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INSTITUTES FOR ENVIRONMENTAL RESEARCH

Solar-Geophysical Data

Descriptive Text

WASHINGTON, D.C.
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SOLAR - GEOPHYSICAL DATA

INTRODUCTION

This pamphlet contains the description and explanation of the data contained in the monthly publication "Solar-Geophysical Data", issued by the Institute for Telecommunication Sciences and Aeronomy of the Environmental Science Services Administration (ESSA). The monthly bulletins are available on a data exchange basis through the World Data Center A, Upper Atmosphere Geophysics, ESSA, Boulder, Colorado 80302, or at a nominal cost through the U. S. Government Printing Office.* These data reports continue the series issued by the Central Radio Propagation Laboratory of the National Bureau of Standards, known since 1956 as the CRPL-F series Part B. The CRPL became the ITSA in October 1965. As before the reports are compiled and edited under the supervision of Miss J. Virginia Lincoln; since June 1965, the compilations have been done by Miss H. I. Leighton.

The reports are intended to keep research workers abreast of the major particulars of solar activity and the associated ionospheric, radio propagation and other geophysical effects. This report series is made possible through the cooperation of many observatories, laboratories and agencies as recorded in the detailed description of the tables and graphs which follow.

Beginning with the February 1967 issue the data have been regrouped within the reports and are being presented according to the month which the observations cover. The pink-paper section contains data for the month one month before the month of publication, the white-paper section contains data for the second month before and the green-paper section contains data for the sixth month before the month of publication. Special data for miscellaneous times are given from time to time in the yellow-paper section. In this descriptive text the page colors correspond to those used for the data publication. These reports should not be considered as definitive publications because of the rapid publication schedule involved for the data from months one and two before that of publication. 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.

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* For sale through the Superintendent of Documents, Government Printing Office, Washington, D. C., 20402. Subscription price: $4.50 annually for domestic mailing. Add $1.00 for foreign mailing. Single issue price 45 cents.

DATA FOR ONE MONTH BEFORE MONTH OF PUBLICATION
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ALERT PERIODS

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

These alerts are of the types recommended for 1966-1967. A full description of the program can be found in IQSY NOTES No. 19, "1966-1967 World Days Program", which is available from the IUWDS Deputy Secretary, Miss J. Virginia Lincoln, ESSA, Boulder, Colorado, U.S.A. 80302. Pertinent information is given below:

Effective January 1, 1967 there were some changes in the scheme for the daily worldwide Alerts, the GEOALERTS. The new plan provides for GEOALERTS (also Advance Alerts, ADALERTS) to be covered by the following conditions (pp 8-9 of IQSY NOTES No. 19):

Solar Flares (in telegrams: SOFLARE). The GEOALERT statement distinguishes between occurrence of a really major flare (PROTONFLARE) and the existence of a region of flare activity (FLARES). Either kind may be forecast (EXPECTED), but only a PROTONFLARE will be recognized after its occurrence in the GEOALERT statement by giving date and time of its occurrence. In all cases, there will be given the heliographic position of the flare (at the time of occurrence) or of a flare-producing solar region (at 0400 UT on the date of the GEOALERT message); for example: "N25E62" for latitude North 25°, central meridian distance East 62°.

For ADALERTS, in addition to PROTONFLARE, the messages recognize all flares of numerical importance 2, 3, 4 and alphabetical importance B (bright), and all very outstanding radio solar noise bursts, especially at 10 cm wavelength, and those of Type IV.

Magnetic Storms (in telegrams: MAGSTORM). The GEOALERT statement attempts to mark the major magnetic disturbances either in a forecast (EXPECTED) or by recognition (EXISTS, or date and time of commencement). As appropriate, self-explanatory words like GREAT, MAJOR, AURORA, will be appended. In general, the ADALERT statement will only recognize the commencement of a storm rather than make forecasts.

Cosmic Events (in telegrams: COSMIC EVENT). The GEOALERT message recognizes a major change in the level of cosmic-ray flux as seen by a neutron monitor, such as FORBUSH DECREASE EXISTS; or COSRAY INCREASE with date and nominal time if available. Also a significant PCA event will be identified by POLCAP ABSORPTION EXISTS. The same conditions are suitable for ADALERT statements.

Note. The following conditions, for which Alerts were issued during IQSY and 1966, have been dropped since they were particularly suited for the solar minimum conditions which have now passed: Solar Calm (SOLCALME) and Magnetic Calm (MAGCALME). These kinds of Alerts have been relegated to the category of special projects which may be undertaken by RWC individually or jointly to meet any special needs. The general solar activity alert (SOLACTIVITY) has been replaced by the more specific SOFLARE Alerts described above. Further, the Stratospheric Warming Alert is being continued. They will be distributed along with the GEOALERT message but will be identified separately as STRATWARM Alerts.

DAILY SOLAR INDICES

The first table presents Zürich relative sunspot numbers, R_Z, for the month. The corresponding data for eleven earlier months are reprinted to permit the trend of solar activity to be followed. On the same page is presented a similar table of twelve months of daily solar flux values at 2800 Mc/s adjusted to one Astronomical Unit, S_a, as reported by the Algonquin Radio Observatory (ARO) of the National Research Council near Ottawa.

The next table gives several available daily indices for the month preceding that of publication. In addition to the calendar date, the table gives the day-number of the year and the day-number of the standard 27-day (solar rotation) cycle. The data presented are Zürich relative sunspot numbers, (R_Z), American relative sunspot numbers, (R_A'), daily solar flux values at 2800 Mc/s, (S), and daily solar flux values, (S_a), adjusted to 1 A.U. for 8800, 4995, 2800, 2695, 1415, and 606 Mc/s.

Graph of Sunspot Cycle -- A graph illustrates the recent trend of Cycle 20 of the 11-year sunspot cycle with predictions of the future level of activity. The customary "12-month" smoothed index, R_{12}, is used throughout, the data being final R_Z numbers except for the current year.

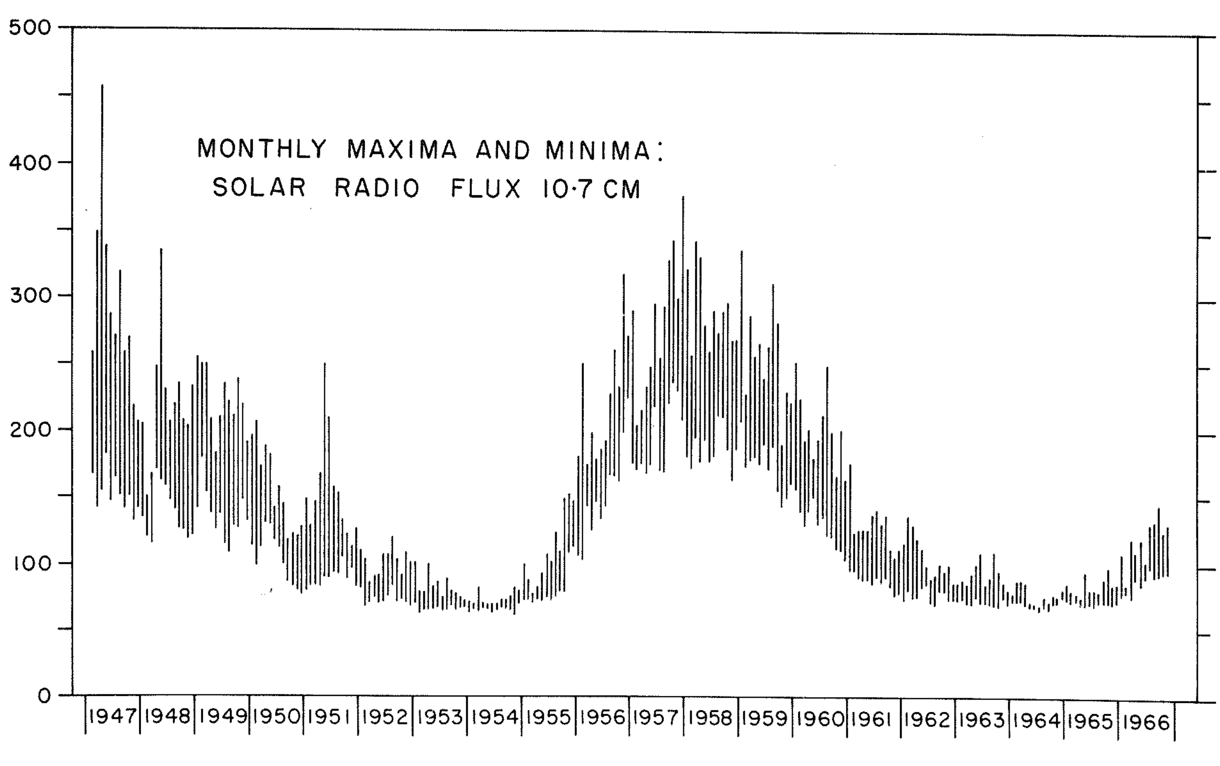
$$R_{12} = 1/12 \sum_{n-5}^{n+5} \left[R_k + 1/2\ (R_{n+6} + R_{n-6})\right]$$ in which R_k is the

mean value of R for a single month k and R_{12} is the smoothed index for the month represented by k = n. Predictions shown are those made for one year after the latest available datum by the method of A. G. McNish and J. V. Lincoln (Trans. Am. Geophys. Union, 30, 673-685, 1949) modified by the use of regression coefficients and mean cycle values recomputed for Cycles 8 through 19. Cycle 20 began October 1964, when the minimum $\bar{R}$ of 9.6 was reached. The values of the smoothed index, R, are given in a table following the graph. They also appear regularly in the Ionospheric Telecommunications Laboratory of I.T.S.A. "Ionospheric Data" reports and in the I.T.S.A. "Ionospheric Predictions" series.

Relative Sunspot Numbers -- The relative sunspot number is an index of the activity of the entire visible disk of the sun. It is determined each day without reference to preceding days. Each isolated cluster of sunspots is termed a sunspot group and it may consist of one or a large number of distinct spots whose size can range from 10 or more square degrees of the solar surface down to the limit of resolution (e.g. 1/25 square degree). The relative sunspot number is defined as $R = K (10g + s)$, where g is the number of sunspot groups and s is the total number of distinct spots. The scale factor K (usually less than unity) depends on the observer and is intended to effect the conversion to the scale originated by Wolf. The provisional daily Zürich relative sunspot numbers, R_Z, based upon observations made at Zürich and its two branch stations in Arosa and Locarno are communicated by M. Waldmeier of the Swiss Federal Observatory. The daily American relative sunspot numbers, R_A', are compiled by Richard H. Davis, Boston, Massachusetts, for the Solar Division of the American Association of Variable Star Observers. The R_A' observations for sunspot numbers are made by a rather small group of extraordinarily faithful observers, many of them amateurs, each with many years of experience. The counts are made visually with small, suitably protected telescopes.

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

Daily Solar Flux Values - Ottawa-ARO -- Daily observations of intensities of the 2800 Mc/s radio emission which originates from the solar disk and from any active regions present are made at the Algonquin Radio Observatory (ARO) of the National Research Council near Ottawa with a reflector 1.8 meters diameter as a continuation of observations which commenced in Ottawa in 1947. Entries refer to a single calibration made near local noon at 1700 UT. When the flux changes rapidly, or there is a burst in progress, the reported value is the best estimate of the undisturbed level for the whole observing day. The various types of outstanding events are listed separately in another table. The observed flux values have variations resulting from the eccentric orbit of the earth in its annual path around the sun. Although these radio values are suitable to use with observed ionospheric and other data, an adjustment must be introduced when the observations are used in studies of the absolute or intrinsic variation of the solar radio flux. Thus the tables show both the observed flux S, and the flux adjusted to 1 A.U., S_a. A graph showing the monthly highs and lows for the last two sunspot cycles is shown in this text. Relative errors over long periods of time are believed to be about $\pm 2\%$, over a few days may be $\pm 0.5\%$. The spectral difference between 2800 Mc/s and 2700 Mc/s solar emissions will be evaluated in the coming sunspot cycle so that the present series of observations at 2800 Mc/s can be transferred to the ITU allocation of 2690 - 2700 Mc/s. A discussion of the absolute errors in the intensity measurements was presented to the XVth General Assembly of URSI by H. Tanaka and T. Kakimura (Information Bulletin of Solar Radio Observatories, No. 21, page 6, November 1966).



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

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

These solar radio noise indices are being published in accordance with a CCIR Recommendation originally from the Xth Plenary Assembly, Geneva, 1963 (and maintained at Oslo, 1966), 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".

<u>Daily Solar Flux Values - AFCRL Sagamore Hill</u> -- The Sagamore Hill Solar Radio Observatory of the Air Force Cambridge Research Laboratories (located at N42°37'54", W70°49'15.15") in 1966 began operating solar patrols at 8800, 4995, 2695, 1415, and 606 Mc/s. Flux calibrations are made at about meridian transit each day. All flux data are corrected to sun-earth distance of 1 A.U. Corrections are also made for atmospheric attentuation based on the following average vertical attentuations:

8800 Mc/s	0.070 db	1415 Mc/s	0.05 db
4995	0.055	606	0.045
2695	0.051		

The system calibrations have been based on the measured antenna temperature of the accurately known flux of Cassiopeia A at the two lower frequencies and the lunar brightness temperature at the two high frequencies. At 2695 the system was calibrated initially on the Ottawa 2800 Mc/s flux measurement for an overlapping period. The calibration has been stable for about one year. Frequent evaluation of system accuracies indicates that no drastic corrections need be made. However, some small correction factors are appropriate.

SOLAR CENTERS OF ACTIVITY

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

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

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

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S O L A R   C E N T E R S   O F   A C T I V I T Y

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

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

For each flare (or subflare in tables in the green section) are listed the reporting observatory using IAU Quarterly Bulletin on Solar Activity designations; the date; beginning and ending times; time of maximum phase; the heliographic coordinates in degrees for the "center of gravity" of the emission region, corresponding to the time of maximum intensity; the distance from center of disk in units of the disk radius; McMath serial number of the plage region; the time of central meridian passage of the position of the flare in tenths of the Universal date; duration in minutes; the flare importance on the IAU scale of Sf* to 4b (see below); observing conditions where 1 means poor, 2 fair and 3 good; nature and completeness of available observations where C** = a complete, or quasi complete, sequence of photographs was obtained, P** = one or a few photographs of the event were obtained resulting in incomplete time coverage, V = all (or most of) the development of the flare was visually observed, or S = flare was seen visually for a small part of its probable duration; time of measurement for either tabulated width of Hα to nearest 1/10A or for tabulated area; measured (i.e. projected) area at maximum intensity in heliographic square degrees (reported originally in millionths of disk by observatory) -- this is not necessarily the maximum area; corrected area in square degrees (see below); maximum effective line-width in Hα to nearest 1/10A; maximum intensity expressed in percent of the local continuum; and remarks in the IAU system of notes

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* For easier visual selection of the more important flares a minus sign, "-", is used to indicate subflares instead of "S".

