FOR OFFICIAL USE

DESCRIPTIVE TEXT
AND
INDEX
FOR
CRPL-F PART B
SOLAR-GEOPHYSICAL DATA

ISSUED

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DESCRIPTIVE TEXT FOR CRPL-F PART B

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SOLAR-GEOPHYSICAL DATA

INTRODUCTION

This pamphlet describes the data published in the monthly CRPL-F Part B report series* which 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. The report is prepared in the Radio Warning Services Section, edited by Miss J. Virginia Lincoln assisted by Miss O. E. Youngdahl. 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 CRPL 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 table includes (1) the daily American relative sunspot numbers, R_A' as compiled by Sarah J. Hill, Wellesley College, Wellesley, Massachusetts, for the Solar Division of the American Association of Variable Star Observers, and (2) the provisional daily Zürich relative sunspot numbers, R_Z, as communicated by M. Waldmeier of the Swiss Federal Observatory. Because of the time required to collect and reduce the observations, R_A' will appear one month later than R_Z.

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. 1/8 square degree). The relative sunspot number is defined

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

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 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.

Solar Flux Values, 2800 Mc/s --The table also lists the daily values of solar flux at 2800 Mc/s recorded in watts/m^2/cycle/second (x 10^{-22}) at Ottawa, Canada and are determined from a calibration performed near 1600 UT. (See Section IV SOLAR RADIO WAVES for more detail.) These solar radio noise indices are being published in accordance with a CCIR Recommindation 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".

Graph of Sunspot Cycle -- The graph illustrates the recent trend of Cycle 19 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 18. Cycle 19 began April 1954, when the minimum $\bar{R}$ of 3.4 was reached. Tabular values of the smoothed index, R, appear regularly in the CRPL-F Part A "Ionospheric Data" reports and CRPL "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 durations 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. 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. The sunspot data are compiled from reports from the U.S. Naval Observatory, and from reports from Europe, Asia and Japan received through the daily ursigram network.

<u>Mount Wilson Magnetic Classifications of Sunspots</u> -- 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. Only those groups for which magnetic measures are available will be listed; no attempt will be made to number groups.

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.

$\beta\gamma$ 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.

Coronal Line Emission Indices -- Emission intensity indices for the green (Fe XIV at λ 5303) and red (Fe X at λ6374) coronal lines are summarized 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(604)-146). The measurements are expressed as the number of 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 have the following meanings:

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

R_6 = same for λ6374.

G_1 = highest value of intensity in quadrant for λ5303.

R_1 = same 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.

Notes: 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. 38, 160. In F185B several corrections were made to October and November 1959 coronal line emission indices published in F183B and F184B, respectively.

2. The October 1962 through March 1963 final coronal line emission indices were revised and the correct data appear in CRPL-F 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 the CRPL on a rapid schedule at the sacrifice of detailed accuracy. Definitive and complete 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 roughly describe the phenomena observed.

Reporting directly to the CRPL are the following observatories: University of Hawaii, Huancayo Geophysical Institute, Lockheed, McMath-Hulbert, Sacramento Peak, Swedish Astrophysical Station on Capri and Wendelstein. The remainder report through the Ursigram centers or are available through the IGY World Data Center-A for Solar Activity, High Altitude Observatory, Boulder, Colorado. Observations are made in the light of the center of the H-alpha line unless noted otherwise. The reports from Sacramento Peak, New Mexico (communicated to CRPL by the High Altitude Observatory at Boulder), are from observations at the USAF

Sacramento Peak Observatory at Sunspot, New Mexico, by Harvard University observers, under contract AF 19 (604)-4961.

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; McMath serial number of the region; duration (flares only), the flare importance on the IAU scale of 1- to 3+; observing conditions where 1 means poor, 2 fair and 3 good; time of measurement for tabulated width of Hα or tabulated area; measured (i.e. projected) maximum area in square degrees; corrected maximum area in square degrees (which equals measured area times secant h where h is the heliocentric angle); maximum effective line-width in Hα expressed in percent of the continuous spectrum. The following symbols are used in the table:

D = Greater than	U = Approximate
E = Less than	☐ = Not reported

(In older lists & = Plus)

A final column lists provisionally the occurrence of simultaneous ionospheric effects as observed on selected field-strength recordings of distant high-frequency radio transmissions: a more nearly definitive list of these ionospheric effects, including particulars, appears in these reports after the lapse of a month (see below). All times are Universal Time (UT or GCT). Beginning with January 1962 data the times of no patrols for flare observations, from the observatories whose data are published in the table and which give such information, are inserted in chronological order with the flare data. 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. A graph also presents these intervals for which there were no patrols for flare observations, the observatories whose data are included are indicated in a footnote.

Notes: 1. All the flare data are recorded on IBM punch cards. As errata are received the punch 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 IGY World Data Center A for Ionosphere and Airglow, CRPL, National Bureau of Standards, Boulder, Colorado, U.S.A.

2. Major errors have occurred in the area listing in these reports for the Russian flares until 1960 data. We at NBS misunderstood some of the original entries. The Simeiz flares in F156B for example, were for June 1957, not July 1957. Revised flare lists, as well, have been received for IGY-IGC flares from the following observatories: Abastumani, Alma-Ata, Moscow Gaish, Kiev University, Pirculi, Simeiz, Tashkent, 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.

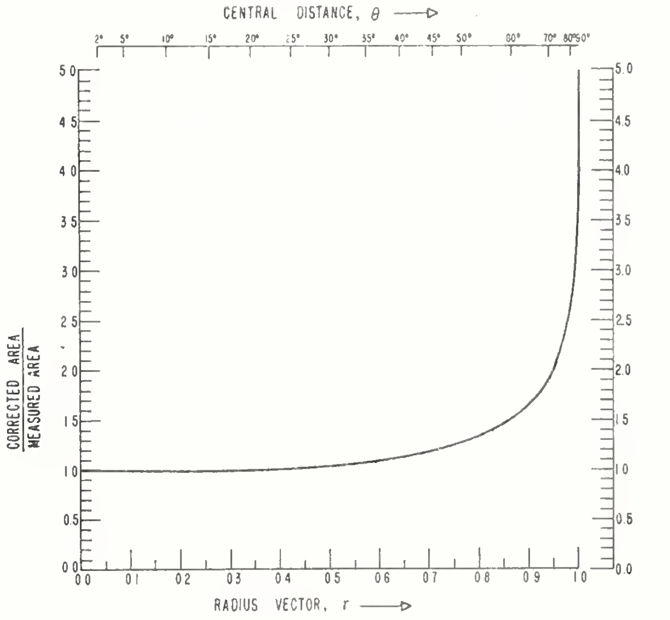
4. The flares incorrectly labelled "Boulder" in F178B and F179B are those for Greenwich Royal Observatory, Herstmonceux. As stated above the corrected data are available on IBM punch cards.

5. Beginning October 1, 1960 the following U.S. observatories: Climax, Hawaii, Lockheed and Sacramento Peak, are reporting maximum area in square degrees corrected according to a method proposed by C. S. Warwick of the National Bureau of Standards. These observatories are now basing their flare importances on this corrected area in accordance with IAU rules. Previously they had based their importances on the measured areas. The formula being used is:

$$\text{Corrected area} = \frac{\text{measured area}}{\cos \phi + 0.2 \sin \phi}$$ 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. Graph was published in CRPL-F 197 Part B, January 1961 and is repeated below.

$$\text{CORRECTED AREA} = \frac{\text{MEASURED AREA}}{(\sqrt{1-r^2} + 0.2r)} = \frac{\text{MEASURED AREA}}{(\cos\theta + 0.2\sin\theta)}$$



Ionospheric Effects -- SID, sudden ionospheric disturbance (and GID -- gradual ionospheric disturbance) 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 signal enhancements at VLF (SES) and sudden frequency deviations (SFD).

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; importance of solar noise burst observed at 18 Mc/s; a geographically widespread index for type of event; station observing event; and associated solar flare, if known.

