactorily.



The times of beginning and ending are given in UT. Symbol "b" is used for an event in progress before time given and "a" for one that ends after the time given. The frequency range for the burst is also given.

21 cm Solar Spectroheliograms -- A daily series of radio spectroheliograms, beginning with December 1964, are presented from the "Fleurs" Radio Astronomy Field Station of the University of Sydney, Sydney, Australia, under the direction of Professor W. N. Christiansen. East-West and North-South arrays in the form of a cross give pencil beam scans with a resolution of about three minutes of arc. This program is supported by ESSA through National Aeronautics and Space Administration assistance.

The maps show the distribution of radio emission across the solar disk at a wavelength of 21 cm by means of brightness temperature values. The unit of brightness temperature is 1700°K. It gives about the same central temperature for the quiet sun as was found at the last minimum epoch (47,000°K). The noise level is about 5 units. Contours have been sketched at the 50 and 100 unit levels to draw attention to the brighter radio plage regions. Since there is equatorial limb brightening of the quiet sun, weak radio plages in the center of the disk are discriminated against. Below each number is a dot marking the point on the disk to which the number specifically refers.

East-West solar scans from the 21 cm solar radio array are also presented beginning with October 1965 data. The fan-beam has 2' of arc resolution. The two short horizontal lines drawn crossing the center line indicate the cold-sky level and the estimated quiet-sun level. The gain may differ from day to day. The curves have not been normalized to account for these gain variations other than the indication of the estimated quiet-sun level.

9.1 cm Solar Spectroheliograms -- Microwave spectroheliograms are made daily at the Radio Astronomy Institute, Stanford University, Stanford, California (N37° 23.9', W122° 11.3') under the direction of Professor R. N. Bracewell. This program is supported by ESSA.

These spectroheliograms show the distribution of microwave emission over the sun's disk as observed with a pencil beam whose East-West width to half power is 3.1', and whose North-South width varies from 3.1' in summer to nearly 6' in mid-winter (actual value 3.1' sec $(38.2° - \delta_{\odot})$ at a declination $\delta_{\odot}$ on the meridian).

For a full description of the instrument and its response see "The Stanford Microwave Spectroheliograph Antenna, a Microsteradian Pencil Beam Interferometer", IRE Transactions on Antennas and Propagation, vol. AP-9, pp. 22-30, 1961, by R. N. Bracewell and G. Swarup.

Since 1 January 1964 the maps have had 21 rows, each containing 25 temperature readings. The original maps, prior to reproduction, have 10 characters per inch horizontally and 3 lines per inch vertically, as on a typewriter; the radius of the solar disk agrees with the international standard of 7.5 cm (2.95 inches). Two + signs at the bottom of the map are 15 cm apart on the original. The center of the map, as fixed by absolute timing, is in the eleventh row, between the units and tens digits of the thirteenth reading (at the centroid of the characters NP, SP, E, W appearing on the edges of the map).

Each reading of microwave emission occupies three spaces, and refers to a point on the sun centrally between the units and tens digits. The horizontal spacing of adjacent readings is about 1.63', and the vertical spacing is about 1.81'. Since the angular diameter of the sun varies with the season by about 1.7 percent, more precise values are 0.3R/2.95 and 1/3 R/2.95, where R is the sun's semi-diameter in minutes of arc taken from The American Ephemeris and Nautical Almanac. Each reading thus refers to a solid angle of about 1.63 x 1.81 square minutes of arc, or 2.50×10^{-7} steradians. We attempt to time our readings to better than 2^s absolute accuracy,* or within about 0.5' at the worst in the horizontal direction. The precision with which the rows of the map are positioned on the sun's disk is a certain fraction of the North-South beamwidth, ranging from about 0.5' in summer to 1.0' in winter.