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

where A* = eruptive prominence for which the base has a heliocentric distance of at least 90°, B = probably the end of a more important flare, C = invisible 10 minutes before, D = brilliant point, E = two or more brilliant points, F = several eruptive centers, G = no spots visible in the neighborhood, H = the flare is accompanied by a dark filament (surge) of high sightline velocity, I = very extensive active region, J = marked variations in the intensity of the plage area, also before and (or) after the real flare event, K = several intensity maxima, L = filaments already existing in the neighborhood show effects of sudden activation, M = the flare has a strong continuous spectrum (is visible in white light), N = the continuous spectrum shows effects of polarization, O = the observations have been made in the calcium II lines H or K, P = the flare shows helium D_3 in emission, Q = the flare shows the Balmer continuum in emission, R = the $H\alpha$ line shows a marked asymmetry suggesting outgoing matter of high velocity, S = brightening follows disappearance of filament, occurs in position of former filament, T = region active all day, U = formation of two relatively close and somewhat parallel bright filaments (II or Y shape), V = occurrence of an explosive phase (very sudden expansion and/or intensity increase within about one minute) -- give the corresponding time, W = great increase in area after time of maximum intensity -- give the corresponding time and area, X = unusually wide $H\alpha$ emission, Y - onset of a system of loop-type prominences, and Z = major sunspot umbra covered by flare. The following symbols are used in the table to explain accuracy of the times reported:

D = greater than
E = less than
U = approximate

All times are Universal Time (UT or GCT).

If importance is not given the symbol ▱ appears in the importance column.

The no-flare patrol observations for the month before that of publication is given in graphical form. The observatories reporting the patrols are indicated.

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* Capital letters used instead of lower case due to limitation of electronic processing equipment.

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

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

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

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

where apparent area is in millionths of the disk and corrected area is in heliographic square degrees.

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

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

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

SOLAR FLARE OBSERVATORIES

CODE NO.	OBS. TYPE	I.A.U. ABREV.	NAME, PLACE AND COUNTRY
824	C	ABST	ABASTUMANI,GEORGIAN,SSR
512	VP	ARCE	ARCETRI,FLORENCE,ITALY
521	VP	AROS	AROSA,SWITZERLAND
508	VP	ATHN	NATL OBS,ATHENS,GREECE
832	C	BAKO	BAKOU,PIRCULI,USSR
560	C	BUCA	NATL OBS,BUCHAREST,ROMANIA
506	VP	CAPF	ANACAPRI,ITALY(GERMAN)
519	V	CAPS	ANACAPRI,ITALY(SWEDISH)
570	VP	CATA	CATANIA,SICILY,ITALY
639	C	CLMX	HIGH ALTITUDE OBS,CLIMAX,COLORADO,USA
826	C	CRIM	SIMEIS,CRIMEA,RSFSR
402	C	CULG	CULGOORA,AUSTRALIA
478	C	HALE	HALEAKALA,MAUI,HAWAII,USA
537	VP	HERS	R.GREENWICH OBS,HERSTMONCEUX,ENGLAND
718	C	HUAN	GEOPHYSICAL INST,HUANCAYO,PERU
313	V	IKOM	IKOMASAN OBS,KYOTO,JAPAN
358		ISTA	UNIV.OBS,ISTANBOUL,TURKEY
382	VP	KAND	KANDILLI OBS.,ISTANBOUL,TURKEY
547	V	KANZ	GRAZ OBS,KANZELHOHE,AUSTRIA
827	VP	KHAR	KHARKOV,UKRANIAN,SSR
828	C	KIEV	KIEV,GAO,UKRANIAN,SSR
309	VP	KODA	KODAIKANAL,INDIA
522	VP	LOCA	LOCARNO,SWITZERLAND
659	C	LOCK	LOCKHEED,LOS ANGELES,CALIFORNIA,USA
876	VP	LVOV	LVOV,UKRANIAN,SSR
468	VP	MANI	MANILA,PHILIPPINE ISLANDS
642	C	MCMA	MCMATH-HULBERT,PONTIAC,MICHIGAN,USA
505	C	MEUD	MEUDON,FRANCE
314	C	MITK	MITAKA,TOKYO,JAPAN
555	C	MONT	MONTE MARIO OBS,ROME,ITALY
515		NERA	NEDERHORST DEN BERG,NETHERLANDS
504	V	ONDR	ONDREJOV,PRAGUE,CZECHOSLOVIA
603	C	OTTA	OTTAWA,ONTARIO,CANADA
359		PURP	PURPLE MTN,NANKING,CHINA
645	C	SACP	SACRAMENTO PEAK,SUNSPOT,NEW MEXICO,USA
572	VP	SALO	SALONIQUE(THESSALONIKA)GREECE
520		SALT	SALTSJOBADEN,STOCKHOLM,SWEDEN
758	C	SANM	SAN MIGUEL,ARGENTINA
862	VP	SIBE	SIBERIE(SIBERIAN IZMIR)IRKUTSK,RSFSR
833	C	TACH	TACHKENT,UZBECK,SSR
556	C	TORT	TORTOSA,SPAIN
502	C	UCCL	UCCLE,R.O.BRUSSELS,BELGIUM
834	C	VORO	VOROSHILOV,USSR
546	VP	WEND	WENDELSTEIN,GFR
523	VP	ZURI	EIDGENOSSISCHE STERNWARTE,ZURICH,SWITZERLAND

The table on page 14 gives the solar flare observatories presently cooperating in international data interchange through the World Data Centers originally established during the International Geophysical Year. For each observatory are given the code numbers used on the punched cards at ESSA; the four letter IAU abbreviations; name, place and country; and type of patrol where C, V and P have the meanings explained above.

Note: All the flare data are recorded on punched cards. As errata are received the punched cards are corrected. These errata are not always published in these reports. Copies of the cards, tabulations from them or some data on magnetic tape are available at cost through the World Data Center A Upper Atmosphere Geophysics, ESSA, Boulder, Colorado U.S.A. 80302.

S O L A R R A D I O W A V E S

Outstanding Occurrences -- Beginning with data for October 1966 the outstanding occurrences observed at discrete frequencies were combined together and presented in one table. They now appear for the month before that of publication. The discussions below give the reporting details for each individual reporter.

In the table a single solar event is indicated by brackets with the reports ordered by frequency from the highest to lowest. The observing station is given followed by type of event as described in the table on page 16. For each event start and maximum phase in UT, duration in minutes and peak and mean flux densities in $10^{-22}Wm^{-2}(c/s)^{-1}$ are listed.

From time to time illustrations of selected outstanding bursts will be included.

The table which follows gives the key for identifying type of event and indicates which frequencies have been or may be expected to report each type of event. The second column lists the URANA or

URANE synoptic code that is used by the International Ursigram and World Days Service for daily telegraphic interchange of data. (See IUWDS Synoptic Codes for Solar and Geophysical Data, Revised Edition 1965.) The name code used to identify each reporting station is included at the bottom of the table.

NUMBER CODE FOR TYPE OF SOLAR RADIO EMISSION EVENT

	Code	IUWDS URAN-Form	Mc/s											
			10700	8800	2800	2695	2690	1415	960	606	328	223	108/107	18
Simple 1	1	E1	x	x	x	x	x	x	x	x	x			
Simple 1F	2	E1			x									
Simple 2	3	E2	x	x	x	x	x	x	x	x	x			
Simple 2F	4	E2			x									
Simple	5								x		x			
Minor	6	A4										x	x	x
Minor +	7											x	x	
Simple 3	20	E3	x	x	x	x	x	x	x	x	x			
Simple 3A	21	E3			x									
Simple 3F	22	E3			x									
Simple 3AF	23	E3			x									
Rise	24	A1	x		x		x		x		x	x	x	
Rise A	25				x									
Fall	26				x									
Rise and Fall	27		x	x		x	x	x	x	x	x			
Precursor	28	E9		x	x									
Post Burst Increase	29	E4	x	x	x	x	x	x	x	x	x			
Post Burst Increase A	30	E4			x									
Post Burst Decrease	31	E5			x									
Fluctuations	40	E7	x	x	x	x	x	x	x	x	x			
Group of Bursts	41	A3,E8	x	x	x	x	x	x	x	x	x	x	x	
Series of Bursts	42	A2										x	x	x
Onset of Noise Storm	43	A7	x	x		x	x	x	x	x	x	x	x	x
Noise Storm in Progress	44	A6										x	x	x
Complex	45	E6	x	x	x	x	x	x	x	x	x			
Complex F	46	E6	x	x	x	x	x	x	x	x	x			
Great Burst	47	E6	x	x	x	x	x	x	x	x	x			
Major	48	A8										x	x	
Major +	49	A9										x	x	

Code	Station	Frequencies Reported, Mc/s
BOUL	ESSA - Boulder	184
HALE	Haleakala - Hawaii	107
OTTA	ARO - Ottawa	2800
PENN	Pennsylvania State Univ.	10700, 2690, 960, 328
PENT	DRAO - Penticton	2700
SGMR	AFCRL - Sagamore Hill	8800, 4995, 2695, 1415, 606
WASH	Washington State Univ.	486

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

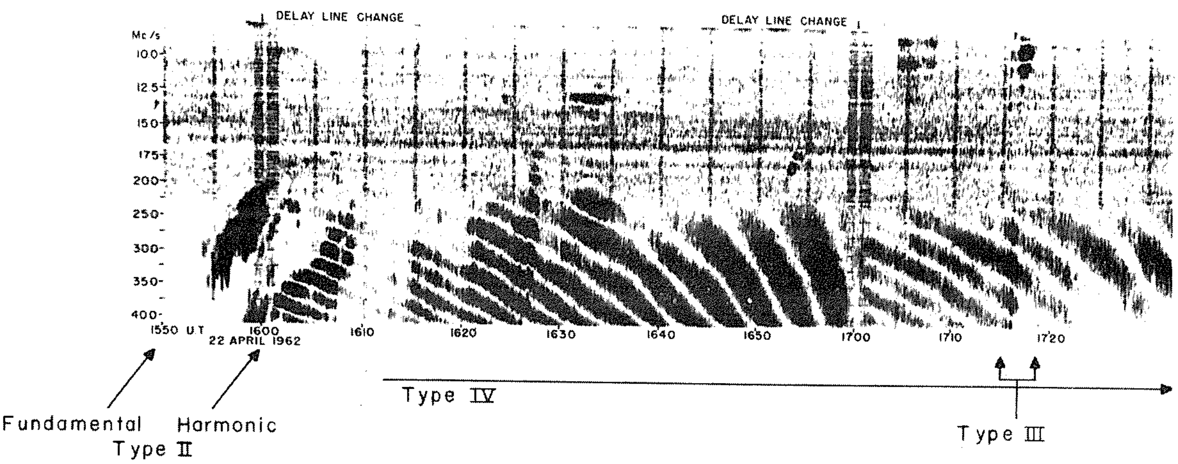
The collecting area of the antennas is approximately 1000 square meters, in two corner reflectors forming an interferometer pair. Observations are taken routinely throughout the Boulder observing day from about 1400 UT to 2400 UT. On the low-frequency side, bursts are frequently limited by an external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

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

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

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

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



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

Interferometric Observations -- Two charts present solar interferometric observations as recorded around local noon at Nançay, France (N47°23', E8^m47^s) the field station of the Meudon Observatory. For 408 Mc/s the plane lobes are parallel to the meridian plan: the half-power width is 1.7 minutes of arc in the East-West direction. The main lobes are about 25' apart (B. Clavelier, Comptes Rendus Acad. Science, Paris, in press).

The records give the position and the intensity of centers observed at this frequency. These daily data are plotted on the same chart. The intensity is given in $10^{-22}W/m^2(c/s)^{-1}$ and clearly indicated for the centers whose flux density is more than 0.20 x $10^{-22}W/m^2(c/s)^{-1}$. The distance between the main lobes being smaller than the radioelectrical diameter of the sun, there is sometimes an ambiguity about the position East or West of the center of activity. In this case, the two possible positions are indicated on the chart by a circle.

For 169 Mc/s the main lobes are parallel to the meridian plane: the half-power width is 3.8 minutes of arc in the East-West direction. The main lobes are about 1° apart (Ann. Astroph. 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. Points of equal intensity given in relative units are joined day after day in the form of isophotes. Four equal intensity levels have been chosen to draw the isophotes. These intensities are proportional to 0.6, 1, 1.5 and 2. The first level corresponds to the sun without any radio storm center.

In each noisy radio region the smoothed intensity around noon is given in $10^{-22}W/m^2(c/s)^{-1}$.

East-West Solar Scans -- Two charts present for each day an East-West strip scan of the sun, one at 21 cm and the other at 43 cm. These data are made possible by the "Fleurs" Radio Astronomy Station of the University of Sydney, Sydney, Australia. An ESSA contract provides some of the support for this work.

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

East-West solar scans are also available from a 45 cm-λ solar radio array. The fan beam has a resolution of 4' of arc. The estimated quiet sun is indicated on the published profiles in the same manner as for the 21 cm-λ scans. The curves have not been normalized for variations in gain.

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

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 below 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 IUWDS-URAN form, but if superimposed upon a Simple or Complex burst as a secondary feature, it is not given a IUWDS-URAN number and is only recorded by the letter "f" added to the basic descriptive term.