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 CRPL-Boulder: Ft. Belvoir, Va., Boulder, Colo. and Anchorage, Alaska (CRPL Stations: BE, BO, AN); Huancayo, Peru (CRPL-Associated Laboratory: HU); and Ft. Monmouth, N.J., White Sands, N. Mex., Adak, Alaska, and Okinawa (U.S. Signal Corps Stations: FM, WD, AD, OK). McMath-Hulbert Observatory (MC) and Hiraiso Radio Wave Observatory, Japan (TO) 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, Enkoping, 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 short-wave 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 CRPL F-reports prior to F-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 IGY 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. The SEA reports come from the following: Dunsink Observatory, Ireland (DU); Observatorio del Ebro, Tortosa, Spain (TR); Research Institute of Atmospherics, Toyokawa, Japan (TY); 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); a group of American Association of Variable Star Observers located at Brooklyn, N.Y. (A1), Paterson, N.J. (A3), Ramsey, N.J. (A5), Oshkosh, Wis. (A6), Blauvelt, N.Y. (A10), Beverley Hills, Calif., (A14) Vermont (A15) and Sao Paulo, Brazil (A16) and an amateur astronomer in Hobart, Tasmania (TA).

These reports are coordinated at CRPL-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:

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

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 the National Bureau of Standards, Boulder, Colo. (BO) recording regularly Rugby, England (GBR 16 kc/s), Balboa, Canal Zone (NBA 18 kc/s) and Maui, Hawaii, U.S.A. (NPM 19.8 kc/s) and recording irregularly Jim Creek, Wash., U.S.A. (NPG 18.6 kc/s), Annapolis, Md., U.S.A. (NSS 22.3 kc/s), Cutler, Maine, U.S.A. (NAA 14.7 kc/s) and Ottawa, Canada (CYZ 40 80 kc/s). Other reports are from NBS Maui, Hawaii, U.S.A. (MU) recording NBA, from Geophysical Institute, College, Alaska, U.S.A. (CO) recording NBA and from Battelle Instutute, Frankfurt, G.F.R. (FR) recording NBA and GBR., and from Tucuman, Argentina (TU) recording NBA.

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 preflare 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 times of the beginning, end, and maximum phase, all in UT, and the maximum positive frequency deviation (in cycles per second) are reported for SFD events. In the station column the receiving location is given, such as National Bureau of Standards, Boulder, Colo., U.S.A. (BO) with the parenthetical remark giving the transmitting station call letters and transmitted frequency to nearest Mc/s together with the frequency deviation in cycles per second. Other receiving stations are Accra, Ghana (AC), Natal, Brazil (NA), University of Hawaii, Makapuu Pt., Oahu, Hawaii, U.S.A. (HA) and Battelle Institute, Frankfurt, G.F.R. (FR).

For each event a flare beginning time, if known, that may be associated with it, is given the final column of the table. An asterisk indicates that at the time of publication there was no known flare patrol being made at that time.

Riometer Absorption Events

The table shows the periods of absorption seen on a riometer at South Pole. The riometer is operated by the National Bureau of Standards, with financial support from the National Science Foundation. The equipment operates at 26 Mc/s and uses a zenithal antenna of beamwidth ± 30° to the half-power points.

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 U.T. 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 Observations -- The data on solar radio emission at 2800 Mc/s (10.7 cm) recorded at the Algonquin Radio Observatory (ARO) of the National Research Council, Ottawa, Canada are presented. Until 1962 similar measurements were made at Ottawa itself. The work is under the direction of A. E. Covington. The daily flux values are given in tabular form in units of 10^{-22} watts/m^2/c/s and are determined from a calibration performed near 1600 UT. When burst activity is in progress at this time, the calibration may be performed at a more suitable hour, so that the reported daily flux is that of the estimated undisturbed sun. 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.

Tabulations of the bursts for each observing day include the URANE code type as reported telegraphically, type in descriptive terms, the time of commencement in UT, duration in hours and minutes, mean flux, UT time of maximum flux and value of peak flux, and remarks. 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 bursts 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.

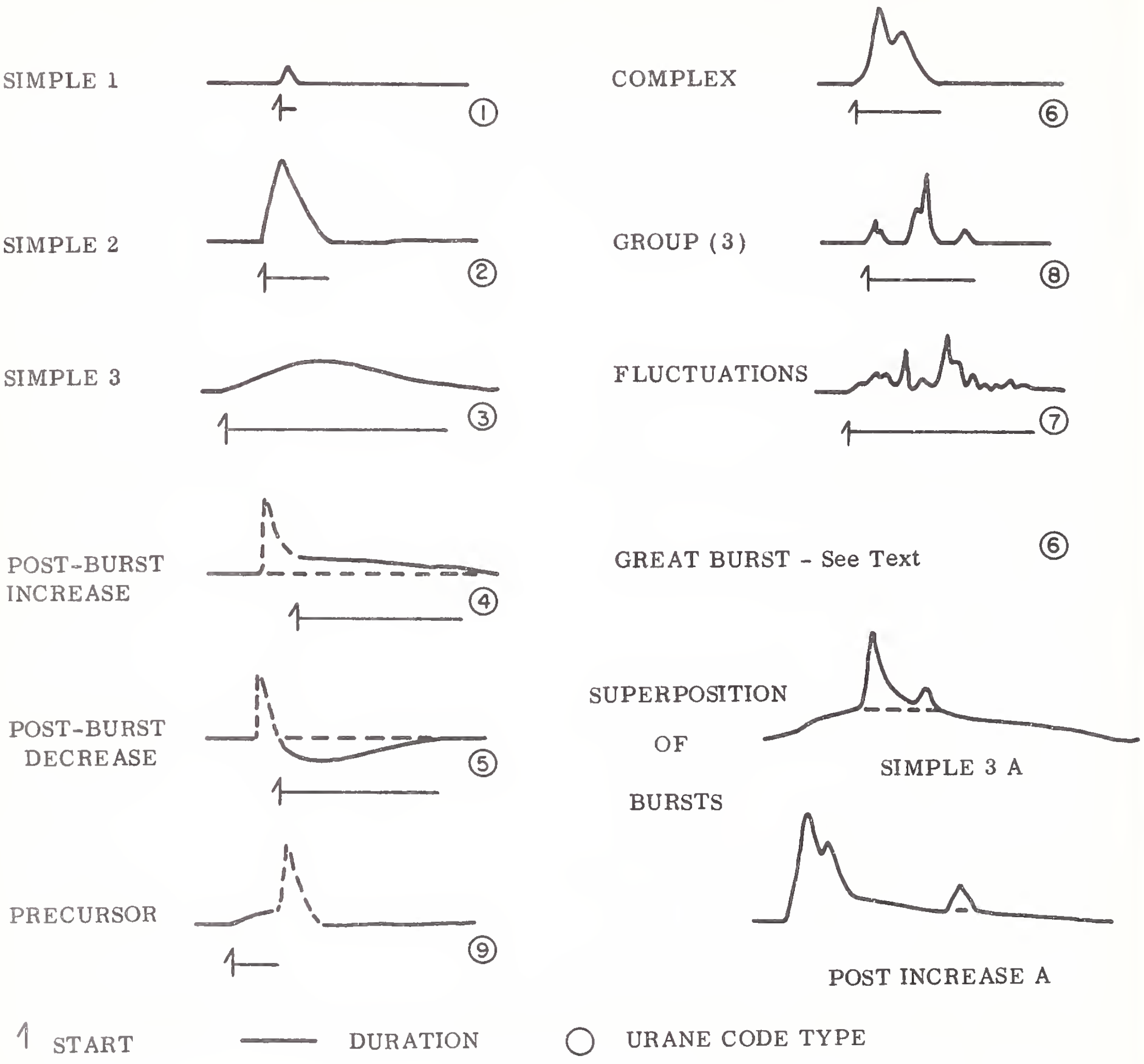
Decreases in the quiet sun level are occasionally observed after Impulsive events and are designated as "Post Burst Decrease" or "Absorption".

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 level 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. Actual value reached in 1954 was 68 flux units.

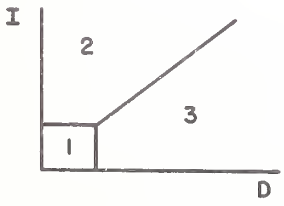
The commencement of a burst is taken when the enhancement of the daily flux shows a departure from the daily level by an amount of approximately 1 flux unit. For the Impulsive bursts this may be determined certainly to within a minute, while for the Gradual Rise and Fall burst, the uncertainty in the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

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

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



RELATION OF SIMPLE BURSTS TO DIAGRAM OF INTENSITY VERSUS DURATION



Region 1 - SIMPLE 1 : Intensity $\leq$ 7.5 flux units
Duration $\leq$ 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

222 Mc/s Interferometric 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 frequency of operation is 222.54 Mc/s. Each of the two antenna arrays consists of eight 10-element Yagi antennas, equatorially mounted to track the sun. The baseline is 299 feet. A continuous measurement of the position of the radio center of gravity relative to its position at meridian transit is made through the use of a digitally operated phase-compensating device. Other details of the system are given in Boeing Document D1-82-0122, "Boeing Lobe Sweep Interferometer System", by John Lansinger and Ralph Gagnon, copies of which are available.