The reading printed on the map in the ith column and jth row is y_{ij} and the corresponding brightness temperature in degrees Kelvin, to the resolution allowed by the instrument, is Cy_{ij}. The unit C is currently 1000°K. (Before 1 July 1965, the unit C varied from day to day around a value of 2000°K which was stated on the map.) The readings are normalized so that the flux density S of the whole sun is equal to the absolute measurement obtained the same day on 10.7 cm by A. E. Covington at the National Research Council, Ottawa. No

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* Examination of the maps for 1964 revealed a small but regular displacement of the maps towards the East; beginning 3 September 1965 this discrepancy has been neutralized by the addition of 2^s to the calculated starting time.

adjustment is made for the difference in wavelength. The formula used is

$$S = \frac{2k}{\lambda^2} C \sum y_{ij} \ (2.50 \times 10^{-7}) \left(\frac{R}{16.02}\right)^2$$

$$= 8.31 \times 10^{-28} \ C \sum y_{ij} \left(\frac{R}{16.02}\right)^2 \ \text{watts m}^{-2} (\text{c/s})^{-1},$$

where S is the flux density of the whole sun, k is Boltzmann's constant (1.38×10^{-23} joules per degree K), λ (= 9.107 cm) is the operating wavelength, and R/16.02 is the ratio of the sun's semi-diameter in minutes of arc to its mean. Active regions are emphasized by dots where the brightness temperature is 40,000°K or more (previously readings of 20 and over were underlined); however, the underlining also shows up the limb brightening at the extremities of the equatorial diameter on occasion. Negative readings which occur do so because of the sharp cutoff in the sensitivity of the instrument to the spatial Fourier components of the source. The two-dimensional response pattern of the instrument to a point source is

$$\text{sinc} \frac{16dx}{\lambda} \ \text{sinc} \ \frac{16d \cos (38.2^\circ - \delta_\odot) y}{\lambda},$$

where $\text{sinc } x = (\sin \pi x)/\pi x$.

Standardized spectroheliograms are available at Stanford Radio Astronomy Institute in the form of punched cards and machine-made contour charts.

Flux densities of active regions may be calculated as follows. A point source on the sun produces a peak excess brightness temperature T_p (relative to the background temperature of the adjacent quiet areas) from which the flux density S_1 of the source can be calculated using the expression

$$S_1 = \frac{2kT_p}{\lambda^2} \Omega ,$$

where Ω is the effective solid angle of the antenna beam.

Now $\Omega = (\lambda/16d)^2 \sec (38.2^\circ - \delta_\odot)$, where d (= 25.00 feet) is the antenna spacing. Hence

$$S_1 = \frac{kT_p \sec (38.2° - \delta_{\odot})}{128d^2}$$

$$= 1.85 \times 10^{-27}\, T_p \sec (38.2° - \delta_{\odot}).$$

V COSMIC RAY INDICES

The tables and chart present the scaled hourly count rate average for each 24 hour interval (Universal Time) for four high counting rate neutron monitors. The monitors have different values of magnetic cut-off rigidity, while the asymptotic cones of acceptance of the four "look" in essentially the same direction in space. The four sets of data can therefore be used to estimate the rigidity dependence of fluctuations which occur in the primary cosmic radiation.

The characteristics of the four stations can be summarized as follows:

Station	Churchill	Deep River	Climax	Dallas
Geographic Latitude	58°45'N	46°36'N	39°22'N	32°47'N
Geographic Longitude	94°05'W	77°30'W	106°11'W	96°48'W
Vertical Cut Off rigidity	< 0.21 BV	1.02 BV	3.03 BV	3.98 BV
Altitude	39M	145M	3400M	208M
Detector	NM64	NM64	IGY	NM64

The Climax, Colorado, USA, neutron monitor, station number B305, data are communicated by J. A. Simpson and G. Lentz of the Enrico Fermi Institute for Nuclear Studies, University of Chicago. The instrument is a standard Chicago type neutron monitor, utilizing 12 BF_3 counter tubes. The station has a mean barometric pressure P = 504.0 mm Hg. For a more detailed description of the neutron intensity monitor and its associated electronics see J. A. Simpson, Annals of the IGY, Vol. IV, Part VII, pp. 351-373 (1957). The following correction factor is used at Climax:

$$R_{corr} = R_{obs}\, e^{\delta P/L}$$

where $\delta P = P - P_{obs}$, the mean minus the observed pressures, and L is the absorption mean free path of 106.0 mm Hg. The data are in scaled counts per hour; the scaling factor being ~~128~~. The publication of these data in this monthly series began September 1960. Earlier data, beginning June 1957, are available in bihourly form at the World Data Center A for Cosmic Rays.