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

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

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

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

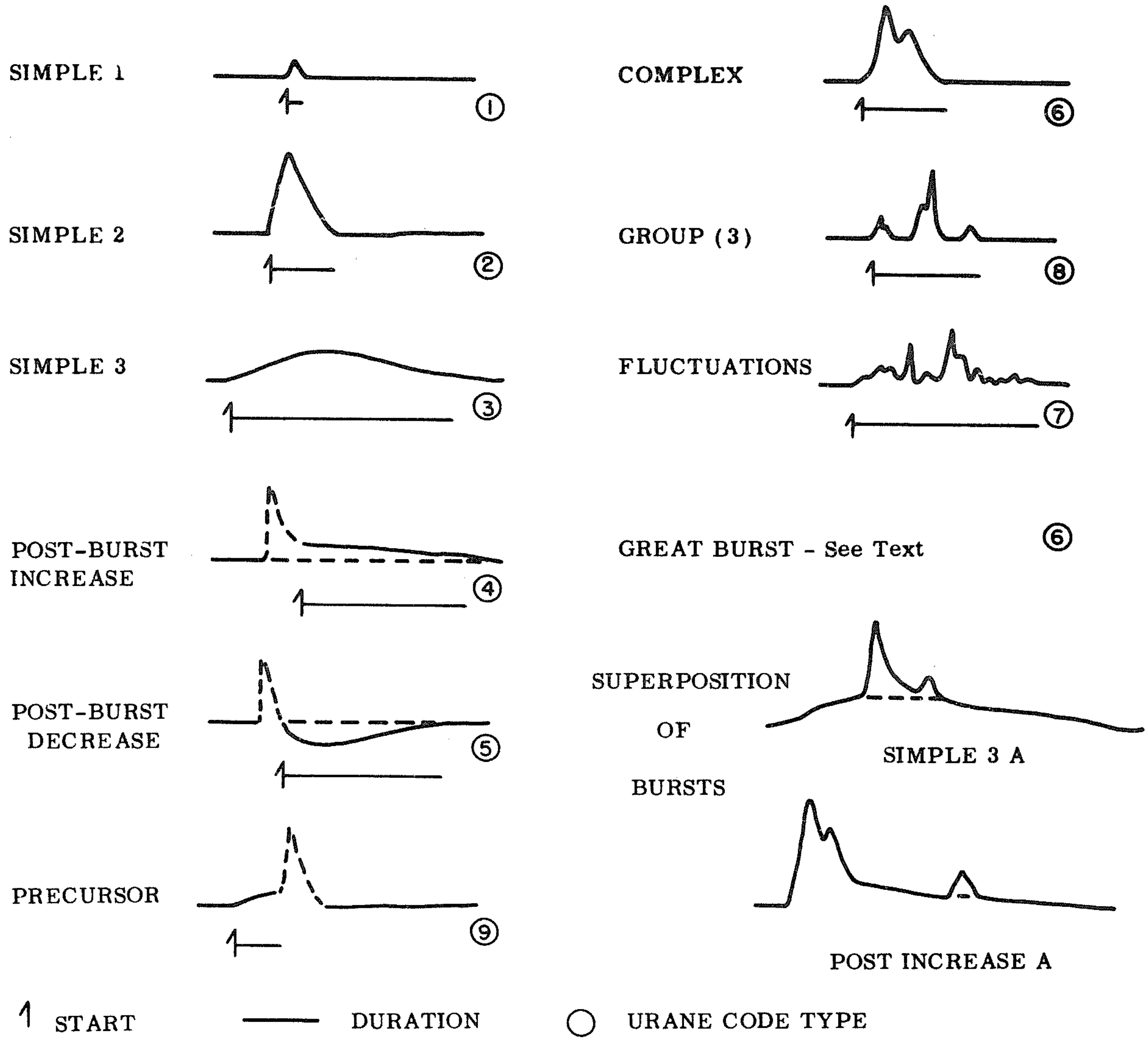
The commencement of a burst is taken when the enhancement of the daily flux shows a departure from the daily level by an amount of approximately 1 flux unit. For the impulsive bursts this may be determined certainly to within a minute while for the Gradual Rise and Fall burst, the uncertainty in the time of commencement may be as great as 5 minutes. The letter "E" appearing after the time of start, indicates that the burst was already in progress at this time. Profiles of typical bursts are produced on page 21.

-- <u>10700, 2700, 960, and 328 Mc/s Pennsylvania State University</u>:

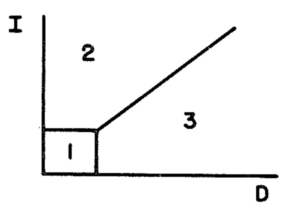
The Radio Astronomy Observatory at the Pennsylvania State University is conducting a daily solar patrol at 10,700 Mc/s, 2,700 Mc/s, 960 Mc/s and 328 Mc/s. An interferometer operating at approximately 80 Mc/s is under construction. The purpose of this patrol is to obtain correlated flux measurements with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

The antennas for the four radiometers now operating are all mounted on a single polar tracking mount located on the roof of the Radio Astronomy Observatory. The 10,700 Mc/s and 2,700 Mc/s radiometers use 4-foot and 6-foot waveguide fed, parabolic reflecting

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



RELATION OF SIMPLE BURSTS TO DIAGRAM OF INTENSITY VERSUS DURATION



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

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

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

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

antennas, respectively. The 960 Mc/s uses a dipole fed, 6-foot parabolic reflecting antenna, while the 328 Mc/s radiometer uses a pair of stacked Yagi antennas.

The receivers operating at 10,700, 2700 and 960 Mc/s are essentially similar switched receivers. The 328 Mc/s receiver is a total power receiver with a band-width of 80 kc/s. The band-width of each of the other three receivers is 8 Mc/s.

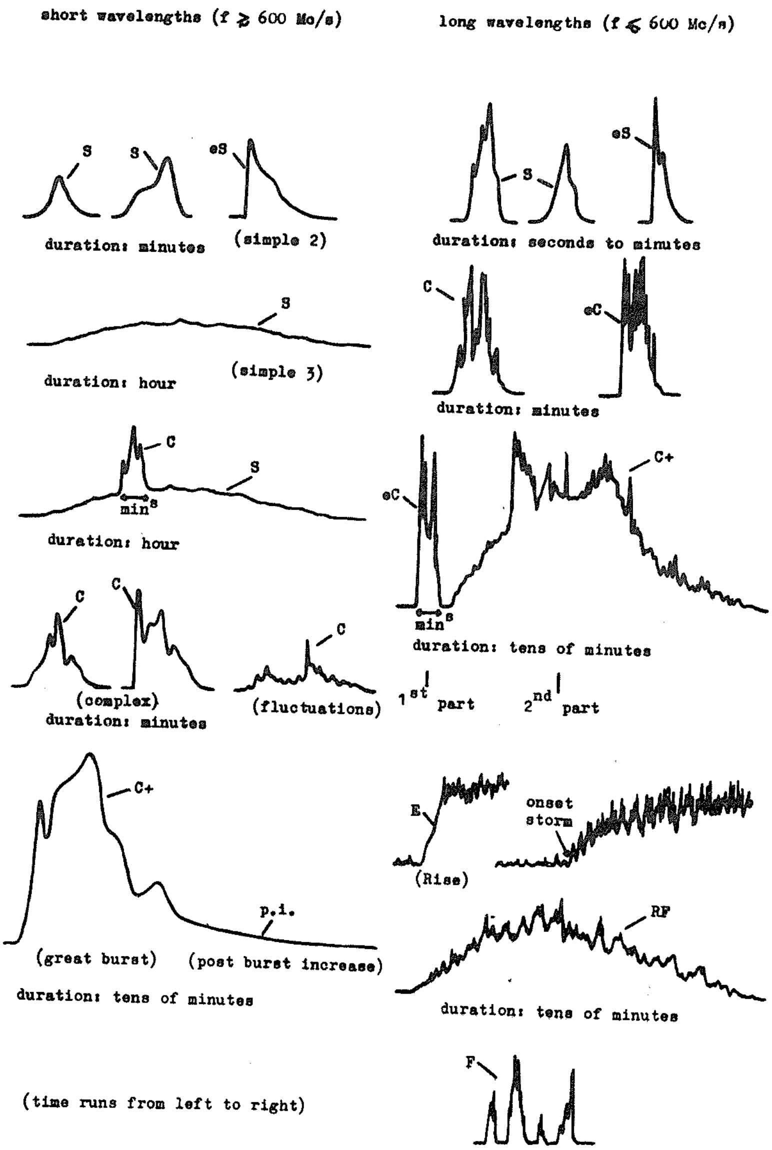
The sensitivities of the two receivers for which data are being reported are approximately 6.0 x $10^{-22}Wm^{-2}(c/s)^{-1}$ for the 10,700 Mc/s system and approximately 1.0 x $10^{-22}Wm^{-2}(c/s)^{-1}$ for the 2700 Mc/s system.

The outstanding occurrences are presented in accordance with the classification scheme on page 19 of IQSY Instruction Manual No. 2 Solar Activity as reproduced on page 23.

-- 8800, 4995, 2695, 1415, and 606 Mc/s Sagamore Hill -- The Sagamore Hill Solar Radio Observatory of the Air Force Cambridge Research Laboratories in 1966 began operating a solar patrol at 8800, 4995, 2695, 1415, and 606 Mc/s. The patrol will include 15,400 Mc/s in 1967. A 20-40 Mc/s swept frequency solar interferometer is also in daily operation. Certain portions of the project were funded by the AFCRL Laboratory Directors Fund. The objectives are to provide high absolute accuracy flux measurements at 606 and 1415 Mc/s (goal ±3%); to provide coverage at other regions in the microwave spectrum with a somewhat lesser absolute accuracy (±5 to 10%), and to study centimeter burst spectra for an explanation of causative mechanisms.

Solar coverage is provided at the two longer wavelengths from sunrise to sunset. A 28-foot diameter polar mounted parabola and a dual frequency feed is used. At 606 Mc/s, the half power beamwidth is about 4°, while at 1415 Mc/s, the underilluminated parabola provides a 3° beam. The shorter wavelengths operate from a polar mounted 8-foot parabola with a multi-frequency feed. Coverage is from sunrise to sunset generally, except for a period when some afternoon data will be lost due to partial antenna blockage. The parabola is underilluminated at 8800 Mc/s. Corrections are employed to convert apparent fluxes to true fluxes where required. Daily flux calibrations are made at about meridian transit each day.

All receivers are essentially "Dicke" radiometers. Bandwidth (IF) of each is about 8 Mc/s. Band pass filters (RF) and single side band operation are employed at 606 and 1415 Mc/s. The other receivers operate double side band where the L.O. is designated the operating frequency.



Classification of distinctive events.

All flux data variation resulting from the varying distance between the sun and the earth is corrected to 1 A.U. Corrections are also made for atmospheric attenuation based on the average vertical attenuations given on page 6. Outstanding occurrences are listed according to the IAU classification, similar to the method of Pennsylvania State University (see figure page 23).

-- 486 Mc/s Washington State University -- The Washington State University at Pullman, Washington operates on a student-need basis a solar radio emission patrol at 486 Mc/s.

The antenna is a 15-foot parabolic dish with a dipole disk feed. The antenna half-power beam-width is approximately 7.25 degrees. The antenna mount and tracking system is capable of both elevation and azimuth variation. An analog computer positions the antenna on the sun. The antenna mount can rotate 360 degrees in azimuth and 180 degrees in elevation. The antenna mount system can operate in winds up to 25 miles per hour.

The 486 Mc/s radiometer is a switched "Dicke" type comparison radiometer. The r-f switch is single pole, double throw, and is driven at 805 c/s. The comparison noise source is a 50 ohm resistor in an environmentally controlled box. The comparison noise temperature is thus the ambient temperature of the insulated box. The box, which also contains the r-f amplifier, first mixer, and first i-f, is mounted on the back side of the parabolic reflector. A control building, 15 feet from the mount, contains the second mixer, second i-f, detectors, and recorder. To improve long-term gain stability, the system has an automatic gain control loop keyed to the standard noise source. The system noise figure is 4.7 db. The receiver half-power beamwidth is 3.0 Mc/s. The antenna signal is synchronously detected at the switching frequency, 805 c/s. The integration time is 2 seconds.

Calibration of the system is achieved by inserting a known noise power into the receiver at the terminals of the r-f switch. This allows calibration of the recorder in terms of the known input noise power. The calibration source is a commercial noise diode instrument.

A measure of the quality of this type of system is the minimum detectable change in temperature (ΔT) at the antenna terminals. Fluctuations in the record, for this system, due to gain variations are negligible when the output noise power of the comparison noise source is nearly equal to the noise power from the antenna. The ΔT, when the above applies, for this system is about 0.5° K.

The comparison noise source of this system is a fixed source, and the ΔT will depend upon the strength of the radio source. When "looking" at the quiet sun, the ΔT is approximately 7° K.

-- 184 Mc/s ESSA Boulder -- Data on solar radio emission at the nominal frequency of 184 Mc/s recorded at the Table Mountain (Boulder) station of the Institute for Telecommunication Sciences and Aeronomy of Environmental Science Services Administration are presented. The antenna is equatorially mounted and linearily polarized. The plane of polarization is parallel to the solar rotation axis.

> Note: Data on solar radio emission at 167 Mc/s recorded at the Gunbarrel Hill (Boulder) station of the National Bureau of Standards were terminated September 30, 1960. Equipment at 108 Mc/s was operated from October 1, 1960 to June 17, 1966.

Only the outstanding occurrences are reported.

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 following the time or duration entries:

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

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

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

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

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

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

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

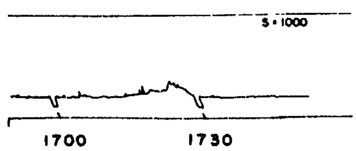
6 - Noise storm -- A temporary increase in radiation characterized by numerous closely spaced bursts, by an increase in the continuum, or by both. Duration is of the order of hours or days.

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

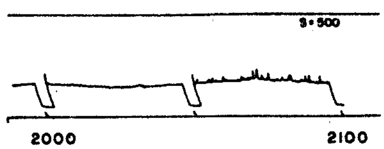
8 - Major burst -- An outburst, or other burst of large amplitude and more than average duration. A major burst is usually complex, with a duration of the order of one to ten minutes.