The data presentation is in the form of amplitude and phase recordings. Two quasi-logarithmic amplitude recorders are used. Of these the higher sensitivity one reaches full scale deflection at a flux level a little greater than 70 x 10^{-22} watts/m^2/c/s. Full scale deflection on the other corresponds to a flux of about 40,000 x 10^{-22} watts/m^2/c/s. The phase recorder provides an indication of difference of phase between the burst and the radio center of gravity of the sun, from which the position of the burst can be estimated.

The burst data are described in accordance with the definitions given in the IAU Quarterly Bulletin on Solar Activity. Thus the symbols s, c, f and e refer to simple and complex variations of intensity, group of bursts and sudden beginning of burst respectively. Major bursts are those with a duration of about three minutes or more and with an energy content of the order, 750 x 10^{-22} watts/m^2/c/s or greater. The time of beginning and maximum are given in UT. Duration in minutes, peak and mean flux densities are also tabulated.

169 Mc/s Interferometric Observations

The 169 Mc/s interferometric observations are recorded around local noon at Nancay, France, (N47°23', E8^m47^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 and much larger than the solar diameter in the North-South direction. The main lobes are about 2° apart (Ann. Astrophys. 20, 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 (C.R. 244, 1460, 1957). Points of intensity 0.5 - 0.75 - 1.0 - 1.5 and 2.0 times 10^{-22} watts/m^2/c/s are joined day after day in the form of isophotes. A bracketed line indicates the width of the recorded lobe pattern in the East-West direction. A short East-West line is used where the source width is not known. The direction of the horizontal pip indicates whether the radio source is in the northern solar hemisphere (pip points toward earlier dates), or in the southern hemisphere (pip points towards later dates). If a pip extends on both sides of the line, the radio source was observed to be close to the solar equator. A circle or semicircle replaces the pip when the North-South coordinate of the position is unknown. For each radio noisy region the smoothed intensity around noon is given in 10^{-22}watts/m^2/c/s.

Note that the isophotes cannot be measured when a radio noisy region of large intensity is on the disk.

108 Mc/s Observations

Data on solar radio emission at the nominal frequency of 108 Mc/s recorded at the Table Mesa (Boulder) station of the National Bureau of Standards 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 CRPL-F Part B reports for details).

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 described for 200 Mc/s observations originally 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.

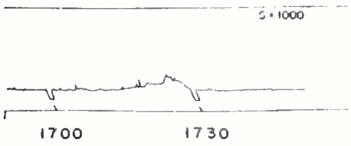
6 - Noise storm -- A temporary increase in radiation characterized by numerous closely spaced bursts, by an increase in the continuum, or by both. Duration is of the order of hours or days.

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

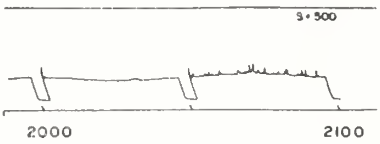
8 - Major burst -- An outburst, or other burst of large amplitude and more than average duration. A major burst is usually complex, with a duration of the order of one to ten minutes.

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.

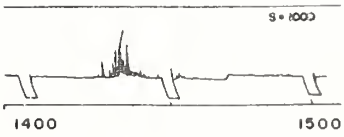
O-RISE IN BASE LEVEL



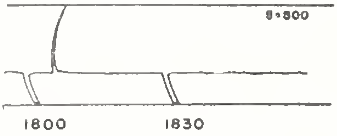
I - SERIES

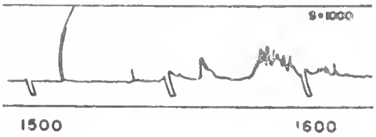


2 - GROUP

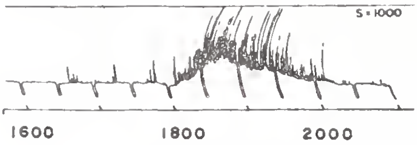


3 - MINOR

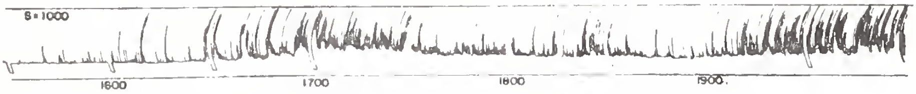




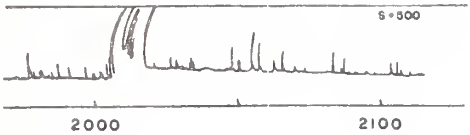
4 - MINOR+



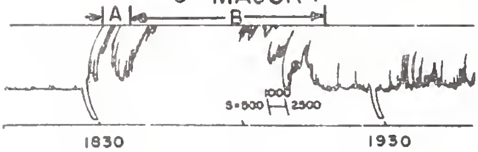
7- ONSET OF NOISE STORM



6-NOISE STORM IN PROGRESS



8- MAJOR



9-MAJOR+

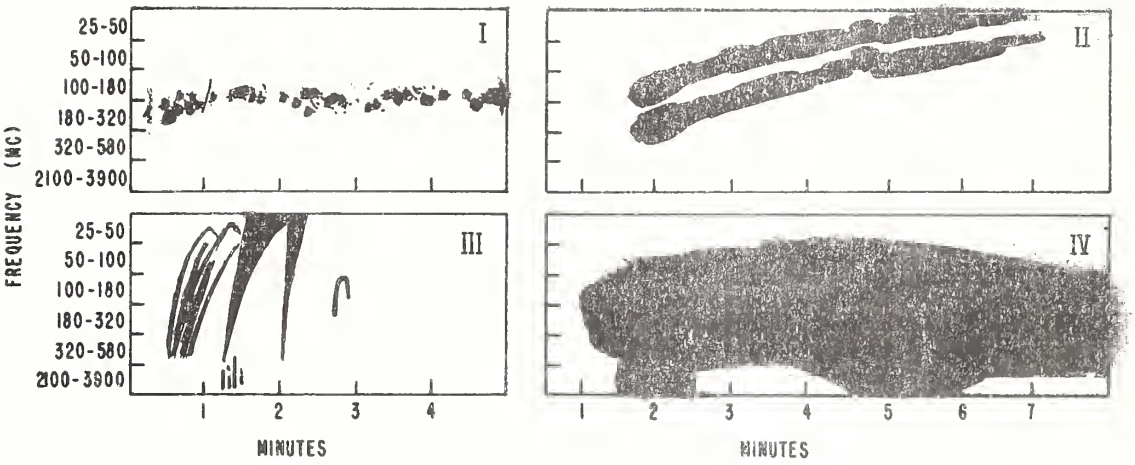
Notes: In the present table, the type classification 0 is not used: it has been included above only for information.

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.

Spectral Observations - Fort Davis

Data are presented on solar radio emission in the spectral range 50-320 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 through the Sacramento Peak Observatory. The equipment used at the Station has been described elsewhere (Thompson, Astrophys. J. 133, 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 cast 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 also given as well as additional remarks when appropriate.

Spectral Observations - High Altitude Observatory, Boulder, Colorado

The research program is supported by the Electronics Research Directorate, Air Force Cambridge Research Laboratories and Goddard Space Flight Center, National Aeronautics and Space Administration.

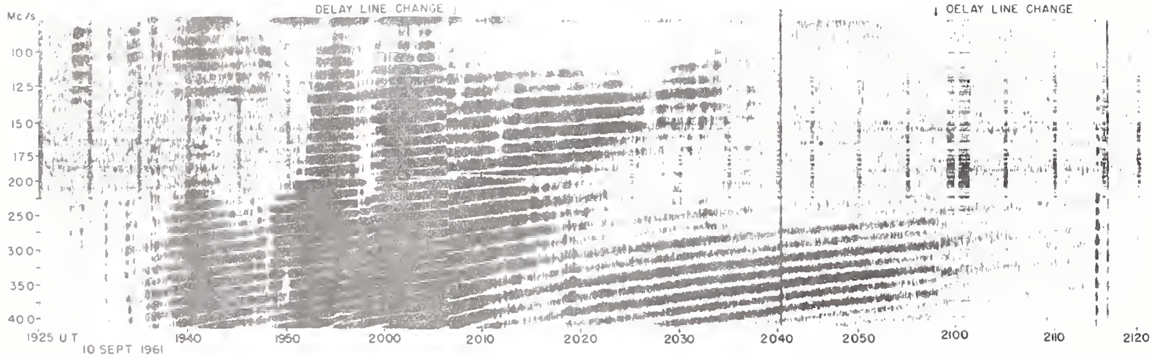
The spectral range is from 7.6 to 41 Mc/s scanned in 0.65 seconds. The collecting area of the antennas is approximately 1000 square meters, in two corner reflectors forming an interferometer pair. Observations are taken routinely throughout the Boulder observing day from about 1400 UT to 2400 UT. On 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 wavelengths; (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" used for in progress before time given and "a" for end after time given. The frequency range for the burst is also given.