The Dallas, U.S.A. and Churchill, Canada, neutron monitors follow the IQSY design described by Carmichael (IQSY Instruction Manual No. 7). The data from Dallas and Churchill have been pressure corrected, using an attenuation length of 140.0 grams cm^{-2}, to constant atmospheric pressures. The Dallas reference pressure was 1000 mb until 6 August 1965, being changed from that date to 995 mb, while Churchill uses 1010 mb. Scaling factors of 120 are employed in both installations. The data have not been corrected for the minor changes ($< 1\%$) in efficiency of monitor which inevitably occur over any appreciable period of time. The Dallas monitor is operated by K. G. McCracken at the Graduate Research Center of the Southwest, Dallas, Texas, while the Churchill monitor is operated by the above, in collaboration with D. C. Rose of the National Research Council of Canada. The Churchill Laboratory of the National Research Council of Canada is responsible for the day-to-day maintenance of the Churchill monitor. The Dallas monitor commenced operation on 1 December 1963, while the Churchill monitor commenced operation on 18 April 1964. Hourly mean data from both installations are routinely distributed to the scientific community on a monthly basis by the Cosmic Ray Laboratory, Graduate Research Center of the Southwest, P. O. Box 30365, Dallas, Texas, 75230, U.S.A.

The chart depicts the variations of cosmic ray intensity recorded by the IQSY design 48-NM-64 neutron monitor at Deep River, Ontario, Canada, as submitted by H. Carmichael and J. F. Steljes of Atomic Energy of Canada Limited, Chalk River, Ontario. The vertical scale lines mark the days of the month in Universal Time: the horizontal scale lines are at intervals of 5% based upon 1.846×10^6 counts per hour (after barometric correction) arbitrarily taken as 100%. The charts have been published from January 1959, publication beginning in the November 1960 issue. From January 1959 to April 1962 a smaller monitor was used and the 100% counting rate was 0.0555×10^6 counts per hour. From May 1962 to January 1965 the monitor was of intermediate size and the 100% counting rate was 0.555×10^6 counts per hour. A preliminary barometric coefficient was used from May 1962 to

October 1962; in the March 1963 issue final revised charts were published for these six months using a better value of the barometric coefficient.

VI GEOMAGNETIC ACTIVITY INDICES

Kp, Ci, Cp, Ap, and Selected Quiet and Disturbed Days -- The data in the table are: five quiet days (Q), ten quiet days (Q or q), and five disturbed days (D) adjacent to date; three-hour range indices Kp; preliminary international character figure, Ci; character figure, Cp (standardized Ci); and daily "equivalent amplitude", Ap.

The data are made available by Commission IV: Magnetic Activity and Disturbances. The Meteorological Office, De Bilt, Holland collects the data from magnetic observatories distributed throughout the world, and compiles the Ci and selected days data. Göttingen University computes the planetary and equivalent amplitude indices. The same data are also published in the Journal of Geophysical Research along with data on sudden commencements (sc) and solar effects (sfe), and principal magnetic storms.

Kp is the mean standardized K-index from 12 observatories between geomagnetic latitudes 47 and 63 degrees. The scale is 0 (very quiet) to 9 (extremely disturbed), expressed in third of a unit, e.g., 5- is 4 and 2/3, 5o is 5 and 0/3, and 5+ is 5 and 1/3. This planetary index is designed to measure solar particle-radiation by its magnetic effects, specifically to meet the needs of research workers in the other geophysical fields.