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

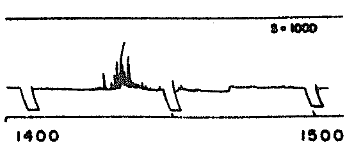
O-RISE IN BASE LEVEL



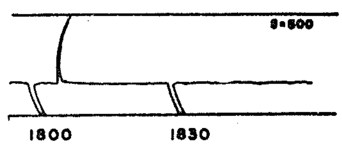
I - SERIES

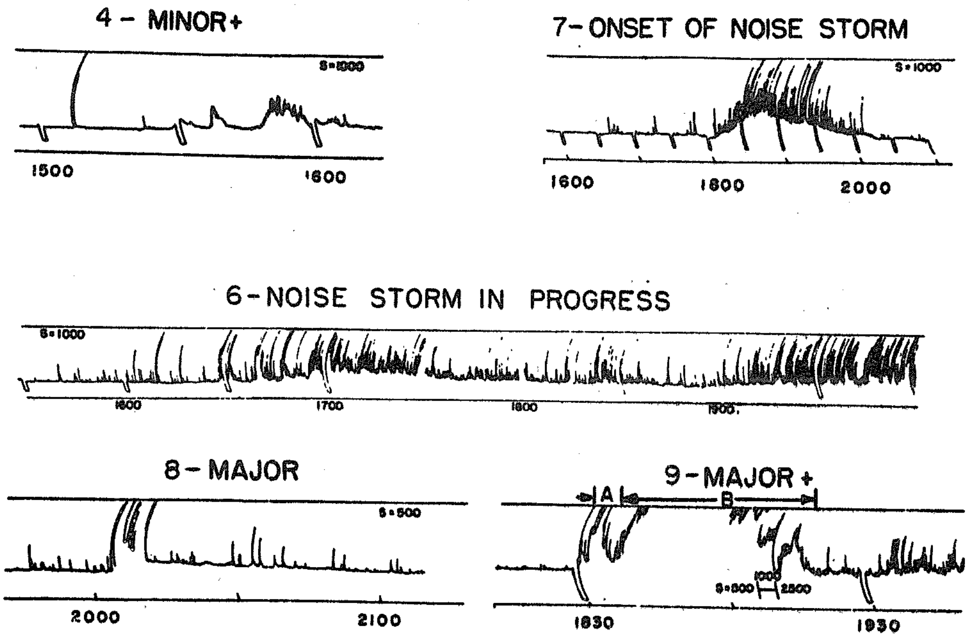


2 - GROUP



3 - MINOR





-- <u>107 Mc/s Haleakala</u> -- Beginning with June 1965 outstanding occurrences of solar radio emission are presented at the nominal frequency of 107 Mc/s as recorded by the Hawaii Institute of Geophysics of the University of Hawaii at the Haleakala Observatory on Maui under the direction of Dr. John L. Jefferies. This program is supported by contract with ESSA. The antenna is equatorially mounted and linearily polarized. The plane of polarization is parallel to the solar rotation axis. The outstanding occurrences are reported in the same manner as for 184 Mc/s described above.

SOLAR PROTON EVENTS

An unnumbered page with a diagonal slash across it will be included whenever provisional outstanding solar proton events have been reported during the month before month of publication. This will be prepared by the Space Disturbance Forecast Center of the I.T.S.A. Space DisturbancesLaboratory. These sheets will be self-explanatory and are not to be used for research reference purposes, but are to be discarded when definitive data are published. They will merely provide some of the immediately available evidence when significant solar proton events have occurred in the previous month.

DATA FOR TWO MONTHS BEFORE MONTH OF PUBLICATION
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SOLAR ACTIVITY CENTERS

On one page per day are presented several photographs or charts of active solar centers recorded at optical and radio wavelengths. For each day the Carrington longitude, Lo, at 0000 UT, position angle, P, and center of sun, Bo, are given. All but one of the diagrams are reduced to the scale of the transparent Stonyhurst disks provided with this text. Though a magnifying glass is needed to read detail, it is felt that the significant regions stand out on the scale used. For those interested, copies with the solar disk at approximately 15 cm in diameter can be made available at cost through the World Data Center A Upper Atmosphere Geophysics.

The data are H-α photographs provided by the USAF Sacramento Peak Observatory at Sunspot, New Mexico; sunspot drawings by the Space Disturbances Laboratory, ESSA; 9.1 cm and 21 cm spectroheliograms from Stanford University and Fleurs Radio Astronomy Station of the University of Sydney, respectively; a tracing of the calcium plage regions available through the McMath-Hulbert Observatory of the University of Michigan -- these are identified by the last three digits of the serial number of the plage with intensity on a scale of 1 to 5 and area in hundreds of millionths of the solar hemisphere given in a table adjacent to the tracing; and the solar magnetogram as observed at Mount Wilson Observatory.

Details of these individual observations follow.

H-α Spectroheliograms -- These H-α spectroheliogram photographs are furnished through the cooperation of the Sacramento Peak Observatory of the U.S. Air Force Cambridge Research Laboratories. The solar flare patrol instrument is a half-Angstrom Halle filter of 4 inches aperture, 70 inch focal length with f-ratio of 17.5. Typical exposure times are one-quarter second.

Sunspot Drawings -- The sunspot drawings are furnished by the Space Disturbances Laboratory of I.T.S.A. at Boulder, Colorado, under the direction of P. S. McIntosh. A 4-inch refractor telescope is used. Days of no observations at Boulder are supplemented by drawings furnished by the Sacramento Peak Observatory.

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

These spectroheliograms show the distribution of microwave emission over the sun's disk as observed with a pencil beam whose East-West width to half power is 3.1', and whose North-South width varies from 3.1' in summer to nearly 6' in mid-winter (actual value 3.1' sec (38.2° - $\delta_{\odot}$) at a declination $\delta_{\odot}$ on the meridian). For a full description of the instrument and its response see "The Stanford Microwave Spectroheliograph Antenna, a Microsteradian Pencil Beam Interferometer", IRE Transactions on Antennas and Propagation, vol. AP-9, pp. 22-30, 1961, by R. N. Bracewell and G. Swarup.

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

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

The reading printed on the map in the *i*th column and *j*th row is y_{ij} and the corresponding brightness temperature in degrees Kelvin, to the resolution allowed by the instrument, is Cy_{ij}. The unit C is currently 5000°K. (Before 1 July 1965, the unit C varied from day to day around a value of 2000°K which was stated on the map.) The readings are normalized so that the flux density S of the whole sun is equal to the absolute measurement obtained the same day on 10.7 cm by A. E. Covington at the National Research Council, Ottawa. No

---

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

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

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

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

where S is the flux density of the whole sun, k is Boltzmann's constant (1.38×10^{-23} joules per degree K), λ (= 9.107 cm) is the operating wavelength, and R/16.02 is the ratio of the sun's semi-diameter in minutes of arc to its mean. Active regions are emphasized by clusters of two-digit numbers where the brightness temperature is 50,000°K or more (previously dots were used to emphasize 40,000°K or more); however, the clustering also shows up the limb brightening at the extremities of the equatorial diameter on occasion. Negative readings which occur do so because of the sharp cutoff in the sensitivity of the instrument to the spatial Fourier components of the source. The two-dimensional response pattern of the instrument to a point source is

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

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

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

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

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

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

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

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

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

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

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

Magnetograms -- The Mount Wilson Observatory solar magnetograms are computer-plotter isogauss drawings. The polarities are indicated. "Plus" signifies the magnetic vector pointed toward the observer. The gauss levels are indicated. At times it is necessary to omit certain levels from a map because of the limited capacity of the computer. In such a case this fact is noted below the title material of each printed disk.

The observations are made with the magnetograph at the 150-foot tower telescope on Mount Wilson. The program is supported in part by the Office of Naval Research. This instrument measures the longitudinal component of the magnetic field using the line λ5250.216 Fe I. A solar magnetograph is basically a flux measuring instrument. It measures the total flux over the aperture which is being used. The magnetograph apertures are square (an image slicer is used) and the raster scan lines are separated by the dimension of the aperture. This separation of the scan lines is given by the

ΔY (DELTAY) printed on the magnetogram. The units of ΔY are the units of the position orientation of the scanning system which correspond to about 0.28 arc seconds. The DELTAX represents in the same units the distance along the scan line between points at which the data were digitized.

The scan is a boustrophedonic raster scan which extends for all scan lines beyond the disk. The data within about 12 arc seconds of the solar limb are not plotted. The scanning system is always oriented so that the scan lines are perpendicular to the central meridian of the sun. The cardinal points on the magnetogram refer to heliocentric coordinates so that the "N" and "S" define the rotation axis of the sun.

The contour lines are generated by connecting straight lines between points on the scan lines representing the various gauss levels. This makes the contour map look somewhat artificial, but it emphasizes the angular resolution. Frequently there are cases where the contour line is formed from only two points - both on the same scan line. In these cases two additional points are added artificially. These points are located midway between the two real points in the scanning direction and half way to each adjacent scan line. Such contours, then, are small diamond-shaped features.

Because the magnetic field strength measured by the magnetograph is the product of the true field strength and the brightness of the image, the fields used to map the contours have been corrected for the brightness at each point. So effects of limb darkening and variable sky transparency have been corrected.

A number of errors can still be present. One of the most common of these is the zero setting of the magnetograph. At times there may be an obvious bias of the fields over the whole disk toward one or the other polarity. This will tend to show very weak features of one polarity more readily than those of the other polarity. The noise in the magnetic signal varies from day to day, but it is almost always present at the 3-gauss level. Occasionally for one reason or another a scan line may be skipped. In this case the isogauss lines will be drawn across the skipped line as if there were no scan line there. Other problems may arise from time to time. In general any feature which is present on only one day should be discounted as an artifact unless there is some particular reason to accept its reality.

Because of the difficulties with the zero offset from day to day, the polar fields will appear to vary. The polar fields can only be studied by comparing them with other weak-field regions observed on the same day.

Sometimes, because of the small scale of the reproductions, it is difficult to make out the details of the field distribution in some regions. Large scale copies of the particular magnetograms may be obtained by writing to:

World Data Center A
Upper Atmosphere Geophysics
ESSA
Boulder, Colorado U.S.A. 80302

<u>Calcium Plage Reports</u> -- The contours are based on estimates made and reported on the day of observation as already stated on page 8 of this text. These data on calcium plage regions are as reported by the McMath-Hulbert Observatory of the University of Michigan supported by ESSA contract. They are the same regions which have been summarized in the table described on page 8.

CORONAL LINE EMISSION INDICES

Emission intensity indices for each quadrant of the limit for the λ5303 (FeXIV) and λ6374 (FeX) coronal lines are listed in the table. 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, by Harvard University observers at Sacramento Peak (the USAF Sacramento Peak Observatory at Sunspot, New Mexico, under contract AF 19(628)-3322), by Pic-du-Midi, and by Kislovodsk. The measurements are expressed in millionths of an angstrom of the continuum of the center of the solar disk (at the same wavelength as the line) that would contain the same energy as the observed coronal line. The indices are:

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

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

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

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

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

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:

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

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.

S U D D E N   I O N O S P H E R I C   D I S T U R B A N C E S

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

The table on page 38 of this text gives the two-letter station code used in the published data table. The geographic location of the station and the type or types of SID information submitted are indicated. These data are made possible for the most part through the auspices of the International Ursigram and World Days Service. Greater detail concerning the reporting stations can be found in "The Listing of Sudden Ionospheric Disturbances" by J. Virginia Lincoln (Planet. Space Sci. 12, 419-434, 1964) and in earlier versions of this text.

SWF -- SWF events are recognized on field-strength recordings of distant high-frequency radio transmissions.

STATION LIST FOR SUDDEN IONOSPHERIC DISTURBANCES TABLE

CODE	STATION LOCATION	SWF	SCNA	SEA	SES	SFD	SPA
AC	= ACCRA, GHANA					X	
AD	= ADAK, ALASKA	X					
AN	= ANCHORAGE, ALASKA	X	X				X
AR	= FLORENCE, ITALY			X			
AT	= ATHENS, GREECE	X					
BA	= BARBADOES, B.W.I.	X					
BE	= FT. BELVOIR, VIRGINIA	X					
BI	= BARTER ISLAND, ALASKA		X				
BN	= BRENTWOOD, ENGLAND	X					
BO	= BOULDER, COLORADO	X	X	X		X	X
BR	= BREISACH, GFR	X					
BY	= BEARLEY, ENGLAND	X					
CA	= CANBERRA, AUSTRALIA	X	X				
DA	= DARMSTADT, GFR	X					
DU	= DUNSINK OBSERVATORY, IRELAND			X			
FR	= FRANKFURT, GFR					X	X
GH	= GODLEY HEAD, N.Z.	X					
GS	= GREENBELT, MARYLAND	X					
HA	= MAUI, HAWAII		X	X		X	X
HK	= HONG KONG, B.C.C.	X					
HU	= HUANCAYO, PERU	X					
JU	= JUHLESRUH, GDR	X					
KE	= KERGUELEN ISLAND			X			
KU	= KUHLUNGSBORN, GDR	X		X			
LI	= LINDAU, GFR	X					
LO	= PRESTON, ENGLAND			X			
MA	= MANILA, PHILIPPINE ISLANDS	X	X	X			X
MC	= PONTIAC, MICHIGAN	X	X	X			
NA	= NATAL, BRAZIL					X	
ND	= NEW DELHI, INDIA		X	X	X		X
NE	= NEDERHORSTDENBERG, NETHERLANDS	X		X			
NU	= NEUSTRELITZ, GDR			X			
NZ	= WELLINGTON, NEW ZEALAND	X					
OK	= OKINAWA, PHILIPPINES	X					
PA	= PARAMARIBO, DUTCH WEST INDIES			X			
PO	= POITIERS, FRANCE			X			
PS	= PREDIGSTUHL, GFR	X					
PU	= PRAGUE, CZECHOSLOVAKIA	X		X			
RO	= ROME, ITALY		X	X			
SL	= SLOUGH, ENGLAND						X
SO	= SOMERTON, ENGLAND	X					
SW	= ENKOPING, SWEDEN	X					
SY	= SYDNEY (CULGOORA), AUSTRALIA	X					
TA	= HOBART, TASMANIA			X			
TO	= HIRAISO, JAPAN	X					
TR	= ST. AUGUSTINE, TRINIDAD, B.W.I.	X					
TS	= TORTOSA, SPAIN			X			
TU	= TUCUMAN, ARGENTINA						X
TY	= TOYOKAWA, JAPAN			X			
UC	= UCCLE, BELGIUM			X			
WS	= WHITE SANDS, NEW MEXICO	X					
UM	= CAMPOS DO JORDAO, BRAZIL				X		X
ZI	= ZILINA, CZECHOSLOVAKIA		X	X			
	AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS						
A1	= VALLEY COTTAGE, N.Y.			X	X		
A2	= PITTSBURG, PENNA.			X			
A3	= PATERSON, N.J.			X	X		
A5	= RAMSEY, N.J.			X	X		
A6	= OSHKOSH, WIS.			X			
A8	= HADDAM, CONN.			X			
A10	= BLAUVELT, N.Y.			X			
A14	= BEVERLY HILLS, CALIF.			X	X		
A15	= BENNINGTON, VERMONT			X			
A16	= SAO PAULO, BRAZIL			X			
A17	= DURBAN, SOUTH AFRICA			X			
A18	= SCITUATE, MASS.			X			
A19	= LATROBE, PENNA.			X			

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

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

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

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

SCNA-SEA -- Sudden ionospheric disturbances next listed in the table are those 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).