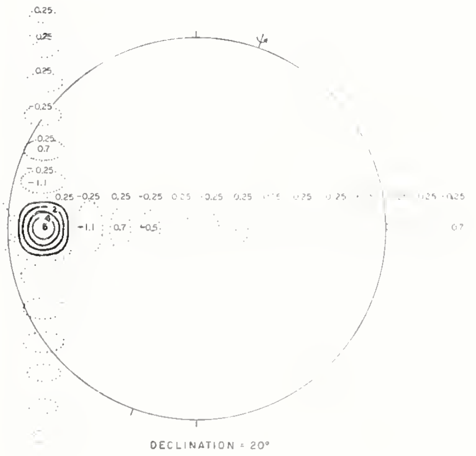
9.1 cm Spectroheliograms

A daily series of radio spectroheliograms obtained with a 3 minute-of-arc pencil-beam antenna located at the Radio Astronomy Institute of the Stanford University, Stanford, California (N 37° 24', W 122° 11'), are presented.

The maps show the distribution of radio emission across the solar disk at a wavelength of 9.1 cm by means of brightness temperature values. The brightness unit, which varies from map to map, is usually about 3000°K. Its value is determined after each map is plotted by reference to the flux density, S, of the whole sun as measured by Covington at 10.7 cm wavelength. Reading of constant brightness temperature equal to or greater than 20 are underlined. A total of all readings, flux-density S at 10.7 cm in units of $10^{-22} w\ m^{-2} cps^{-1}$, and brightness unit in°K are presented at the bottom of each map. The axis of rotation of the sun is shown by a curly arrow placed near the North Pole. A circle shows the photosphere: a correction has been applied for the variation of the sun's semi-diameter, so that the photospheric circle is reproduced with a constant diameter of 5 cm. This is an integral submultiple of the IAU standard of 15 cm used on the full size originals, which are available on request from the Stanford Radio Astronomy Institute. A set of Stonyhurst disks with a diameter of 5 cm is reproduced on transparent paper at the end of this text.

A detailed description of the Stanford microwave spectroheliograph has been given by Bracewell and Swarup (IRE Trans., Vol. AP 9, January 1961). The instrument scans the sun from West to East with rotation of the earth. At the end of each scan, pencil-beams are shifted in a North-South direction by means of 16 variable phase-shifters placed in the North-South array. Recently the Stanford spectroheliograph has been digitized so that the finished maps are available within a few hours after the observations. A positional accuracy of better than ±1/2 minute-of-arc in the location of bright features is maintained.

Observations are made each day near local noon. The width of the antenna beams which scan the sun change from nearly 3' x 3' in mid-summer to nearly 3' x 6' in mid-winter. At a declination δ on the meridian the beamwidths are 3.1 minutes East-West and 3.1 sec $(38^\circ\!.2 - \delta)$ North-South. The theoretical response of the antenna to a point source is shown below. Further details are given in the above mentioned reference. The response to a source of finite size is the convolution of this pattern with the source distribution. The subsidiary lobes, which are positive and negative, may be reduced by smoothing the maps but this would also widen the primary beam. A simple procedure for smoothing is to average four alternate values located at the corner of a rectangle with horizontal and vertical sides. Any spurious lobes arising because of antenna maladjustments are kept in control by periodic phase adjustment of the antenna.



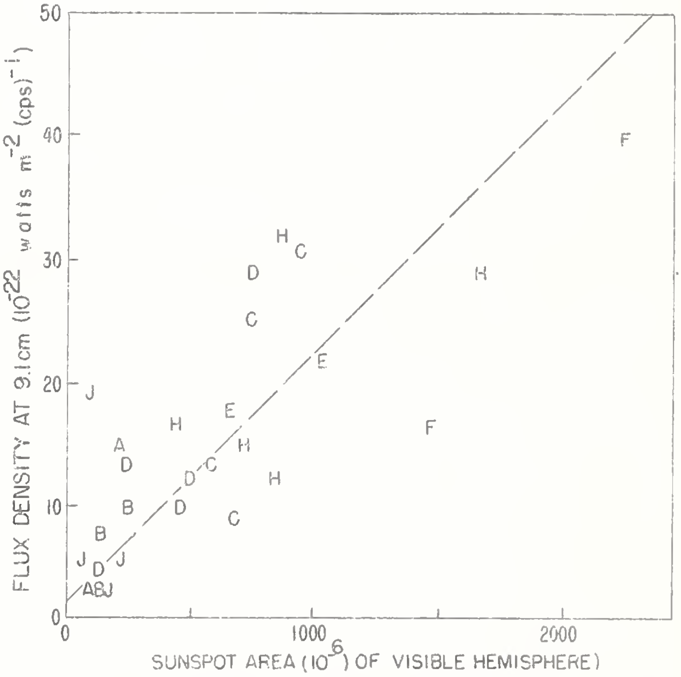


FIG. I SCATTER DIAGRAM SHOWING THE RELATION BETWEEN RADIO FLUX AND SUNSPOT AREA

Results of a preliminary investigation of the 9.1 cm solar maps have been reported by Swarup (Stanford Electronics Laboratories Scientific Report No. 13 under Contract AF 18 (603) 53, 1961). Recently it has been found that the size of many strong sources at 9.1 cm is less than that of the antenna beam. Therefore, for strong sources, peak brightness temperatures in the 9.1 cm maps are lower than actual by a factor of more than 3 or 4.

A relation between flux densities of radio sources and area of the associated sunspots is shown above. Each point is represented by a letter denoting Zurich classification of sunspot groups. For a strong source, the flux density decreases to about 25% as the region rotates from the central meridian to the limb. For a weak region, there is less variation. The flux density of a localized region may be found by taking a total of all the readings over the area concerned, subtracting an estimated background, dividing by the total for the day, and multiplying by S. For a compact source, an approximate value of flux density in units of 10^{-22}w m^{-2}cps^{-1}, can be readily obtained by multiplying peak brightness temperature by a factor 3×10^{-5} sec $(38.2 - \delta)$, where δ is the declination of the sun.

V COSMIC RAY INDICES

The table presents the scaled hourly count rate average for each 24 hour interval (Universal Time) from the Climax, Colorado, USA, neutron monitor, station number B305, as 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 is located at an altitude of 3400 meters at 39° 22'N, 106° 11'W, geographic, with 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, pages 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 CRPL series began September 1960. Earlier data, beginning June 1957, are available in bihourly form at the IGY World Data Center A for Cosmic Rays.

The chart depicts the variations of cosmic ray intensity recorded by a 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 station is at an altitude of 145 meters at 46°06'N; 77°37'W. The magnetic rigidity cutoff for charged primaries is close to 1 GV. The vertical scale lines mark the days of the month in Universal Time: the horizontal scale lines are at intervals of 5% based upon 555,000 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 May 1962 the readings have been taken from a new monitor, ten times as large as the one used previously. Prior to May 1962 the 100% level was 55,500 counts per hour. A preliminary barometric coefficient was used for the new monitor from May 1962 until 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

C, Kp, Ap, and Selected Quiet and Disturbed Days -- The data in the table are: (1) preliminary international character figures, C; (2) geomagnetic planetary three-hour range indices, Kp; (3) daily "equivalent amplitude", Ap; (4) magnetically selected quiet and disturbed days.

This table is made available by the Committee on Characterization of Magnetic Disturbances of IAGA, IUGG. The Meteorological Office, De Bilt, Holland collects the data from magnetic observatories distributed throughout the world, and compiles C and selected days. The Chairman of the Committee 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 flare effects (sfe), and principal magnetic storms.

The C-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).