The Ci-figure is the arithmetic mean of the subjective classification by all observatories of each day's magnetic activity on a scale of 0 (quiet) to 2 (storm).

The Cp-figure is a standardized version of the Ci-figure and is derived from the indices Kp by converting the daily sum of ap into the range 0.0 to 2.5.

Ap is a daily index of magnetic activity on a linear scale rather than on the quasi-logarithmic scale of the K-indices. It is the average of the eight values of an intermediate 3-hourly index "ap", defined as one-half the average gamma range of the most disturbed of the three force components, in the three-hour interval at standard stations; in practice, ap is computed from the Kp for the 3-hour interval. The extreme range of the scale of Ap is 0 to 400. Values of Ap (like Kp and Cp) have been published for 1932 to 1961 in IAGA Bulletin No. 18 by J. Bartels, distributed by North-Holland Publishing Company, Amsterdam.

The magnetically quiet and disturbed days are selected in accordance with the general outline in Terr. Mag. (predecessor to J. Geophys. Res.) 48, pp. 219-227, December 1943. The method in current use calls for ranking the days of a month by their geomagnetic activity as determined from the following three criteria with equal weight: (1) the sum of the eight Kp's; (2) the sum of the squares of the eight Kp's; and (3) the greatest Kp.

Chart of Kp by Solar Rotations -- Monthly a graph of Kp is given for eight solar rotations, furnished through the courtesy of the Geophysikalisches Institut of the University of Göttingen. Annually a graph of the whole year by solar rotations is included. From time to time another 27-day rotation chart depicting the daily geomagnetic character figure, C9, is presented. C9 is obtained from Cp by reducing the Cp-values to integers between 0 and 9 according to the key given in the charts.

The activity indices are described by J. Bartels in Annals of the IGY, Vol. IV, pp. 227-236, London Pergamon Press 1957. Below the chart of Kp a table of Ap indices for the last 12 months is presented so that trends in magnetic activity can be easily followed.

VII RADIO PROPAGATION QUALITY INDICES

One can take as the definition of a radio propagation quality index: the measure of the efficiency of a medium-powered radio circuit operated under ideal conditions in all respects, except for the variable effect of the ionosphere on the propagation of the transmitted signal. The indices given here are derived from monitoring and circuit performance reports, and are the nearest practical approximation to the ideal index of propagation quality.

Quality indices are expressed on a scale that ranges from one to nine. Indices of four or less are generally taken to represent significant disturbance. (Note that for geomagnetic K-indices, disturbance is represented by high numbers.) The adjectival equivalents of the integral quality indices, known as the CRPL quality figure scale, are as follows:

1 = useless	4 = poor-to-fair	7 = good
2 = very poor	5 = fair	8 = very good
3 = poor	6 = fair-to-good	9 = excellent

The forecasts are expressed on the same scale. The tables summarizing the outcome of forecasts include categories P-Perfect; S-Satisfactory; U-Unsatisfactory; F-Failure. The following conventions apply:

P - Forecast quality equal to observed.

S - Forecast quality one grade different from observed.

U - Forecast quality two grades different from observed when both forecast and observed were ≥ 5, or both ≤ 5.

F - Other times when forecast quality two or more grades different from observed.

Full discussion of the reliability of forecasts requires consideration of many factors besides the over-simplified summary given.

The quality figures represent a consensus of experience with radio propagation conditions. Since they are based entirely on monitoring or traffic reports, the reasons for low quality are not necessarily known and may not be limited to ionospheric storminess. For instance, low quality may result from improper frequency usage for the path and time of day. Although, wherever it is reported, frequency usage is included in the rating of reports, it must often be an assumption that the reports refer to optimum working frequencies. It is more difficult to eliminate from the indices conditions of low quality for reasons such as multipath or interference. These considerations should be taken into account in interpreting research correlations between the Q-figures and solar, auroral, geomagnetic or similar indices.