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

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

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

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.

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.

SFD -- A sudden frequency deviation (SFD) is an event where the received frequency of an HF radio wave reflected from the ionosphere increases suddenly, peaks, and then decays back to the transmitted frequency. Sometimes several peaks occur and usually the frequency deviation takes on negative values during the decaying portion of an SFD. The largest SFD observed at Boulder had a peak frequency deviation of about 61 c/s. The peak frequency deviation for most SFD's is less than 0.5 c/s. The start-to-maximum time is typically about 1 minute. SFD's are caused by sudden enhancements of ionization at E and F1 region heights produced by impulsive flare radiation at wavelengths longer than 4 Å. Flashes of radiation at wavelengths longer than 100 Å contribute to most SFD's. A more complete discussion of SFD's can be found in "An Investigation of Sudden Frequency Deviations Due to the Immediate Ionospheric Effects of Solar Flares" by R. F. Donnelly, E.S.S.A. Technical Report No. I.T.S.A. 19.

SFD's are presently observed at Boulder (BO) on frequencies near 2.1, 3.3, 4, and 5.1 Mc/s with near-vertical propagation (station call letters KKE42) and on frequencies near 8.9, 9.9, 11.1, 12.1, and 13 Mc/s transmitted from near Havana, Illinois (WWI) to Boulder (1290 km). SFD observations at Boulder on WWV have been discontinued since WWV has moved from Virginia to Colorado. SFD observations made in New Delhi and at the University of Hawaii will be reported with the station abbreviations ND and HA respectively.

The number entered in the SFD column of the table gives the peak frequency deviation in tenths of c/s. The entry in the same row in the stations column gives the corresponding station location, transmitter call letters, and the approximate frequency in Mc/s. For example, a "12" in the SFD column followed by HA(WWVH5) in the stations column means the peak frequency deviation observed at the University of Hawaii on 5 Mc/s WWVH was 1.2 c/s.

To summarize the table lists these phenomena jointly giving: date, beginning, ending and maximum phase in UT; a geographically widespread index for type of event; 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; if SFD gives the peak frequency deviation in tenths of c/s; stations observing event; and associated solar flare if known (asterisk if no patrol at time of event). In the tables D = greater than, E = less than and U = approximate for times indicated.

IONOSPHERIC ABSORPTION EVENTS

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

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

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

S O L A R X - R A Y R A D I A T I O N

The Naval Research Laboratory's NRL X-Ray Monitoring Satellite (1965-93A) has provided numerous measurements of solar x-ray emissions during 1966. The data published consist of table of observing times and daily averages of the solar x-ray flux. Outstanding events are also listed. This program is under the direction of Robert W. Kreplin of the Naval Research Laboratory. The tables combine the data reported by the Naval Research Laboratory (NRL), ESSA-Boulder, Colorado (BOU), and Aberdeen, South Dakota (ABR).

Instrumentation for the experiment consist of eight photometers and four Geiger counters. The bands covered include 1-8, 8-16, and 44-60 Angstroms which are identical to those flown in the 1964-01D and 1965-16D. The Geiger counter photometers cover the 1-8 and 0.5-3 Angstrom regions. Kreplin, R. W., "Final Data and Calibrations For The Explorer 30 (NRL SOLRAD 8) X-ray Monitoring Experiment (1965-93A)", E. O. Hulbert Center for Space Research, NRL, 24 Jan. 1966, describes the experiment in some detail giving the actual wavelength response curves of the photometers, as well as a discussion of preliminary results.

The column entries in the tables are explained below:

<u>Daily Average X-ray Flux Indices</u> -- The average x-ray flux index for each day is calculated from individual records made during the intervals listed in the table of observing times. Four x-ray bands

are normally monitored but because of the great variability observed in the 0.5-3 A band these data are not included in the table of daily averages.

44-60 A Index -- The reduction of the 44-60 A photometer signal to flux values involves the use of a "gray body" approximation (Kreplin, R. W., Ann. Geophys. 17, 151-161, 1961) in which a temperature of 0.5 x 10^6 °K is used to define the wavelength distribution. Austin, Purcell, and Tousey (Astron. J. 69, 133, 1964) have photographed a line spectrum in the region 44-60 A. Unit quantitative measurements of the line intensities are made for this region, the 44-60 A flux levels must be used with some reservation. Comparisons of flux values at different times can, however, be made with an accuracy set by a standard deviation of about 2% in the flux value obtained from the record of an individual satellite pass during quiet solar conditions.

8-20 A Index -- The 8-20 A flux index is calculated on the assumption that this region of the solar spectrum may be approximated by a 2 x 10^6 °K "gray body".

Measurement of the solar spectrum between 13 and 26 Angstroms by Blake, Chubb, Friedman and Unzicker (Astrophys. J. 142, 1-12, 1965) has revealed a number of emission lines thus the same qualifications must be made in assigning error to the absolute flux values as we made in the case of the 44-60 A index.

The standard deviation in the average flux is about 8% for this band.

0-8 A Index -- The flux in this spectral range is calculated using a 2 x 10^6 °K "gray body" approximation. For purposes of comparison of the flux indices a standard deviation of about 15% in the average flux value computed for a single pass may be used.

Outstanding Events -- In this table are listed those intervals and flux indices when the flux in the 0-8 A and 0-3 A bands was significantly different from the average for the day or when a change in flux value with time was observed. In this table the 44-60 A index is omitted because of the relatively small changes observed with solar activity.

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

COSMIC RAY INDICES

Tabulated Observations -- The table presents the daily (UT) average counting rates per hour (scaled) for four high counting rate neutron monitors, Churchill, Deep River, Climax and Dallas. These monitors have different values of magnetic cutoff rigidity, while their asymptotic cones of acceptance "look" approximately in the equatorial plane in essentially the same direction in space. The four sets of data can therefore be used to estimate the rigidity dependence of fluctuations which occur in the primary cosmic radiation.

The characteristics of the four stations are given below; the data have been corrected using the listed barometric coefficients to the listed mean station pressures.

Station	Churchill	Deep River	Climax	Dallas	Alert
Geog. Lat., N.	58°45'	46°36'	39°22'	32°47'	82°30'
Geog. Long., W.	94°05'	77°30'	106°11'	96°48'	62°20'
Cut Off, BV	< 0.21	1.02	3.03	3.98	0.00
Altitude, m	39	145	3400	208	sea level
Detector type	NM64	NM64	IGY	NM64	NM64
Scaling factor	120	300	*100	120	100
Baro. coeff. %/mm. Hg.	.971	.987	.943	.971	.987
Mean press., mm. Hg.	757.6	747	504	746.3	752

* from January 1, 1966

The Climax, Colorado, USA, neutron monitor, station B305, data are communicated by J. A. Simpson and G. Lentz of the Enrico Fermi Institute for Nuclear Studies, University of Chicago. The instrument is a standard Chicago type neutron monitor, utilizing 12 BF_3 counter tubes. The station has a mean barometric pressure of 504.0 mm Hg. For a more detailed description of the neutron intensity monitor and its associated electronics see J. A. Simpson "Annals of the IGY", Vol. IV, Part VII, pp. 351-373 (1957). The publication of these data in this monthly series began September 1960. Earlier data, beginning June 1957, are available in bihourly form at the World Data Center A for Upper Atmosphere Geophysics.

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

The Deep River, Ontario, Canada, neutron monitor, station B211, follows the IQSY design (IQSY Instruction Manual No. 7). Publication of the daily rates in this series began in January 1966 but a monthly chart of hourly values from Deep River, described below, has been published herein since January 1959. The original data can be obtained from Atomic Energy of Canada Ltd., Chalk River, Ontario, Canada, or from any of the World Data Centers.

Chart -- The chart depicts the variations of cosmic ray intensity recorded by the IQSY design 48-NM-64 neutron monitor at Deep River, Ontario, Canada, as submitted by H. Carmichael and J. F. Steljes of Atomic Energy of Canada Ltd., Chalk River, Ontario. The vertical scale lines mark the days of the month in Universal Time: the horizontal scale lines are at intervals of 5% based upon 1.846×10^6 counts per hour (after barometric correction) arbitrarily taken as 100%. The charts have been published from January 1959, publication beginning in the November 1960 issue. From January 1959 to April 1962 a smaller monitor was used and the 100% counting rate was 0.0555×10^6 counts per hour. From May 1962 to January 1965 the monitor was of intermediate size and the 100% counting rate was 0.555×10^6 counts per hour. A preliminary barometric coefficient was used from May 1962 to October 1962; in the March 1963 issue final revised charts were published for these six months using a better value of the barometric coefficient.

Beginning with the chart for July 1966 the variations of cosmic ray intensity as recorded by the IQSY design 18-NM-64 neutron monitor at Alert, North West Territories, Canada, are also presented. The Alert graph is plotted on the same scale but percentages are given for Deep River only. The Alert graph is normalized so that 100% is 0.6678 x 10^6 counts per hour and the 100% level is normally at 110% on the Deep River scale.

The Alert station is unique because its asymptotic cone of acceptance in space is less than 10° wide and is aligned within 7° of the spin axis of the earth. Hence, unlike the other four stations whose cones of acceptance rotate with the earth approximately in the plane of the ecliptic, Alert always "looks" into a fixed cone directed northwards. It experiences negligible periodic diurnal intensity variation.

The monitor at Alert was provided and is maintained by Atomic Energy of Canada but it is housed in a building provided by the National Research Council of Canada. Day-to-day operation is by courtesy of the Canadian Meteorological Service.

GEOMAGNETIC ACTIVITY INDICES

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

The data are made available by the Permanent Service of Geomagnetic Indices of IUGG: Association of Geomagnetism and Aeronomy through Commission IV: Magnetic Activity and Disturbances. The Meteorological Office, De Bilt, Holland, collects the data from magnetic observatories distributed throughout the world, and compiles the Ci and selected days data. Göttingen University computes the planetary and equivalent amplitude indices. The same data are also published in the Journal of Geophysical Research.

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

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

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

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

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

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

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

Principal Magnetic Storms --

Finally a table presents the principal magnetic storms for the month as reported by several observatories through cooperation with the International Association of Geomagnetism and Aeronomy. These are the data formerly published in the Journal of Geophysical Research. They are now, however, grouped by the storm rather than by station. The geomagnetic latitude of the station is indicated. The beginning time is given to the hour and minute in UT. The ending time is given only to the nearest hour. This is the time of cessation of reasonably marked disturbance movements in the trace. More specifically, the time when the K-index measure has diminished to 2 or less for a reasonable period.

The type of sudden commencement, if any, together with its magnitude in each element D, H or Z is next in the table: sc = sudden commencement; sc* = small initial impulse followed by main impulse (in this case the amplitude is that of the main pulse only, neglecting the initial brief pulse); dots in these columns represent a storm with gradual commencement; dashes indicate no data entries. Signs of amplitudes of D and Z are taken algebraically; D reckoned positive if toward the east and Z reckoned positive if vertically downward. The storm is classified as moderate (m) if an individual K index reaches 5, as moderately severe (ms) if K index 6 or 7 is reached, and as severe (s) if K index 8 or 9 is reached. In the next columns the day and the three-hour periods on that day when the K index reached its maximum are given. Finally, in the last three columns the maximum ranges in D, H and Z during the storm are given.

The data are assigned an arbitrary storm number which appears in the final column. In some cases a single number has been assigned though beginning times occur on two consecutive dates. For each date the data are listed in north-to-south geomagnetic latitude order. The table on page 49 gives the abbreviations used for the observatory names.

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

GEOMAGNETIC OBSERVATORIES

Code	Station	Geomag. Latitude
AABA	Addis Ababa	5.4N
ALIB	Alibag	9.6N
AMBE	Amberley	47.7S
ANNA	Annalmalainagar	1.5N
APIA	Apia	16.1S
BANG	Bangui	4.8N
BINZ	Binza	3.4S
BOUL	Boulder	49.0N
COLL	College	64.6N
ELIZ	Elizabethville	12.7S
FRED	Fredericksburg	49.6N
GNAN	Gnangara	43.2S
GUAM	Guam	4.0N
HRMN	Hermanus	33.3S
HONO	Honolulu	21.1N
HUAN	Huancayo	0.6S
HYDE	Hyderabad	7.6N
IRKU	Irkutsk	40.8N
KGLN	Port-aux-Francais	57.3S
MBOR	M'Bour	21.3N
MIQR	Macquarie Island	61.1S
MWSN	Mawson	73.1S
PILR	Pilar	20.2S
PMOR	Port Moresby	18.6S
SJUA	San Juan	29.9N
SITK	Sitka	60.0N
TOOL	Toolangi	46.7S
TVAN	Trivandrum	1.1S
TUCS	Tucson	40.4N
WKES	Wilkes	77.7S
WITT	Witteveen	54.1N

significant disturbance. (Note that for geomagnetic K-indices, disturbance is represented by high numbers.) The adjectival equivalents of the integral quality indices, known as the CRPL quality figure scale, are as follows:

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

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

P - Forecast quality equal to observed.

S - Forecast quality one grade different from observed.

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

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

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

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

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

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

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

(a) Whole-day radio quality indices, which are averages of the four 6-hourly indices.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Transmission 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 3 or greater were observed. (For data through December 1966 the range for quality 5 or greater was given. The change has been made to correspond roughly to the lower limit of satisfactory MUX operation between commercial stations. Using S-meter readings ≥ 3 this is a field strength of ≥ 0.4 μV/m. The blacker the diagram, the quieter the day has been: a narrow strip indicates either high LUHF, low MUF, or both. These diagrams are based on data reported to ESSA by the German Post Office through the Fernmeldetechnisches Zentralamt, Darmstadt, Federal Republic of Germany, being observations every one and a half hours of selected transmitters located in the eastern portion of North America, as received at Lüchow from December 1, 1966. Since January 6, 1958 the transmitters monitored are restricted to those located north of 39° latitude. The transmitters are on frequencies from about 4 to 30 Mc/s. The magnetic activity index, A_{Fr}, from Fredericksburg, Virginia, is also given for each day.