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 ionospheric field. A complete description of Kp has appeared in Bulletin 12b, "Geomagnetic Indices C and K, 1948" of the Association of Terrestrial Magnetism and Electricity (IATME), International Union of Geodesy and Geophysics.

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. The method is described in IATME Bulletin No. 12h (for 1953) p. viii f. 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 the graph of Kp for four solar rotations is furnished through the courtesy of Dr. J. Bartels, Geophysikalisches Institute, Gottingen. 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.

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 are as follows:

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

CRPL 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 $\geqslant 5$, or both $\leqslant 5$.

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 North Atlantic Radio Warning Service (NARWS), the CRPL forecasting center at Ft. Belvoir, Virginia, from radio traffic data for North Atlantic transmission paths closely approximating New York-to-London. These are reported to CRPL by the Canadian Defence Research Board, Canadian Broadcasting Corporation, and the following agencies of the U.S. Government: -- Coast Guard, Navy, Army Signal Corps, U.S. Information Agency. Supplementing these data are CRPL monitoring, direction-finding observations and field-strength measurements of North Atlantic transmission made at Belvoir.

The original reports are submitted on various scales and for 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-J) are issued once a week and are applicable to 1 to 7 days ahead. 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-Js). The forecast entitled "final" consists of the most recent of the above forms and is scored against the whole-day quality index.

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

> 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 CRPL 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 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 Path -- The CRPL quality figures, Qp, are compiled by the North Pacific Radio Warning Service (NPRWS), the CRPL forecasting center at Anchorage, Alaska from measurements made at the station of field-strength and fading-rate characteristics on several suitable transmissions, on absorption characteristics as measured by riometer, and on reports of radio traffic data from the U.S. Air Force, Federal Aviation Agency and Radio Corporation of America. These data indicate propagation conditions for moderately long transmission paths in the North Pacific equivalent to Seattle-to-Anchorage or Anchorage-to-Tokyo.

The original data are reported on various scales and for various time intervals. The observations for each 8-hour or 24-hour period are averaged on the original scale. This average is compared with reports for the same period in the preceding two months and expressed as a deviation from the 3-month mean. The deviations are put on the 1 to 9 scale of quality which is assumed to have a standard deviation of 1.25 and a mean for the various periods as follows:

03-11 hours UT	5.33	19-02 hours UT	6.00
11-18	5.33	00-24	5.67

The 8-hour and 24-hour indices Qp are determined separately. Each index is weighted mean of the data available for the period.

The table includes the 8-hourly quality figures: whole day quality figures; short-term forecasts issued by NPRWS three times daily at 02^h, 09^h and 18^h UT, applicable to the stated 8-hour periods; advance forecasts issued weekly by NPRWS (CRPL-Jp report) modified as necessary by Special Disturbance Warning (CRPL-SDW) and supplementary forecasts (CRPL-Jps); and half-day averages of geomagnetic K indices from Sitka.

> Note: From March 15, 1959 to August 1963 the short-term forecast schedule was twice daily and the North Pacific quality figures used for evaluation were 12-hourly during that period.

Comparison Charts

A chart compares the North Atlantic short-term forecasts with Qa-figures. A second chart compares the outcome of the final North Atlantic and North Pacific 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 CRPL by the German Post Office through the Fermeldetechnischen 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, Va., is also given for each day.

VIII ALERT PERIODS

The table gives the Advance Geophysical Alerts as initiated by the Western Hemisphere Regional Warning Center at Ft. Belvoir, Va., and also the Worldwide Geophysical Alerts as designated by the IUWDS World Warning Agency, Ft. Belvoir, Va.

Beginning October 1, 1963 these alerts are of the types recommended for the International Years of the Quiet Sun (IQSY). A full description of the program will be found in IQSY Instruction Manual No. 1 WORLD DAYS, which is available from the IQSY Secretariat, 6 Cornwall Terrace, London NW1, England. Pertinent information from the manual is quoted below.

Types of Alerts: Alerts are issued on two time scales: Advance Alerts are prompt and are distributed regionally; GEOALERTS are slower and have world-wide distribution. The categories of phenomena described are magnetic storms, magnetic calm, solar flare, general solar activity, solar quiet, 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 world-wide 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 disc.

Solar Calm Alert (SOLCALME) is issued when the sun is extremely quiet. Geophysical stations will be alerted that there is a relative minimum in solar activity. Solar observatories should be on the look-out for the birth of a new region on the sun.

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 world EXPECTED.

and elaboration:

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

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

(iii) for SOLACTIVITY, can add words FLARES or EAST LIMB or GAMMA SUNSPOT or RADIO SPOT or NEW REGION BORN, if appropriate.

or Geographical Region of initial detection and movement expected, used <u>only</u> in connection with STRATWARM. (Example: ORIGIN WEST EUROPE MOVING CANADA).

IX INDEX FOR CRPL-F PART B

On the following pages the index gives the number of the CRPL-F Part B report or reports in which data for any month in question will be found beginning with January 1962. 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. Copies of these indices are available upon request.

INDEX FOR 1962-1963 DATA PUBLISHED IN CRPL-F PART B

	1962 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1963 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
American Relative Sunspot Numbers R_A'	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	
Zurich Provisional Relative Sunspot Number R_Z	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231
Zurich Final Sunspot Numbers R_Z	223	223	223	223	223	223	223	223	223	223	223	223										
2800 Mc-Daily Values of Solar Flux (Ottawa)	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231
2800 Mc-Daily Values of Solar Flux (Final - Ottawa)	223	223	223	223	223	223	223	223	223	223	223	223										
Mt. Wilson Magnetic Characteristics of Sunspots	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	none	227	228	229	230	231
Calcium Plage and Sunspot Regions	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231
Coronal Line Emission Indices - Provisional	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231
- Final	213	213	213	216	216	216	220	220	220	226	226	226	226	226	226	228	228	228	231	231	231	
Optical Observations Flares	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231
	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231			
Flare Patrol Observations	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231
	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231			
Subflares	211	From here on subflares included with flares.																				
Ionospheric Effects (SWF)	211	212	213	214	215	216	219	219	219	220	221	222	223	224	225	226	227	228	229*	230*	231	
(SCNA-SEA-Bursts)	211	212	213	214	215	216	219	219	219	220	221	222	223	224	225	226	227	228	229	230	231	
(SPA)	211	212	213	214	215	216	219	219	219	220	221	222	223	224	225	226	227	228	229	230	231	
2800 Mc-Outstanding Occurrences (Ottawa)	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231
2800 Mc-Hours of Observations (Ottawa)	212	212	212	215	215	215	218	218	218	221	221	221	224	224	224	227	227	227	230	230	230	
25-530 (50-320 as of Jan 1963) (Fort Davis)	213	213	213	216	216	216	219	219	219	222	222	222	225	225	225	228	228	228	230	230	230	
221 Mc-Interferometric Occurrences (Boeing-Seattle)	-	-	-	221	221	221	221	221	221	221	221	221	222	223	224	225	229	229	229			
169 Mc-Interferometric Observations (Nançay)	210	211	212	213	214	215	216	217	219	219	220	221	222	223	224	225	226	227	228	229	230	231
108 Mc-Outstanding Occurrences (Boulder)	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231
108 Mc-Hours of Observations (Boulder)	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231
7.6-41 Mc - (HAO-Boulder)	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231
9.1 cm (Stanford)				213	214	215	216	217	218	219	220	221	222	-	-	225	226	227	228	229	230	231
Cosmic Ray Neutron Counts (Climax)	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	
Cosmic Ray Neutron Counts (Deep River)	211	212	213	214	223	223	223	223	223	223	223	222	223	224	225	226	227	228	229	230	231	
Geomagnetic Indices C, Kp, Ap, - Selected Days	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	
27-Day Charts of Kp Indices for Year	221	221	221	221	221	221	221	221	221	221	221	221										
NARWS - CRPL Quality Figures & Forecasts	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	
NARWS - Comparison Graphs	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	
NPRWS - CRPL Quality Figures & Forecasts	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	
NPRWS - Comparisón Graphs	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	
NARWS - Graphs of Useful Frequency Range	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	
Alert and SWI Decisions	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231

* Addenda to July SWF in 230 and to August SWF in 231.