North Atlantic Radio Path -- The CRPL quality figures, Qa, are compiled by the Telecommunications and Space Disturbance Services Center at Fort Belvoir, Virginia, from radio traffic data for North Atlantic transmission paths closely approximating New York-to-London. These are reported by the Canadian Defence Research Board, Canadian Broadcasting Corporation, and the following agencies of the U. S. Government: Coast Guard, Navy, Army Communications Center, U. S. Information Agency. Supplementing these data are ESSA monitoring, direction-finding observations and field-strength measurements of North Atlantic transmission made at Fort Belvoir.

The original reports are submitted on various time intervals. The observations for each 6-hour interval are averaged on the original scale. These 6-hour indices are then adjusted to the 1 to 9 quality-figure scale by a conversion table prepared by comparing the distribution of these indices for at least four months, usually a year, with a master distribution determined from analysis of the reports originally made on the 1 to 9 quality-figure scale. A report whose distribution is the same as the master is thereby converted linearly to the Q-figure scale. The 6-hourly quality figure is the mean of the reports available for that period.

The 6-hourly quality figures are given in this table to the nearest one-third of a unit, e.g., 5o is 5 and 0/3; 5- is 4 and 2/3; 5+ is 5 and 1/3. Other data included are:

(a) Whole-day radio quality indices, which are weighted averages of the four 6-hourly indices, with half weight given to quality grades 5 and 6. This procedure tends to give whole-day indices suitable for comparison with whole-day advance forecasts which seek to designate the days of significant disturbance or unusually quiet conditions.

(b) Short-term forecasts, issued every six hours by the North Atlantic Radio Warning Service. These are issued one hour before 00^h, 06^h, 12^h, 18^h, UT and are applicable to the period 1 to 7 hours ahead.

(c) Advance forecasts (CRPL-Jc) are issued once a week and are applicable to 1 to 7 days ahead for HF radio propagation conditions on typical high latitude paths passing through or near the auroral zone. They are scored against the average of the whole day North Atlantic and North Pacific quality figures. They are modified as necessary by one of two types of the Special Disturbance Warnings applicable 1 to 6 days ahead (CRPL-SDW or CRPL-Jc supplement).

(d) Half-day averages of the geomagnetic K indices measured by the Fredericksburg Magnetic Observatory of the U. S. Coast and Geodetic Survey, K_{Fr}.

(e) Predictions of the daily A-index for Fredericksburg, A_{Fr}, issued weekly applicable to 1 to 7 days ahead, are compared with the observed A_{Fr}.

Note: Beginning with data for September 1955, Qa has been determined from reports that are available within a few hours or at most within a few days,

> including for the first time, the local CRPL/ESSA observations. Therefore these are the indices by which the forecasters assess every day the conditions in the recent past. Over a period of several years, they have closely paralleled the Qa indices which excluded CRPL/ESSA observations and included three additional reports received after a considerable lag. Qa was first published to the nearest one-third of a unit at the same time.

North Pacific Radio Area -- The CRPL radio propagation quality for the North Pacific Area, Qp, is compiled by the ITSA Space Disturbance Monitoring Station at Anchorage, Alaska from measurements made at the station of signal-to-noise ratios on the following circuits: Seattle-to-Anchorage on 12 Mc/s and 5 Mc/s; Adak-to-Anchorage on 10 Mc/s and 5 Mc/s; Thule-to-Anchorage on 12 Mc/s and 9 Mc/s; and Tokyo-to-Anchorage on 15 Mc/s. Each circuit identifies itself every half-hour and during this short period the signal drops to the noise level of the path. The circuits are calibrated in dbm (decibels below 1 milliwatt) and the values scaled, for each hour, are the differences in db between the median signal level and the median noise level. This is the signal-to-noise value.