DATA FOR SIX MONTHS BEFORE MONTH OF PUBLICATION
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SOLAR FLARES

The table in this section presents the revised solar flare data for six months before month of publication. The first line of each group is the standardized report which normalizes the individual observatory reports by the method developed by Constance Sawyer (Astrophysical Journal, January 1967). The flare importance reported by each observatory is corrected by an amount that depends on the reported importance, the reporting observatory, and the position of the flare on the solar disk. Then the various reports are grouped together, and average values are computed for times of beginning, maximum and end, and for position, importance, and measured area. For each grouped report are given a serial number; date; mean beginning, mean end and mean maximum phase times in UT; mean heliographic coordinates of the flare followed by central distance in units of a solar radius; serial number of McMath plage region; day and tenth of day of central meridian passage of the flare position; mean duration in minutes; mean corrected importance on the former I.A.U. classification scheme of 1- to 3+; mean measured area; and in remarks column number of flare reports, number of valid reports of importance and number of valid reports of area. Reports of importance from an observatory that saw the maximum phase of the flare are considered valid. The grouped report is given first and the individual observatory reports are listed below as described on page 11. The intervals of no-flare-patrol are entered appropriately in the table as well.

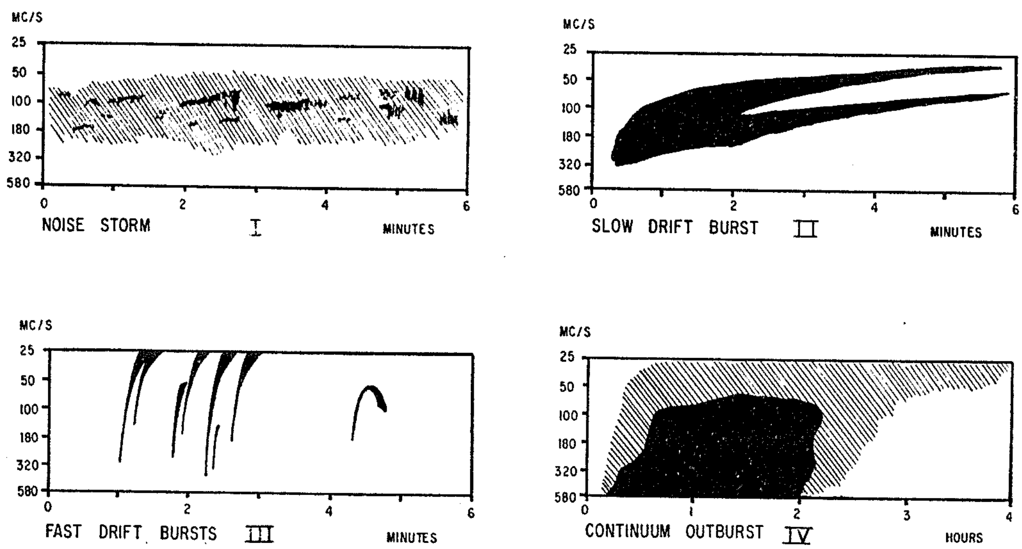
The no-flare-patrol observations are also given graphically indicating the observatories which have submitted patrol time reports. Because some observatories report flares, but not the periods covered by their observations, flares may be included in the table during hours of reported no patrol.

SOLAR RADIO EMISSION
SPECTRAL OBSERVATIONS

Solar spectral events from Fort Davis (Texas), Culgoora (Australia) and Boulder (Colorado) are presented in a combined table. (The Boulder data were also published in these reports in the month after observation.) In general, observations are made from sunrise to sunset (exact UT times are listed daily in the tables). Times of beginning and ending of bursts are listed to the nearest minute in UT. For short bursts only the commencing times are listed. The following symbols are used to denote the type of activity: b = single burst; c = underlying continuum (particularly with type I); DP = drifting pairs; g = small group (<10) bursts; G = large group (>10) bursts; RS = reverse slope bursts; s = storm in the sense of intermittent but apparently connected activity; U = U-shaped type III burst; Uncl = unclassified activity; V = continuum associated with type III bursts.

Commencing January 1, 1967 the method of reporting intensities and frequency ranges of bursts has been slightly modified, to conform with new international arrangements. The intensity of bursts is now denoted by the number of interconnecting dashes between starting and ending times. Three classes of intensity are listed: one interconnecting dash denotes bursts of weak intensity; two interconnecting dashes denote moderate intensity; and three interconnecting dashes denote strong intensity. At 100 Mc/s, the three intensity ranges correspond approximately to 5-50, 50-200, and >200 x $10^{-22} Wm^{-2} (c/s)^{-1}$ respectively. The frequency ranges of the bursts are divided into decimeter, meter, and dekameter ranges, implying bursts recorded in the bands 580-300, 300-30 and 30-10 Mc/s respectively.

<u>Harvard Radio Astronomy Station, Fort Davis, Texas</u> -- Summaries are presented of solar radio bursts recorded in the frequency range 10-580 Mc/s. The research program is supported by financial assistance from the Air Force Cambridge Research Laboratories and the Sacramento Peak Observatory. The equipment used at the Station has been described earlier (Thompson, Astrophys. J. 133, 643, 1961). Idealized examples of the four main types of bursts are shown below.



Culgoora Solar Observatory -- The observations at Culgoora, Australia are made by the C.S.I.R.O. Division of Radiophysics, Sydney, Australia. Before approximately 2330 UT and after approximately 0430 UT the equipment is operated on low sensitivity for the frequency range 10-210 Mc/s. Between 2330 to 0430 UT, the equipment on 10 to 70 Mc/s is on low sensitivity and experimental equipment on 70 to 250 Mc/s is on high sensitivity.

Astrogeophysics Department, University of Colorado -- This equipment was described on pages 17-18.

SOLAR X-RAY RADIATION

The solar x-ray emission data from the NRL x-ray monitoring satellite (1965-93A) are here presented in a graphic form. These data are generally plotted one point per reception by a tracking station. More points, however, are plotted if there is considerable variation. Overlapping points have been removed when adjacent stations receive the same values. These plots are prepared in half-month intervals.

DATA FOR

MISCELLANEOUS TIME PERIODS

This section of the bulletin will consist of information available either annually or on a non-routine publication basis.

The descriptive material necessary to understand the data will be included in the issue presenting the data.

At the times Retrospective World Intervals are announced, in accordance with the rules set forth in IQSY NOTES No. 19, page 11, these will be presented in this section.

A C K N O W L E D G E M E N T S

These monthly reports would not be possible without the continuing support and cooperation of scientists throughout the world. Much of the data included have been obtained through either the International Ursigram and World Days Service program or the international exchange of geophysical observations between World Data Centers in accordance with the principles set forth in recommendations of relevant organizations of the International Council of Scientific Unions.

Special thanks are due to many individuals including the following:

Name	Organization	Data Type
R. H. Davis	American Association of Variable Star Observers	Sunspots, SID
P. S. McIntosh	I.T.S.A., Space Disturbances Laboratory	Sunspots
M. Waldmeier	Swiss Federal Observatory	Sunspots
H. Dodson Prince	McMath-Hulbert Observatory	Calcium plages, flares, SID
R. Howard	Mount Wilson Observatory	Magnetic classifications of sunspots, magnetograms
J. W. Evans	Sacramento Peak Observatory	Flares, coronal indices
A. A. Giesecke	Instituto Geofisico del Peru	Flares, SID
R. G. Giovanelli	CSIRO Division of Physics, Sydney, Australia	Flares
J. J. Hennessey	Manila Observatory	Flares, SID
J. T. Jefferies	Hawaii Institute of Geophysics	Flares, solar noise, SID
Y. Ohman	Anacapri Swedish Observatory	Flares
H. Ramsey	Lockheed Observatory	Flares
C. Sawyer	I.T.S.A., Space Disturbances Laboratory	Flares

Name	Organization	Data Type
R. N. Bracewell	Stanford University	Solar noise
J. P. Castelli	USAF Cambridge Research Laboratories	Solar noise
W. N. Christiansen	University of Sydney	Solar noise
A. E. Covington	National Research Council, Canada	Solar noise
L. B. Craine	Washington State University	Solar noise
J. P. Hagen	Pennsylvania State University	Solar noise
W. K. Klemperer	I.T.S.A., Space Disturbances Laboratory	Solar noise
A. R. Maxwell	Harvard Radio Astronomy Station, Fort Davis, Texas	Solar noise
R. Michard	Meudon Observatory	Solar noise
J. W. Warwick	University of Colorado	Solar noise
J. P. Wild	CSIRO Division of Physics, Sydney, Australia	Solar noise
D. B. Bucknam	I.T.S.A., Space Disturbance Forecast Center	Solar proton events
H. L. DeMastus	Sacramento Peak Observatory	Hα photographs
J. W. Firor	High Altitude Observatory	Coronal indices
	Cable and Wireless, Ltd.	SID
H. J. Chivers	I.T.S.A., Space Disturbance Monitoring Station	SID, radio quality figures
R. F. Donnelly	I.T.S.A., Space Disturbances Laboratory	SID
T. Fortini	Mount Mario Observatory, Rome	SID
A. G. Jean	I.T.S.A., Space Disturbances Laboratory	SID
S. Katahara	NBS, Maui Station	SID

Name	Organization	Data Type
A. P. Mitra	National Physical Laboratory, India	SID
P. C. Yuen	University of Hawaii	SID
G. C. Reid	I.T.S.A., Space Disturbances Laboratory	Riometer
R. W. Kreplin	U.S. Naval Research Laboratory	Solar x-rays
R. K. Oines	Northern State College, Aberdeen, South Dakota	Solar x-rays
R. H. Olson	I.T.S.A., Space Disturbances Laboratory	Solar x-rays
H. Carmichael	Atomic Energy of Canada, Ltd.	Cosmic rays
K. G. McCracken	Graduate Research Center of the Southwest, Dallas, Texas	Cosmic rays
J. A. Simpson	University of Chicago	Cosmic rays
M. Siebert	Göttingen University, G.F.R.	Magnetic indices
J. Veldkamp	Meteorological Office, DeBilt, Holland	Magnetic indices
B. Beckmann	Fernmeldetechnisches Zentralamt, Darmstadt G.F.R.	Radio quality figures
E. J. Wiewara	I.T.S.A. Telecommunications and Space Disturbance Services Center	Radio quality figures

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SOLAR-GEOPHYSICAL DATA

On the following pages will be found the serial number of the report or reports in which data of a given type for any given month will be found, beginning with data for July 1957 through December 1966.

STONYHURST DISKS

Two transparancies provide Stonyhurst disks in the size of several of the solar maps or drawings presented in the second section of these monthly reports.

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	1957 Jul	Aug	Sep	Oct	Nov	Dec	1958 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Zurich Provisional Relative Sunspot Number R_Z	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173
Zurich Final Sunspot Numbers R_Z	166	166	166	166	166	166	175	175	175	175	175	175	175	175	175	175	175	175
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3200 Mc-Daily Data & Outstanding Occurrences (USNRL)								176	175	174	172	170	170	170	170	171	172	173
2800 Mc-Outstanding Occurrences (Ottawa)	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173
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470 Mc-Outstanding Occurrences (Boulder)	156	157	159	159	161	162	163	164	165									
200 Mc-Daily Data (Cornell)	156	157	158	159	160	161	163	163	164	165	167	167	168	169	170	171	172	173
200 Mc-Outstanding Occurrences (Cornell)	156	157	158	159	160	161	163	163	164	165	167	167	168	169	170	171	172	173
169 Mc-Interferometric Observations (Nançay)	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	172	173
167 Mc-Daily Data (Boulder)	156	157	158	159	162	162	163	164	165	167	168	169	170	172	173	174	175	176
167 Mc-Outstanding Occurrences (Boulder)	156	157	159	159	162	162	163	164	165	168	169	169	170	172	173	174	175	176
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Zurich Provisional Relative Sunspot Number R_Z	174	175	176	177	178	179	180	181	182	183	184	185
Zurich Final Sunspot Numbers R_Z	187	187	187	187	187	187	187	187	187	187	187	187
2800 Mc-Daily Values of Solar Flux (Ottawa)	174	175	176	177	178	179	180	181	182	183	184	185
Calcium Plage and Sunspot Regions	174	175	176	177	178	179	180	181	182	183	184	185
Coronal Line Emission Indices	174	175	176	177	178	179	180	181	183	183	184	185
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Subflares	175	176	177	178	179	180	181	182	183	184	185	186
Ionospheric Effects (SWF)	175	176	177	178	179	180	181	182	183	184	185	186
Ionospheric Effects (SCNA-SEA-Bursts)	180	181	182	183	184	184	184	185	186	187	187	188
9530 Mc-Daily Data & Outstanding Occurrences (USNRL)	174	175	176	177								
3200 Mc-Daily Data & Outstanding Occurrences (USNRL)	174	175	176	177								
2800 Mc-Outstanding Occurrences (Ottawa)	174	175	176	177	178	179	180	181	182	183	184	185
2800 Mc-Hours of Observation (Ottawa)	176	176	176	179	179	179	182	182	182	185	185	185
200 Mc-Outstanding Occurrences (Hawaii)						180	182	185				
169 Mc-Interferometric Observations (Nançay)	174	175	176	177	178	179	180	181	182	183	184	185
167 Mc-Outstanding Occurrences (Boulder)	176	177	178	178	179	180	180	181	182	183	184	185
167 Mc-Hours of Observation (Boulder)	182	182	182	182	182	182	182	182	182	183	184	185
25-580 Mc-Spectrum Observations (Ft. Davis)	182	182	182	184	184	184	188	188	188	192	192	192
Geomagnetic Indices C, K_p, A_p, - Selected Days	175	176	177	178	179	180	181	182	183	184	185	186
27-Day Charts of K_p Indices for Year	186	186	186	186	186	186	186	186	186	186	186	186
NARWS - CRPL Quality Figures & Forecasts	175	176	177	178	179	180	181	182	183	184	185	186
NARWS - Comparison Graphs	175	176	177	178	179	180	181	182	183	184	185	186
NARWS - Graphs of Useful Frequency Ranges	175	176	177	178	179	180	181	182	183	184	185	186
NPRWS - CRPL Quality Figures & Forecasts	175	176	177	178	179	180	181	182	183	184	185	186
NPRWS - Comparison Graphs	175	176	177	178	179	180	181	182	183	184	185	186
Alert and SWI Decisions	174	175	176	177	178	179	180	181	182	183	184	185
Cosmic Ray Neutron Counts (Deep River)	195	195	195	195	195	195	195	195	195	195	195	195