International Geophysical Calendar for the International Years of the Quiet Sun, 1964 and 1965

1. **Purpose**—The International Geophysical Calendar designates days and intervals selected for special attention for geophysical observations, experiments, data interchange or analyses. It is thus a framework for world-wide and interdisciplinary coordination in those programs where it is not practical or meaningful to carry out the same work for each and every day. The Calendar serves mainly the branches of geophysics dealing with the earth's atmosphere. A principal use is for the coordination of the sampling of the many phenomena which vary significantly during the course of a year. For many geophysical programs, the Committee for the International Years of the Quiet Sun 1964-65 (IQSY) has made recommendations on work to be carried out for the days or intervals marked on the Calendar (see paragraphs 12 to 17 below). It is also common for individual geophysical stations or groups of stations to arrange some of their plans of observations according to the Calendar. Thus geophysicists can expect that their colleagues in other countries, in other laboratories and in other geophysical disciplines will tend to be making increased efforts for the days and intervals marked on the Calendar; the amount of geophysical data in existence, at the World Data Centers and elsewhere, will accordingly be greater for Calendar days.

This abbreviated explanation of the International Geophysical Calendar is adapted from IQSY Manual No. 1, World Days Program, issued 1963 by the IQSY Secretariat, 6 Cornwall Terrace, London NW 1, Great Britain. The Manual should be consulted for full details on the Calendar and other IQSY world days such as solar and geophysical Alerts and the Retrospective World Intervals.

2. **Universal Time** (U.T.) is the standard of time for all world days on the Calendar, i.e., each begins at 0000 UT and ends at 2400 UT.

3. **Regular Geophysical Days (RGD)** are each Wednesday throughout the IQSY 1964-1965. This weekly sampling schedule is particularly designed for the purposes of the meteorological program of IQSY but has also been adopted for some other geophysical programs.

4. **Regular World Days (RWD)** are three consecutive days each month, always Tuesday, Wednesday, Thursday near the middle of the month. They are intended for observations, exeriments or analyses which can or need be made for about 10% of days and which should be spaced (in groups of three days) throughout the year.

5. **Priority Regular World Days (PRWD)** are one day each month — the RWD which are also a RGD (Wednesday). They are for work which can or needs to be done only one day each month throughout the year.

6. **Quarterly World Days (QWD)** are one day in each quarter of the year. They are the PRWD which fall within the World Geophysical Intervals (WGI) and are also a RGD (Wednesday). The QWD serve to co-ordinate seasonal high-altitude rocket experiments.

7. **World Geophysical Intervals (WGI)** during IQSY are 14 consecutive days in each season, beginning on the second Monday of the selected months. They always include the three RWD of the month and the QWD for the season. Some of the WGI are considered of higher priority than others in certain programs. The WGI are intended for intensified programs aimed at the statistics of seasonal variations or the timing of seasonal changes. The schedule of WGI relative to the equinoxes and solstices is deliberately made different from year to year so that in due course a WGI will cover the time of seasonal change of each of various geophysical phenomena.

8. **Solar Eclipses,** whether total, annular or partial, are marked on the Calendar. Geophysical stations in the eclipse zones treat these days as world days and undertake special programs to study eclipse effects on the earth's atmosphere. For maps of the eclipse zones and pertinent details, see IQSY Manual for the World Days Program or any standard astronomical ephemeris or year-book.

9. **Meteor Showers** of special interest are also marked on the Calendar, including some of the important visual showers and also unusual showers observable mainly by radio and radar techniques. Attention is called to these days (selected by P. Millman (Ottawa)) in case ionization produced by meteors may account for unusual effects in other geophysical experiments.

10. **"World Days" not appearing on Calendar**—The occurrence of unusual solar or geophysical conditions are announced or forecast through various types of geophysical **"Alerts"** which are widely distributed by telegram and radio broadcast on a current schedule. The types of alerts are: magnetic storm (in telegrams MAGSTORM), magnetic calm (MAGCALME), solar flare (SOFLARE), solar activity (SOLACTIVITY), solar calm (SOLCALME), cosmic ray event (COSMIC EVENT), and sudden and unusual stratospheric warmings (STRATWARM). These Alerts are issued by the IQSY-IUWDS World Warning Agency or under certain circumstances by one of the solar-geophysical Regional Warning Centers. The meteorological telecommunications network coordinated by WMO carries the world-wide Alerts once daily soon after 0400 UT (as from Oct. 1963). Many geophysical stations in the various disciplines increase their programs or carry on special experiments to take advantage of the special solar or geophysical conditions during the period of Alert. The IQSY Manual for the World Days Program contains full details, including recommended scientific programs. Selections of **Retrospective World Intervals,** after a delay of a few weeks or months, are also announced by the World Warning Agency. An additional service of the Regional Warning Centers is to notify geophysical and solar stations promptly **(Ursigrams)** with summary details of immediately significant geophysical observations and of major solar events which have important and sometimes long-lasting geophysical effects. The telegraphic addresses of the Regional Warning Centers are as follows: AGIWARN WASHINGTON (USA); DEMPA KOKUBUNJI (JAPAN); NIZMIR MOSCOW (USSR);IONOSPHAERE DARMSTADT (G.F.R.) or CNETAGI BAGNEUX (FRANCE) or AGI NEDERHORSTDENBERG (NETHERLANDS).

11. **The International Ursigram and World Days Service (IUWDS)** is a permanent scientific service of the International Union of Radio Science (URSI), with the participation of the International Astronomical Union and the International Union Geodesy and Geophysics. The IUWDS adheres to the Federation of Astronomical and Geophysical Services of the International Council of Scientific Unions. The IUWDS coordinates the international aspects of the world days program and rapid data interchange, and also publishes subsequently an annual **Calendar Record** of solar and geophysical indices and events.

Suggested Scientific Programs for World Days and Intervals on the Calendar

(The following material is adapted from recommendations of the CIG-IQSY Committee, IInd Assembly, Rome, March 1963 (see IQSY Notes No. 3, 1963, issued by IQSY Secretariat) or its Reporters or spokesmen for the various scientific disciplines. Any supplementary recommendations will appear in future issues of IQSY Notes).

12. **Meteorology**—Particular efforts should be made to obtain the maximum quantity of data on the **RGD**—each Wednesday, UT. Rocket ascents and ozone- and radiation-sonde ascents should be made on these days. Maximum altitude balloon ascents should be made at 0000 and 1200 UT.

During **WGI** the following observations should be made at all appropriate stations: (a) on all days: two maximum altitude balloon soundings; (b) on Mondays and Fridays: two maximum altitude balloon soundings, one ozone sounding, one radiation sounding, one rocket sounding; (c) on Wednesdays: at least two and preferably four maximum altitude balloon soundings, one radiation sounding, one ozone sounding, at least one and preferably two rocket soundings. **Note:** where Meteorological Services and Institutes have difficulty in carrying out the recommended programs during all WGIs, priority should be given to the WGI in October 1964 and March 1965. Stations which are able to carry out the recommended program during only one WGI should choose October 1964 if in the Southern Hemisphere and March 1965 if in the Northern Hemisphere.

13. **Geomagnetism**—It has always been a leading principle for geomagnetic observatories that operations should be as continuous as possible. Thus the great majority of stations taking part in the geomagnetic program of the IQSY will undertake the same program without regard to the IQSY Calendar. The days marked on the Calendar will be of interest mainly to the following two types of geomagnetic stations: **(a)** stations recording quick-run micropulsations (with fast chart speeds) are requested to make such records on every **RGD**—each Wednesday, UT—according to the following schedule: 1964 Jan. 1, from 0000 to 0400 UT; Jan 8, from 0100 to 0500 UT; Jan. 15, from 0200 to 0600 UT; etc. The observatories are not obliged to send their recordings to the World Data Centers except by special request (see IQSY World Days Manual under Retrospective World Intervals on Micropulsations). **(b)** Stations which, in addition to other IQSY activities, are equipped for making magnetic observations, but which can not carry out such observations and reductions on a continuous schedule are encouraged to carry out such work at least on **RWD** (and during times of MAGSTORM Alert).

Attention is called to the opportunity which the expected quiet conditions of the IQSY period may provide for a profitable study of the geomagnetic effect of **solar eclipses**, marked on the Calendar.

14. **Ionosphere**—For the vertical incidence sounding program, the summary recommendations are **(a)** soundings to be made at 5-minute intervals or less on **RWDs**; **(b)** f-plots are made for high latitude stations and representative stations at lower latitudes for all days (i.e. including **RWDs** and **WGIs**), **(c)** profile parameters hc, qc to be determined and sent to WDCs for **RWDs** for all stations except those undertaking full profile programs or producing monthly median profiles; **(d)** copies of ionograms for **PRWDs** are to be sent to WDCs; **(e)** stations in the eclipse zone should take continuous observations on solar eclipse days and special observations on adjacent days in accordance with detailed recommendations in the IQSY World Days or Ionosphere Manuals.