Predictions of signal-to-noise for undisturbed conditions on each path are made available by the ITSA Ionospheric Telecommunications Laboratory, Frequency Utilization Section in Boulder, Colorado. The actual daily values on each path are compared with these predicted values and this comparison is then used to decide whether conditions are normal or otherwise. The following five classifications describe the radio propagation quality with respect to the predicted normal values:

N++ Conditions giving more than 15db above predicted signal-to-noise values (considered as $Q = \geq 8$).

N+ Conditions giving between 5db and 15db above predicted signal-to-noise values (considered as $Q = 7$).

No Conditions within 5db of the predicted signal-to-noise values (considered as $Q = 6$).

N- Conditions giving between 5db and 15db below predicted signal-to-noise values (considered as $Q = 5$).

N-- Conditions giving more than 15db below predicted signal-to-noise values (considered as $Q = \leq 4$).

The hourly values are combined to give the 6-hourly and whole day values that are found in the table. The half-day averages of the geomagnetic K indices and the daily A-index measured by the Sitka, Alaska Magnetic Observatory of the U. S. Coast and Geodetic Survey, K_{Si} and A_{Si} are given.

Forecasts of HF propagation conditions for the North Pacific are no longer made at the Anchorage station. There is a local tape-recorded service, telephone (area code 907) 277-3355 giving a statement of current magnetic conditions, a forecast of geomagnetic conditions for the coming day, current ionospheric conditions, a radio propagation quality figure for the past 24 hours and a predicted figure for the next 24 hours, predicted in-out time for various operational radio circuits and a report of special events, if any, such as abnormal D region absorption.

Comparison Charts -- A chart compares the North Atlantic short-term forecasts with the 6-hourly Qa-figures. A second chart compares the outcome of the high latitude advance forecasts with a type of "blind" forecast. For the latter, the frequency for each quality grade, as determined from the distribution of quality grades in the four most recent months of the current season, is partitioned among the grades observed in the current month in proportion to the frequencies observed in the current month.

Useful Frequency Ranges -- Ranges of useful frequencies on the North Atlantic radio path are shown in a series of diagrams, one for each day. The shaded area indicates the range of frequencies for which transmissions of quality 5 or greater were observed. The blacker the diagram, the quieter the day has been: a narrow strip indicates either high LUHF, low MUF, or both. These diagrams are based on data reported to ESSA by the German Post Office through the Fernmeldetechnischen Zentralamtes, Darmstadt, Germany, being observations every one and a half hours of selected transmitters located in the eastern portion of North America. Since January 6, 1958 the transmitters monitored are restricted to those located north of 39° latitude. The magnetic activity index, A_{Fr}, from Fredericksburg, Virginia, is also given for each day.

VIII ALERT PERIODS

The table gives the Advance Geophysical Alerts as initiated by (or received by) the Western Hemisphere Regional Warning Center of the International Ursigram and World Days Service at Fort Belvoir, Virginia, and also the Worldwide Geophysical Alerts as designated by the IUWDS World Warning Agency, Fort Belvoir, Va.

These alerts are of the types recommended for the International Years of the Quiet Sun (IQSY) modified slightly to fit increasing solar activity. A full description of the IQSY program can be found in IQSY Instruction Manual No. 1 WORLD DAYS, which is available from the IQSY Secretariat, 6 Cornwall Terrace, London NW1, England. A revised 1966 Manual will be issued by the IUWDS through the CIG Secretariat, 6 Cornwall Terrace, London NW1, England. Pertinent information is given below:

Types of Alerts -- Alerts are issued on two time scales: Advance Alerts are prompt and are distributed regionally; GEOALERTS are slower and have worldwide distribution. The categories of phenomena described are magnetic storms, magnetic calm, solar flare, general solar activity, cosmic events, and stratospheric warmings.

Alerts issued by a Regional Warning Center (or an individual geophysical institution or station) are called Advance Alerts (in telegrams: ADALERT). These may be issued at any time of day as may be practical, as soon as the phenomenon is observed or recognized. ADALERTS are distributed mainly in the region of origin, but are also interchanged among the RWCs.