INDEX FOR 1960-1961 DATA PUBLISHED IN CRPL-F Part B

	1960 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1961 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
American Relative Sunspot Numbers R_A'	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
Zurich Provisional Relative Sunspot Number R_Z	186	187	186	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209
Zurich Final Sunspot Numbers R_Z	199	199	199	199	199	199	199	199	199	199	199	199	211	211	211	211	211	211	211	211	211	211	211	211
Mt. Wilson Magnetic Characteristics of Sunspots																								
2800 Mc-Daily Values of Solar Flux (Ottawa)	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209
Calcium Plage and Sunspot Regions	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209
Coronal Line Emission Indices - Provisional	186	187	188	189	190	191	192	193	195	196	196	197	198	199	200	201	202	203	205	205	207	207	208	209
- Final	189	189	189	193	193	193	196	196	196	199	199	199	204	204	204	205	205	205	208	208	208	212	212	212
Optical Observations Flares	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209
	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	210-	210	211	212
	191	191	194	194	201	195	201	201	201	199	201	201	208	208	208	208	208		208					
	194	194				201				201														
		196																						
Flare Patrol Observations	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209
	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	210	210	211	212
	191	191			202	202	202	202	202	202	202	202	208	208	208	208	208		208					
Subflares	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
Ionospheric Effects (SWF)	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	207	206	207	208	209	210
(SCNA-SEA-Bursts)	188	189	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
(SPA)																		204	205	206	207	208	209	210
2800 Mc-Outstanding Occurrences (Ottawa)	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209
																			206		209		209	
2800 Mc-Hours of Observation (Ottawa)	188	188	188	191	191	191	194	194	194	197	197	197	200	200	200	203	203	203	206	206	206	209	209	209
450-1000 Mc - (Owens Valley)											197	197	198	201	202	202	202	203	207	207	207	207		
											198													
25-580, 2100-3900 Mc - (Fort Davis)	197	197	197	198	198	198	199	199	199	200	200	200	203	203	203	204	204	204	208	208	208	209	209	209
169 Mc-Interferometric Observations (Nançay)	186	187	188	189	190	191	192	193	194	195	196	197	198	200	201	201	202	203	204	205	206	207	208	209
108 Mc-Outstanding Occurrences (Boulder)	186	187	188	189	190	191	192	193	194	195*	196	197	198	199	200	201	202	203	204	205	206	207	208	209
7.6-41 Mc-(HAO-Boulder)															207	207	207	207	207	207	207	207	208	209
9.1 cm - (Stanford)				196	197	199	210	211	212	212	212			213	213									
Cosmic Ray Neutron Counts (Climax)									195	196	197	198	199	200	201	202	203	204	205	206	207	208	210	210
Cosmic Ray Neutron Counts (Deep River)	195	195	193	195	195	195	195	195	195	196	197	198	199	200	201	202	203	204	204	206	207	208	209	210
					205														205					
Geomagnetic Indices C, Kp, Ap, - Selected Days	187	188	189	190+	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
27-Day Charts of Kp Indices for Year	198	198	198	198	198	198	198	198	198	198	198	198	208	208	208	208	208	208	208	208	208	208	208	208
NARWS - CRPL Quality Figures & Forecasts	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
NARWS - Comparison Graphs	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
NPRWS - CRPL Quality Figures & Forecasts	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
NPRWS - Comparison Graphs	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
NARWS - Graphs of Useful Frequency Ranges	187	188	190	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
Alert and SWI Decisions	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209

FOOTNOTES: +F190 also includes R, relative sunspot number and C9, magnetic index in 27-day diagram January 1959-April 1959.
*Data up to October 1960 for 167 Mc.
Additional optical observations flares, for June 1959 in F 200.
International Geophysical Calendar for 1962 in F 207

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

1962	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
American Relative Sunspot Numbers R_A'	211	212	213	214	215	216	217	218	219	220	221	222
Zurich Provisional Relative Sunspot Number R_Z	210	211	212	213	214	215	216	217	218	219	220	221
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
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
Calcium Plage and Sunspot Regions	210	211	212	213	214	215	216	217	218	219	220	221
Coronal Line Emission Indices - Provisional	210	211	212	213	214	215	216	217	218	219	220	221
- Final	213	213	213	216	216	216	220	220	220	226	226	226
Optical Observations Flares	210	211	212	213	214	215	216	217	218	219	220	221
	213	214	215	216	217	218	219	220	221	222	223	224
Flare Patrol Observations	210	211	212	213	214	215	216	217	218	219	220	221
	213	214	215	216	217	218	219	220	221	222	223	224
Subflares	211	From here on subflares included with flares.										
Ionospheric Effects (SWF)	211	212	213	214	215	216	219	219	219	220	221	222
(SCNA-SEA-Bursts)	211	212	213	214	215	216	219	219	219	220	221	222
(SPA)	211	212	213	214	215	216	219	219	219	220	221	222
2800 Mc-Outstanding Occurrences (Ottawa)	210	211	212	213	214	215	216	217	218	219	220	221
2800 Mc-Hours of Observations (Ottawa)	212	212	212	215	215	215	218	218	218	221	221	221
25-580 (50-320 as of Jan 1963) (Fort Davis)	213	213	213	216	216	216	219	219	219	222	222	222
221 Mc-Interferometric Occurrences (Boeing-Seattle)	-	-	-	221	221	221	221	221	221	221	221	221
169 Mc-Interferometric Observations (Nançay)	210	211	212	213	214	215	216	217	219	219	220	221
108 Mc-Outstanding Occurrences (Boulder)	210	211	212	213	214	215	216	217	218	219	220	221
108 Mc-Hours of Observations (Boulder)	210	211	212	213	214	215	216	217	218	219	220	221
7.6-41 Mc - (HAO-Boulder)	210	211	212	213	214	215	216	217	218	219	220	221
9.1 cm (Stanford)				213	214	215	216	217	218	219	220	221
Cosmic Ray Neutron Counts (Climax)	211	212	213	214	215	216	217	218	219	220	221	222
Cosmic Ray Neutron Counts (Deep River)	211	212	213	214	223	223	223	223	223	223	223	222
Geomagnetic Indices C, Kp, Ap, - Selected Days	211	212	213	214	215	216	217	218	219	220	221	222
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
NARWS - Comparison Graphs	211	212	213	214	215	216	217	218	219	220	221	222
NPRWS - CRPL Quality Figures & Forecasts	211	212	213	214	215	216	217	218	219	220	221	222
NPRWS - Comparisón Graphs	211	212	213	214	215	216	217	218	219	220	221	222
NARWS - Graphs of Useful Frequency Range	211	212	213	214	215	216	217	218	219	220	221	222
Alert and SWI Decisions	210	211	212	213	214	215	216	217	218	219	220	221

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

1963	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
American Relative Sunspot Numbers R_A'	223	224	225	226	227	228	229	230	231	232	233	234
Zurich Provisional Relative Sunspot Number R_Z	222	223	224	225	226	227	228	229	230	231	232	233
Zurich Final Sunspot Numbers R	235	235	235	235	235	235	235	235	235	235	235	235
2800 Mc/s-Daily Values of Solar Flux (Ottawa)	222	223	224	225	226	227	228	229	230	231	232	233
2800 Mc/s-Daily Values of Solar Flux (Final-Ottawa)	233	233	233	233	233	233	233	233	233	233	233	233
2800 Mc/s-Daily Values of Adjusted Solar Flux (ARO)												
Mt. Wilson Magnetic Characteristics of Sunspots	222	223	224	225	none	227	228	229	230	231	232	233
Calcium Plage and Sunspot Regions	222	223	224	225	226	227	228	229	230	231	232	233
Coronal Line Emission Indices - Provisional	222	223	224	225	226	227	228	229	230	231	232	233
- Final	226	226	226	228	228	228	231	231	231	234	234	234
Optical Observations Flares	222	223	224	225	226	227	228	229	230	231	232	233
	225	226	227	228	229	230	231	232	233	234	235	236
Flare Patrol Observations	222	223	224	225	226	227	228	229	230	231	232	233
	225	226	227	228	229	230	231	232	233	234	235	236
Solar X-Ray Radiation												
Ionospheric Effects - (SWF-ABS-SCNA-SEA-SPA-SES-SFD-Bursts)*	223	224	225	226	227	228	229*	230*	231*	232	233	234
26 Mc/s Riometer Events (South Pole) - Provisional									231	232	233	234
2800 Mc/s - Outstanding Occurrences (ARO-Ottawa)	222	223	224	225	226	227	228	229	230	231	232	233
2800 Mc/s - Hours of Observations (ARO-Ottawa)	224	224	224	227	227	227	230	230	230	233	233	233
223 Mc/s - Interferometric Occurrences (Boeing - Seattle)	222#	223#	224#	225#	229	229	229					
169 Mc/s - Interferometric Observations (Nancay)	222	223	224	225	226	227	228	229	230	231	232	233
108 Mc/s - Outstanding Occurrences (Boulder)	222	223	224	225	226	227	228	229	230	231	232	233
108 Mc/s - Hours of Observation (Boulder)	222	223	224	225	226	227	228	229	230	231	232	233
50 - 320 Mc/s - (Fort Davis)+	225	225	225	228	228	228	230	230	230	234	234	234
7.6-41 Mc - (HAO-Boulder)	222	223	224	225	226	227	228	229	230	231	232	233
9.1 cm (Stanford)	222	-	-	225	226	227	228	229	230	231	232	233
Cosmic Ray Neutron Counts (Climax)	223	224	225	226	227	228	229	230	231	232	234	234
Cosmic Ray Neutron Counts (Deep River)	223	224	225	226	227	228	229	230	231	232	233	234
Geomagnetic Indices C, Kp, Ap - Selected Days	223	224	225	226	227	228	229	230	231	232	233	234
27-Day Chart of Kp Indices for Year	233	233	233	233	233	233	233	233	233	233	233	233
27-Day Chart of C9 for Year	233	233	233	233	233	233	233	233	233	233	233	233
NARWS - CRPL Quality Figures & Forecasts	223	224	225	226	227	228	229	230	231	232	233	234
NARWS - Comparison Graphs	223	224	225	226	227	228	229	230	231	232	233	234
NPRWS - CRPL Quality Figures & Forecasts	223	224	225	226	227	228	229	230	231	232	233	234
NPRWS - Comparison Graphs	223	224	225	226	227	228	229	230	231	232	233	234
NARWS - Graphs of Useful Frequency Range	223	224	225	226	227	228	229	230	231	232	233	234
IQSY Alert Decisions**	222	223	224	225	226	227	228	229	230	231	232	233

* Addenda to July SWF in 230 and to August SWF in 231
+ 25-580 Mc/s (Fort Davis) prior to January 1963
** Alert and SWI Decisions before November 1963
° Revisions to September Climax Monitor in 234
°° Addenda to Jan. Feb. and Mar. 1964 - Flares in 240 and 241
\# = 221 Mc/s before May 1963

Cosmic ray indices from Dallas super neutron monitor for January through September 1964 and from Churchill super neutron monitor for May through September 1964 were given in 243.

INDEX FOR 1964 DATA PUBLISHED IN CRPL-F PART B

1964	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
American Relative Sunspot Numbers R_A'	235	236	237	238	239	240	241	242	243	244	245	246
Zurich Provisional Relative Sunspot Number R_Z	234	235	336	237	238	239	240	241	242	243	244	245
Zurich Final Sunspot Numbers R_Z	247	247	247	247	247	247	247	247	247	247	247	247
2800 Mc/s-Daily Values of Solar Flux (Ottawa)	234	235	236	237	238	239	240	241	242	243	244	245
2800 Mc/s-Daily Values of Solar Flux (Final-Ottawa)	245	245	245	245	245	245	245	245	245	245	245	245
2800 Mc/s-Daily Values of Adjusted Solar Flux (ARO)	240	240	240	240	240	240	240	241	242	243	244	245
2800 Mc/s-Daily Values of Adjusted Solar Flux (Final-Ottawa)	245	245	245	245	245	245	245	245	245	245	245	245
Mt. Wilson Magnetic Characteristics of Sunspots	234	235	236	237	238	239	240	241	242	243	244	245
Calcium Plage and Sunspot Regions	234	235	236	237	238	239	240	241	242	243	244	245
Coronal Line Emission Indices - Provisional	234	235	236	237	238	239	240	241	242	243	244	245
- Final	237	237	237	240	240	240	243	243	243	248	248	248
Optical Observations Flares	234*	235*	236*	237	238	239	240	241	242	243	244	245
	237	238	239	240	241	242	243	244	245	246	248	248
Flare Patrol Observations	234	235	236	237	238	239	240	241	242	243	244	245
	237	238	239	240	241	242	243	244	245	246	248	248
Solar X-Ray Radiation	243	247	247	241	241	241	244	244	245	245		
Solar X-Ray Radiation (Revised)				249	255	264	266	266				
Ionospheric Effects - (SWF-SCNA-SEA-SPA-SES-SFD-Bursts)	235	236	237	238	239	240	241	242	243	244	245	246
26 Mc/s Riometer Events (South Pole) - Provisional	235	236	237	238	239	240	241	242	243	244	245	246
30 Mc/s Riometer Events (Frobisher Bay) - Final												
30 Mc/s Riometer Events (Great Whale River)												
10700, 2700, 960, 328 Mc/s - Solar Noise Observations (Pennsylvania State University)							252	252	252	252	252	252
2800 Mc/s - Outstanding Occurrences (ARO-Ottawa)	234	235	236	237	238	239	240	241	242	243	244	245
2800 Mc/s - Hours of Observations (ARO-Ottawa)	236	236	236	239	239	239	242	242	242	245	245	245
223 Mc/s - Interferometric Occurrences (Boeing - Seattle)												
169 Mc/s - Interferometric Observations (Nançay)	234	235	236	237	238	239	240	241	242	.243	244	245
108 Mc/s - Outstanding Occurrences (Boulder)	234	235	236	237	238	239	240	241	242	243	244	245
108 Mc/s - Hours of Observation (Boulder)	234	235	236	237	238	239	240	241	242	243	244	245
107 Mc/s - Outstanding Occurrences (Haleakala)												
50 - 320 Mc/s - (Fort Davis)+	237	237	237	240	240	240	243	243	243	246	246	246
7.6-41 Mc/s-(HAO - University of Colorado - Boulder)	234	235	236	237	238	239	240	241	242	243	244	245
9.1 cm Spectroheliograms (Stanford)	234	235	236	237	238	239	240	241	242	243	244	245
21 cm Spectroheliograms (Fleurs)												250
21 cm Solar Scans (Fleurs)												
Cosmic Ray Neutron Counts (Deep River)	235	236	237	238	239	240	241	242	243	244	245	246
Cosmic Ray Neutron Counts (Churchill)					245	243	243	243	243	244	245	246
Cosmic Ray Neutron Counts (Climax)	235	236	237	238	239	240	241	242	243	244	245	246
Cosmic Ray Neutron Counts (Dallas)	243	243	243	243	243	243	243	243	243	244	245	246
Geomagnetic Indices C, Kp, Ap - Selected Days	235	236	237	238	239	240	241	242	243	244	245	246
27-Day Chart of Kp Indices for Year	245	245	245	245	245	245	245	245	245	245	245	245
27-Day Chart of C9 for Year	245	245	245	245	245	245	245	245	245	245	245	245
NARWS - CRPL Quality Figures and Forecasts	235	236	237	238	239	240	241	242	243	244	245	246
NPRWS - CRPL Quality Figures and Forecasts	235	236	237	238	239	240	241	242	243	244		
High Latitude - CRPL Quality Figures and Forecasts											245	246
High Latitude - Comparison Graphs											245	246
NARWS - Comparison Graphs	235	236	237	238	239	240	241	242	243	244	245	246
NPRWS - Comparison Graphs	235	236	237	238	239	240	241	242	243	244		
NARWS - Graphs of Useful Frequency Range	235	236	237	238	239	240	241	242	243	244	245	246
IQSY Alert Decisions	234	235	236	237	238	239	240	241	242	243	244	245