For the ionospheric drifts program, observations are made on all **RWDs**, on all **WGIs**, on every Wednesday (**RGDs**) and on every Thursday (day following each **RGD**). Hourly tabulations for all days mentioned are sent to the WDCs.

For the ionospheric absorption program, diurnal hourly observations are made on all **RWDs** and hourly tabulations sent to WDCs. Continuous observations on **solar eclipse** days, where possible, for stations in eclipse zone.

For back-scatter and forward-scatter programs, observations should be made on all **RWDs** at least.

For topside sounding experiments, it is recommended to send copies of records to WDCs for all **RWDs** at least.

All programs should take notice of the days of unusual **meteor shower** activity in case unusual ionospheric phenomena are noted.

15. **Solar Activity**—Observatories are invited to issue and send to the WDCs of all IQSY disciplines special reports of their regular and any special observations on all **solar eclipse** days to assist in the interpretation of geophysical observations made in the eclipse zones.

The total **solar eclipse** of May 30, 1965 will be characterized by long duration (about 4 minutes) on the central line. It is recommended that comprehensive solar observations be made of this eclipse, both optical and radio.

16. **Cosmic Rays, Aeronomy**—Experimenters should take into account that observational effort in other disciplines tends to be intensified on the days marked on the Calendar, and schedule balloon and rocket experiments accordingly if there are no other geophysical reasons for choice.

17. **Space Research**—In view of the variability of the D and E regions of the ionosphere, it is desirable to make rocket measurements of their characteristics on the same day at as many locations as possible. Where feasible, experimenters should endeavor to launch rockets on the **Quarterly World Days (QWD)** since these are also days when there will be maximum support from ground observations.

TABLE OF WORLD DAYS MARKED ON THE CALENDAR

1964

1964	RWD	PRWD	QWD	RGD	WGI	ECL.	Meteors
Jan.	14, 15, 16	15	15	1, 8, 15, 22, 29	13-26	14	3-4
Feb.	18, 19, 20	19	—	5, 12, 19, 26	—	—	—
Mar.	17, 18, 19	18	—	4, 11, 18, 25	—	—	—
Apr.	14, 15, 16	15	15	1, 8, 15, 22, 29	13-26	—	21-22
May	19, 20, 21	20	—	6, 13, 20, 27	—	—	4-5
June	16, 17, 18	17	—	3, 10, 17, 24	—	10	4-8
July	14, 15, 16	15	15	1, 8, 15, 22, 29	13-26	9	28-30
Aug.	18, 19, 20	19	—	5, 12, 19, 26	—	—	9-13
Sep.	22, 23, 24	23	—	2, 9, 16, 23, 30	—	—	—
Oct.	20, 21, 22	21	21	7, 14, 21, 28	12-25*	—	19-21
Nov.	17, 18, 19	18	—	4, 11, 18, 25	—	—	15-17
Dec.	15, 16, 17	16	—	2, 9, 16, 23, 30	—	3-4	12-14, 22

* Priority WGI, particularly Southern Hemisphere

1965

1965	RWD	PRWD	QWD	RGD	WGI	ECL.	Meteors
Jan.	12, 13, 14	13	13	6, 13, 20, 27	11-24	—	3
Feb.	16, 17, 18	17	—	3, 10, 17, 24	—	—	—
Mar.	16, 17, 18	17	17	3, 10, 17, 24, 31	8-21**	—	—
Apr.	20, 21, 22	21	—	7, 14, 21, 28	—	—	21-22
May	18, 19, 20	19	—	5, 12, 19, 26	—	30	4-5
June	15, 16, 17	16	16	2, 9, 16, 23, 30	14-27	—	4-8
July	20, 21, 22	21	—	7, 14, 21, 28	—	—	28-30
Aug.	17, 18, 19	18	—	4, 11, 18, 25	—	—	10-14
Sep.	14, 15, 16	15	15	1, 8, 15, 22, 29	13-26	—	—
Oct.	19, 20, 21	20	—	6, 13, 20, 27	—	—	19-21
Nov.	16, 17, 18	17	—	3, 10, 17, 24	—	23	15-17
Dec.	14, 15, 16	15	15	1, 8, 15, 22, 29	13-26	—	12-14, 22-23

** Priority WGI, particularly Northern Hemisphere

This Calendar for 1964 and 1965 has been drawn up by A. H. Shapley, Chairman, and J. V. Lincoln, Deputy Secretary, of the IUWDS Steering Committee, in close association with the CIG-IQSY Committee and its Reporters and spokesmen for the various scientific disciplines. Similar Calendars have been issued annually beginning with the IGY, 1957-58, and have been published in various widely available scientific publications.

Additional copies are available upon request to IUWDS, c/o Secretary General of URSI, 7 Place Danco, Brussels 18; or to IQSY Secretariat, 6 Cornwall Terrace, London NW 1.

IQSY

International Geophysical Calendar 1964

1964 **JANUARY**

S	M	T	W	T	F	S
			△1	2	3̲	4̲
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	

1964 **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	29

1964 **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				

1964 **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	2̲1̲	△22	23	24	25
26	27	28	△29	30		

1964 **MAY**

S	M	T	W	T	F	S
					1	2
3	4̲	5̲	△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						

1964 **JUNE**

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

1964 **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	2̲8̲	△2̲9̲	3̲0̲	31	

1964 **AUGUST**

S	M	T	W	T	F	S
						1
2	3	4	△5	6	7	8
9̲	1̲0̲	1̲1̲	△12	1̲3̲	14	15
16	17	⑱	△⑲	⑳	21	22
23	24	25	△26	27	28	29
30	31					

1964 **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			

1964 **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	1̲9̲	⑳	◇21	㉒	23	24
25	26	27	△28	29	30	31

1964 **NOVEMBER**

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

1964 **DECEMBER**

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

⑰	Regular World Day (RWD)	◇24	Quarterly World Day (QWD), also a PRWD and RGD
[31]	Day of Solar Eclipse	⑱	Priority Regular World Day (PRWD)
7̲	Day with unusual meteor shower activity	△15	Regular Geophysical Day (RGD)
[16 17]	World Geophysical Interval (WGI)	+	Priority WGI, particularly Southern Hemisphere

IQSY

International Geophysical Calendar 1965

1965 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						

1965 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						

1965 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			

+

1965 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	

1965 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					

1965 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			

1965 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

1965 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				

1965 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		

1965 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						

1965 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				

1965 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	

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					

⑰ Regular World Day (RWD)

31 Day of Solar Eclipse

7 Day with unusual meteor shower activity

16 17 World Geophysical Interval (WGI)

◆24 Quarterly World Day (QWD), also a PRWD and RGD

⑱ Priority Regular World Day (PRWD)

△15 Regular Geophysical Day (RGD)

\+ Priority WGI, particularly Northern Hemisphere

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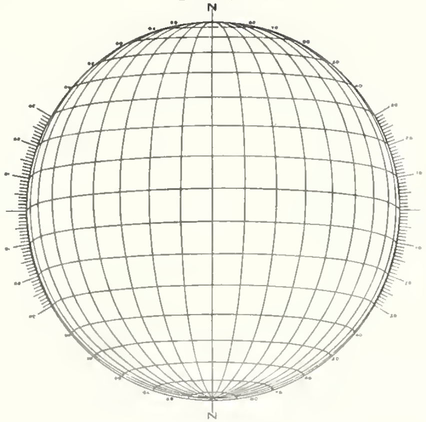

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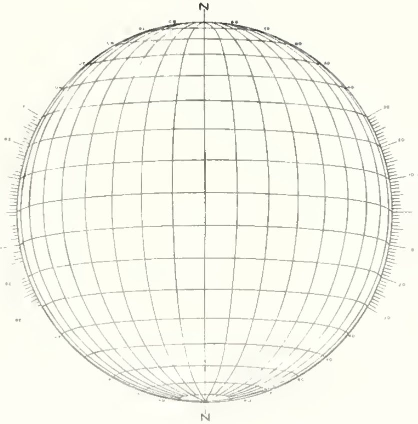