Alerts issued by the World Warning Agency are called GEOALERTS. They are issued daily at a stated time of day, 0400 UT. They are given extensive and worldwide distribution, mainly through the WMO telecommunications network.

Magnetic Storm Alert (MAGSTORM) is issued when a significant geomagnetic storm with Kp index of 5 or more is: (a) expected, (b) has just started, or (c) is in progress. If appropriate, the degree of geophysical interest of the storm may be indicated by supplementary words: (d) aurora observed, (e) aurora probable (if K-index reaches 7), or (f) cosmic-ray Forbush decrease (COSRAY DECREASE) > 2% on a neutron monitor.

Magnetic Calm Alert (MAGCALME) is issued when geomagnetic activity is unusually low and no significant disturbance is expected within the next 24 hours.

Solar Flare Alert (SOFLARE) is issued when a relatively important solar flare has been observed; the nominal time of the flare is given. Issued only as regional Advance Alerts.

Solar Activity Alert (SOLACTIVITY) is issued when the general level of solar activity is relatively high because of the presence of one or more active centers on the solar disk.

Cosmic Event Alert (COSMIC EVENT) is issued when there is evidence for the first or continued arrival of energetic solar particles at the earth. The degree of geophysical interest of the event is indicated by the supplementary information (a) cosmic-ray increase (COSRAY INCREASE) or (b) polar cap ionospheric absorption event (POLCAP ABSORPTION).

Stratospheric Warming Alert (STRATWARM) is issued when a sudden and unusual increase in temperature at 30 km or above has been detected. The general geographical region where the warming phenomena have been observed is specified; such events however usually involve the high level circulation of the entire hemisphere at high latitudes after a period of several days, and an estimate of the area to be effected is given.

Timing information:

(i) if phenomenon has already started the nominal UT time of start is given by a date-time group: JJHHmmZ, where JJ is date; HHmm is hours and minutes, UT; and Z is conventional symbol to indicate UT. (Example: 220613Z - 22nd day, 06 hours 13 minutes UT.); or

(ii) if phenomenon is in progress, indicate by the word EXISTS; or

(iii) if phenomenon is predicted, indicate by the word EXPECTED;

and elaboration:

(i) for MAGSTORM, can add words AURORA OBSERVED or AURORA PROBABLE or COSRAY DECREASE, if appropriate; or

(ii) for COSMIC EVENT, can add words COSRAY INCREASE or POLCAP ABSORPTION; or

(iii) for SOLACTIVITY, can add words FLARES or EAST LIMB or GAMMA SUNSPOT or RADIO SPOT or NEW REGION BORN, if appropriate. Geographical Region of initial detection and movement expected, used only in connection with STRATWARM. (Example: ORIGIN WEST EUROPE MOVING CANADA.)

IX INDEX FOR CRPL-F PART B

The index appearing on page 47 gives the number of the CRPL-FB report or reports in which data for any month in question will be found beginning with January 1964. The index for July 1957 through December 1959 data was published with the November 1961 descriptive text. The index for January 1960 through December 1961 was published with the November 1962 descriptive text. The index for January 1962 through December 1962 was published with the November 1963 descriptive text. The index for January 1963 through December 1963 was published with the November 1964 descriptive text. Copies of these indices are available upon request.

For information the Calendar issued by the IUWDS is reproduced on page 49.

IUWDS International Geophysical Calendar for 1966

1966 JANUARY

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

1966 FEBRUARY

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28					

1966 MARCH

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

1966 APRIL

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

1966 MAY

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

1966 JUNE

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

1966 JULY

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

1966 AUGUST

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

1966 SEPTEMBER

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

1966 OCTOBER

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

1966 NOVEMBER

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

1966 DECEMBER

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

1967 JANUARY

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

(11) Regular World Day (RWD)