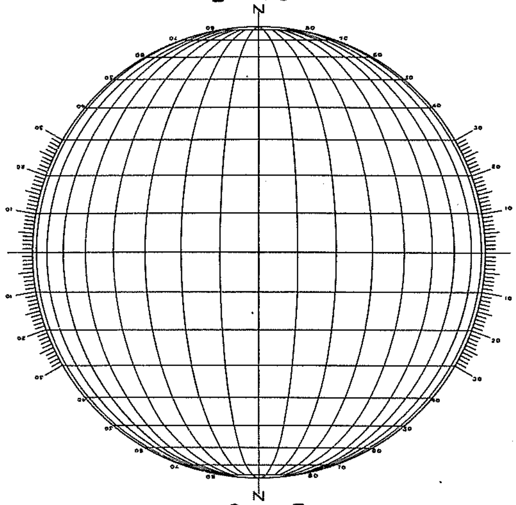
FOOTNOTES: *Addenda to Jan. Feb. and Mar. 1964 - Flares in 240 and 241
+25- 320 Mc/s (Fort Davis) beginning April 1965
X-Ray (SR-3 and Injun 1) June-Dec. 1961 in 249
X-Ray (Vela) October 18-31, 1963 in 249
Radar Meteor Indices were published in 246 and 251

INDEX FOR 1965-1966 DATA PUBLISHED IN CRPL-F PART B

	1965												1966												1967
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan
American Relative Sunspot Numbers R_A'	247	248	249	250	251	252	253	254	255	256	257	257	258	259	260	261	262	263	264	265	266	267	268	269	270
Zürich Provisional Relative Sunspot Numbers R_Z	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270
Zürich Final Sunspot Numbers R_Z	258	258	258	258	258	258	258	258	258	258	258	258													
2800 Mc/s-Daily Values of Solar Flux (Ottawa)	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270
2800 Mc/s-Daily Values of Solar Flux (Final-Ottawa)	257	257	257	257	257	257	257	257	257	257	257	257													
2800 Mc/s-Daily Values of Adjusted Solar Flux (ARO)	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270
2800 Mc/s-Daily Values of Adjusted Solar Flux (Final-Ottawa)	257	257	257	257	257	257	257	257	257	257	257	257													
Mt. Wilson Magnetic Characteristics of Sunspots	246	247	248	249	---	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270
Mt. Wilson Magnetograms																					269	269	269	270	
Calcium Plage and Sunspot Regions	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270
Coronal Line Emission Indices - Provisional	247	248	248	249	250	251	252	253	---	256	257	257	258	259	260	261	---	---	---	---	---	---	---	---	---
- Final	249	249	249	252	252	252	256	256	256	258	258	258	261	261	261	264	264	264	267	267	267	270	270	270	
Optical Observations Flares	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270
	249	250	251	252	253	255	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269				
Optical Observations Flares (Addenda)														266		266&268	266								
Flare Patrol Observations	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270
	249	250	251	252	253	255	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269				
Solar X-Ray Radiation (NRL)															264			264	265	267	267	269	269	269	
Solar X-Ray Radiation (Aberdeen, S. Dakota)													261	261	261	261	262	263	264	265	266				
Solar X-Ray Radiation (France)																267	267								
Solar X-Ray Radiation (ESSA-Boulder)												270	270	270	270	270									
Ionospheric Effects - (SWF-SCNA-SEA-SPA-SES-SFD-Bursts)	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	
30 Mc/s Riometer Events (Frobisher Bay)	247	248	249	250	251																				
30 Mc/s Riometer Events (Great Whale River)						252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	
10700, 2700, 960, 328 Mc/s - Outstanding Occurrences (Pennsylvania State University)	252	252	252	256	256	256	263	263	263	263	263	263	258	259	260	261	262	263	264	265	266	267	268	269	270
8800, 4995, 2695, 1415 and 606 Mc/s Outstanding Occurrences (AFCRL, Sagamore Hill)													260	260	260	261	262	263	264	265	266	267	268	269	270
2800 Mc/s - Outstanding Occurrences (ARO-Ottawa)	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270
2800 Mc/s - Hours of Observations (ARO-Ottawa)	248	248	248	251	251	251	254	254	254	257	257	257	258												
486 Mc/s - Outstanding Occurrences (Washington State Univ.)																			264	265	266	267	268	269	270
223 Mc/s - Interferometric Occurrences (Boeing - Seattle)					251	252	253	253	254	255	256														
408 Mc/s - Interferometric Observations (Nancay)											257	257	258	259	260	261	262	264	264	265	266	267	268	269	270
169 Mc/s - Interferometric Observations (Nancay)	246	---	---	---	---	---	---	253	254	255	257	257	258	259	260	261	262	264	264	265	266	267	268	269	270
108 Mc/s - Outstanding Occurrences (Boulder)	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	---	---	---	---	---	---	---
108 Mc/s - Hours of Observation (Boulder)	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	---	---	---	---	---	---	---	---	---	---
107 Mc/s - Outstanding Occurrences (Haleakala)						252	253	253	254	255	256	257	258	---	261	---	---	---	---	---	---	---	---	---	---
25 - 320 Mc/s - (Fort Davis)+	249	249	249	252	252	252	255	255	255	258	258	258	261	261	261	264	264	264	267	267	267	270	270	270	
7.6-41 Mc/s - (HAO - University of Colorado - Boulder)	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270
9.1 cm Spectroheliograms (Stanford)	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	
21 cm Spectroheliograms (Fleurs)	250	250	254	254	257	257	257	259	260	263	263	263	263	263	263	266	266	266	267	267	267	268	---	269	
21 cm Solar Scans (Fleurs)										255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270
43 cm Solar Scans (Fleurs)																261	262	263	264	265	266	267	268	269	270
Cosmic Ray Neutron Counts (Deep River)	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	
Cosmic Ray Neutron Counts (Alert)																			265	266	267	268	269	270	
Cosmic Ray Neutron Counts (Churchill)	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261										
Cosmic Ray Neutron Counts (Climax)	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	
Cosmic Ray Neutron Counts (Dallas)	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261										
Geomagnetic Indices Ci, Cp, Kp, Ap - Selected Days	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	
Principal Magnetic Storms																			270	270	270	270	270	270	
Sudden Commencement and Solar Flare Effects													270	270	270	270	270	270	270	270	270				
27-Day Chart of Kp Indices for Year	258	258	258	258	258	258	258	258	258	258	258	258	270	270	270	270	270	270	270	270	270	270	270	270	
27-Day Chart of C9 for Year	258	258	258	258	258	258	258	258	258	258	258	258	270	270	270	270	270	270	270	270	270	270	270	270	
NARWS - CRPL Quality Figures and Forecasts	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	
NPRWS - CRPL Quality Figures and Forecasts	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	
High Latitude - CRPL Quality Figures and Forecasts	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	
High Latitude - Comparison Graphs	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	
NARWS - Comparison Graphs	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	
NPRWS - Comparison Graphs																									
NARWS - Graphs of Useful Frequency Range	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	
IQSY/IUWDS Alert Decisions	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270

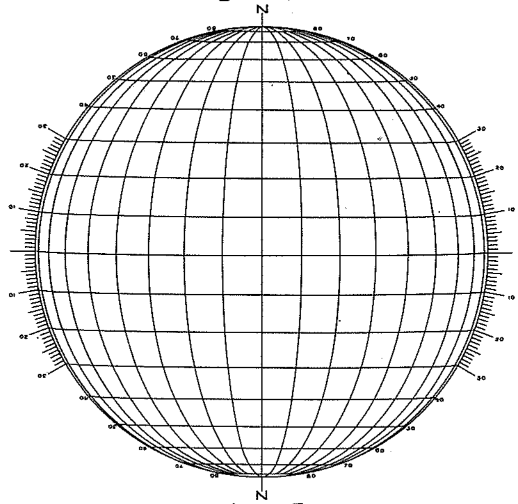
NOTES: +50 -320 Mc/s (Fort Davis) before April 1965
X-Ray (SR-3 and Injun 1) June-Dec. 1961 in 249
X-Ray (Vela) October 18-31, 1963 in 249
Radar Meteor Indices were published in 246 and 251

B = +0°



B = −0°

B = +1°



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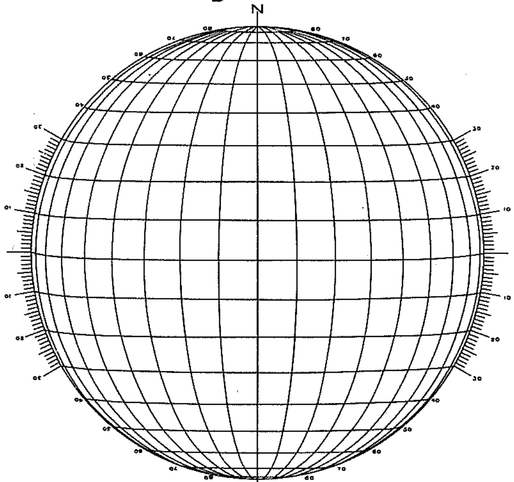
B = +2°



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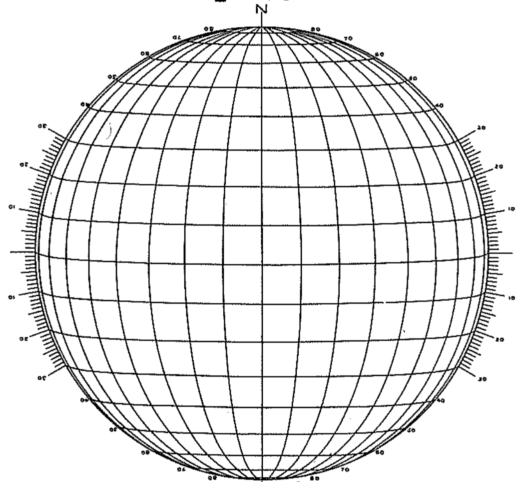

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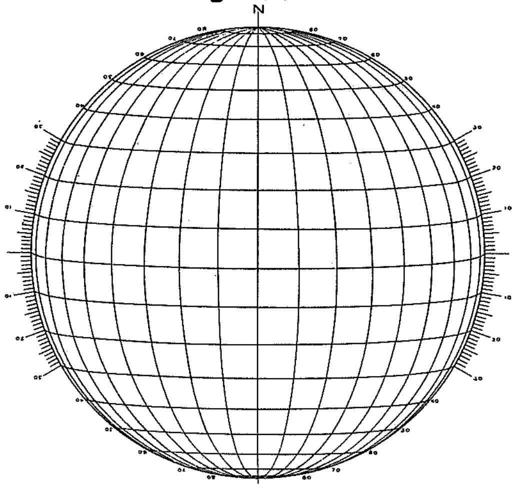

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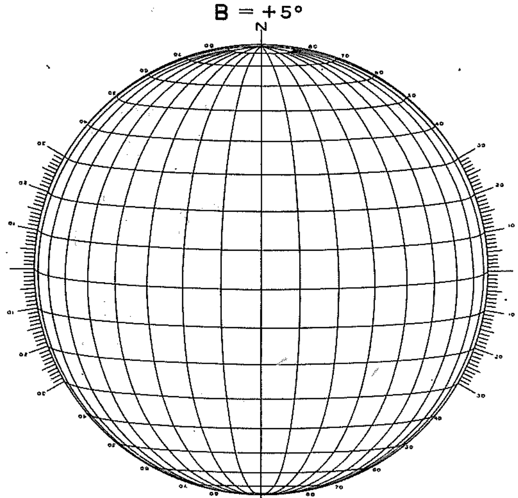

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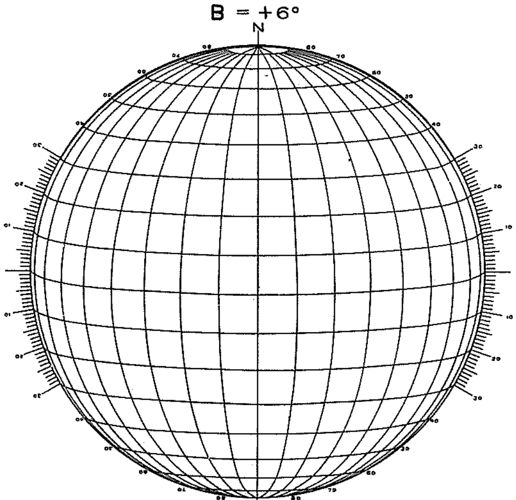
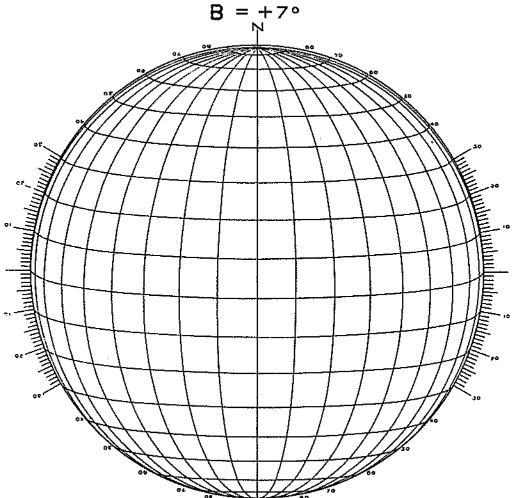


B = −6°

B = +7°



B = −7°