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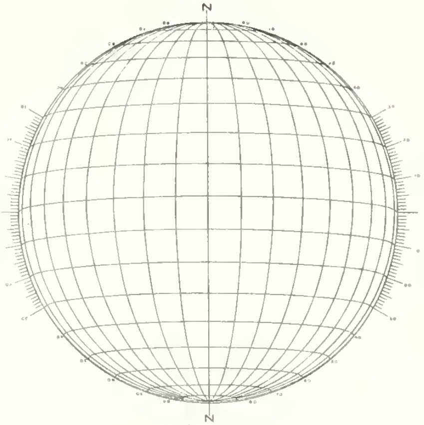

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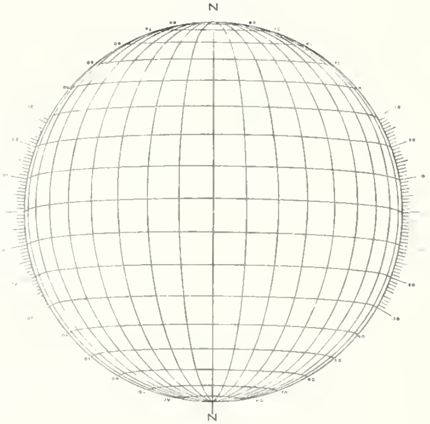

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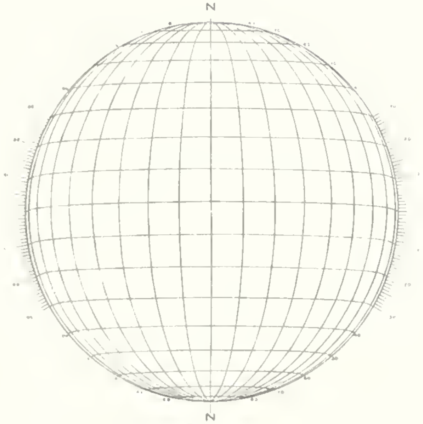

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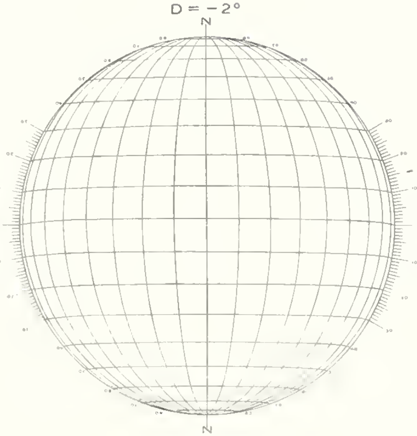

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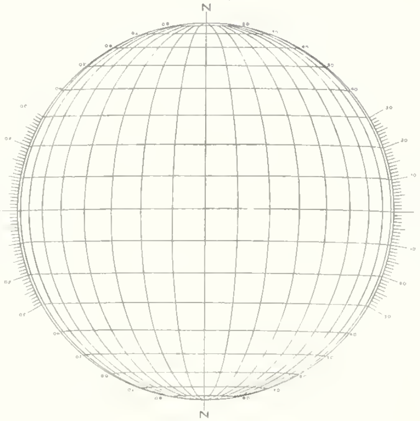

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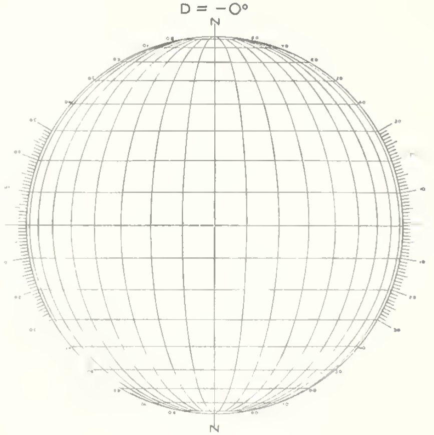

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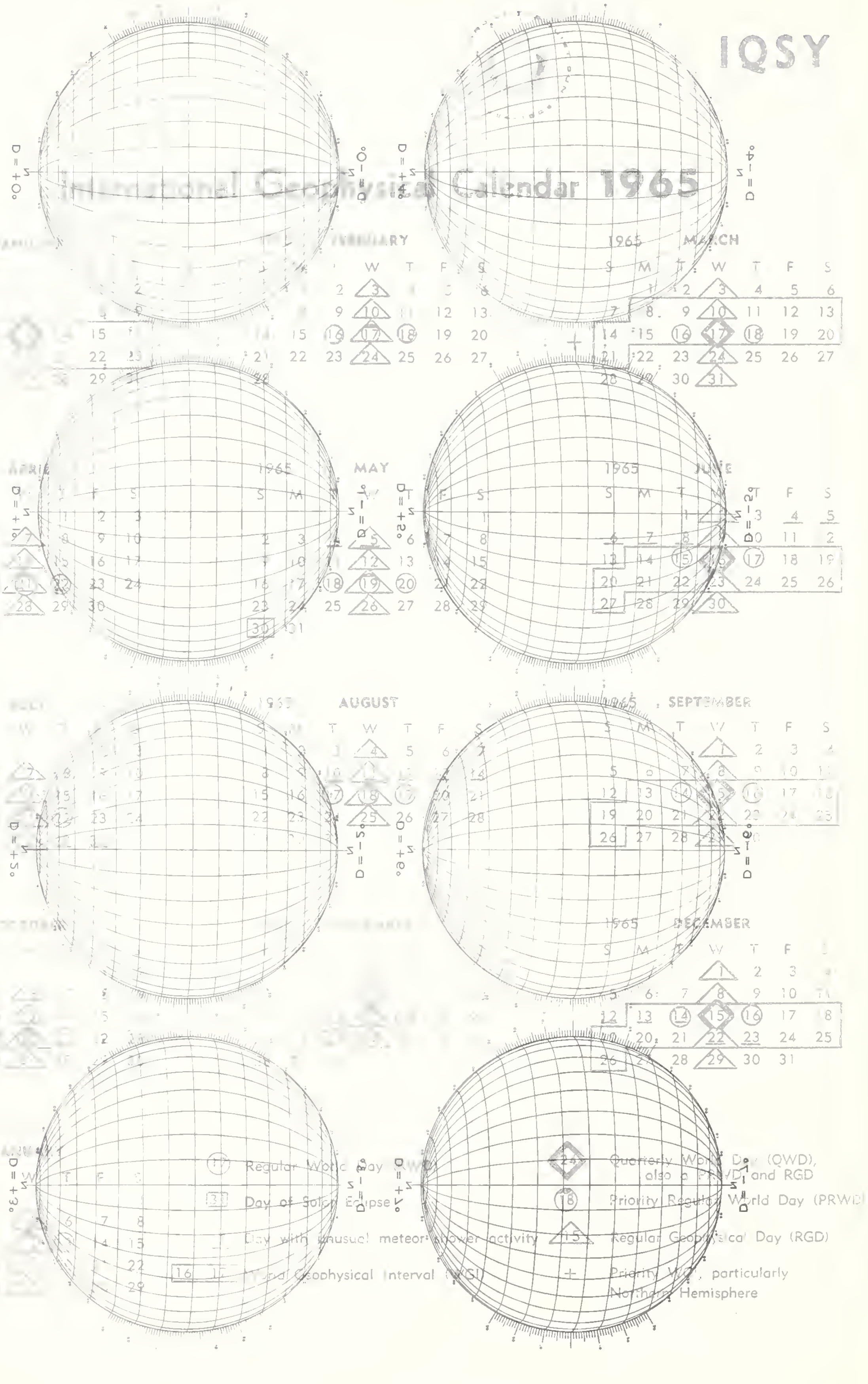

IQSY

International Geophysical Calendar 1965

1965 JANUARY

[illegible]

1965 FEBRUARY

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

1965 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			

1965 APRIL

S	M	T	W	T	F	S
				1	2	3
[illegible]	[illegible]	[illegible]	7	8	9	10
[illegible]	[illegible]	[illegible]	14	15	16	17
[illegible]	[illegible]	20	21	22	23	24
[illegible]	[illegible]	27	28	29	30	

1965 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					

1965 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			

1965 JULY

[illegible]

1965 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
[illegible]	[illegible]	[illegible]				

1965 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		

1965 OCTOBER

[illegible]

1965 NOVEMBER

[illegible]

1965 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	

1966 JANUARY

[illegible]

(17)	Regular World Day (RWD)	◇24	Quarterly World Day (QWD), also a PRWD and RGD
31	Day of Solar Eclipse	(18)	Priority Regular World Day (PRWD)
11	Day with unusual meteor shower activity	△15	Regular Geophysical Day (RGD)
16 17	World Geophysical Interval (WGI)	+	Priority WGI, particularly Northern Hemisphere