[20] Day of Solar Eclipse

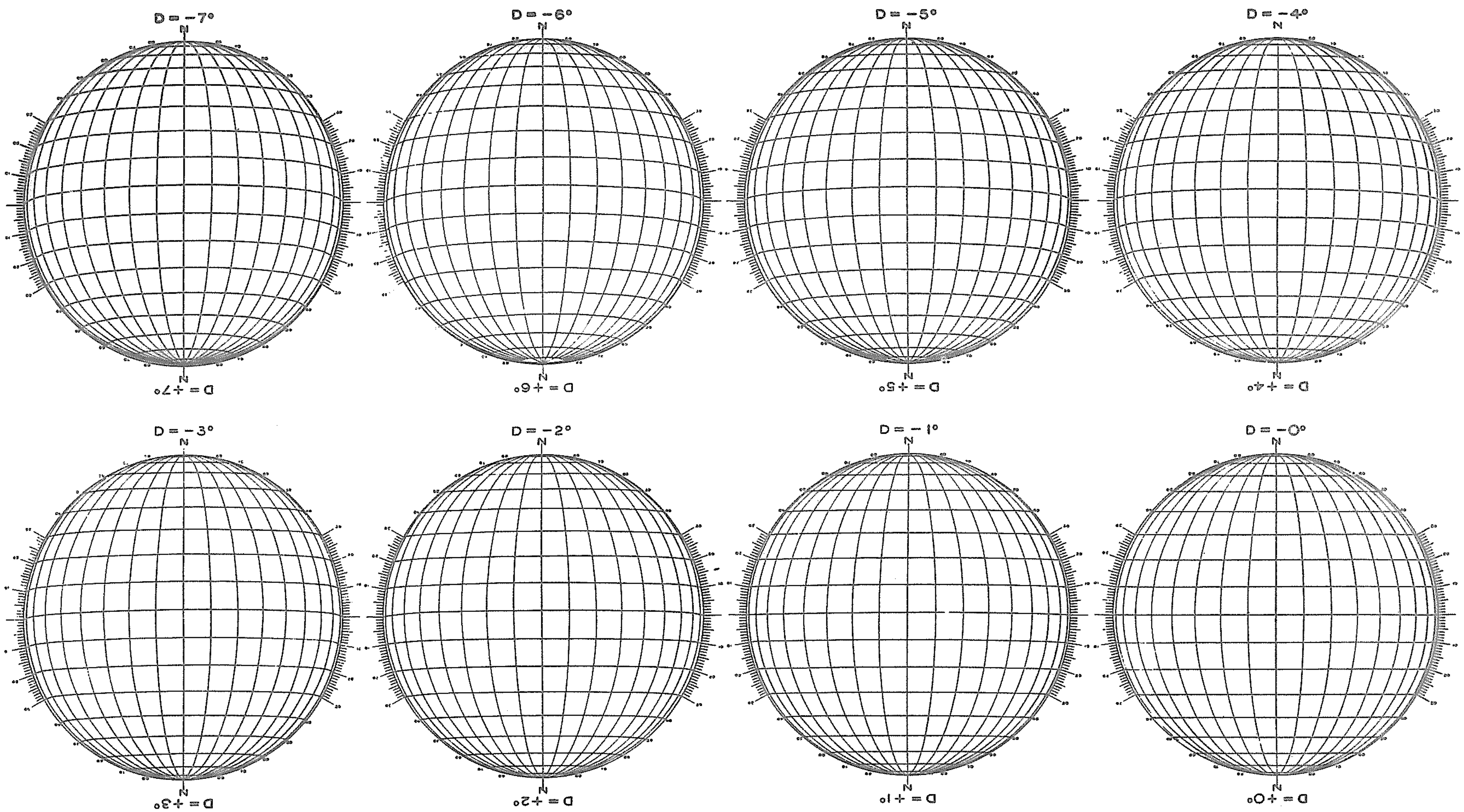
3 Day with unusual meteor shower activity

[7 8] World Geophysical Interval (WGI)

◇16 Quarterly World Day (QWD) also a PRWD and RGD

(12) Priority Regular World Day (PRWD)

△5 Regular Geophysical Day (RGD)



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