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PART B

SOLAR - GEOPHYSICAL DATA

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JANUARY 1956

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
CENTRAL RADIO PROPAGATION LABORATORY
BOULDER, COLORADO

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PART B

NATIONAL BUREAU OF STANDARDS
CENTRAL RADIO PROPAGATION LABORATORY
BOULDER, COLORADO

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SOLAR - GEOPHYSICAL DATA

INTRODUCTION

This monthly report series is intended to keep research workers abreast of the major particulars of solar activity and the associated ionospheric, radio propagation and other geophysical effects. It is made possible through the cooperation of many observatories, laboratories and agencies as recorded in the detailed description of the tables and graphs which follows. The Editor is Miss J. V. Lincoln.

I RELATIVE SUNSPOT NUMBERS

American and Zürich Daily Numbers -- The table lists (1) the daily American relative sunspot numbers, R_A', as compiled by the Solar Division of the American Association of Variable Star Observers, and (2) the provisional daily Zürich relative sunspot numbers, R_Z, as communicated by the Swiss Federal Observatory. Because of the time required to collect and reduce the observations, R_A' will normally appear one month later than R_Z.

The relative sunspot number is an index of the activity of the entire visible disk. It is determined each day without reference to preceding days. Each isolated cluster of sunspots is termed a sunspot group and it may consist of one or a large number of distinct spots whose size can range from 10 or more square degrees of the solar surface down to the limit of resolution (e.g. 1/8 square degrees). 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 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 and elsewhere. They usually differ slightly from the provisional values. The American numbers, R_A', are not revised.

Graph of Sunspot Cycle -- The graph illustrates the recent trend of Cycle 19 of the 11-year sunspot cycle and some predictions of the future level of activity. The customary "12-month" smoothed

index, $\overline{R}$, is used throughout, the data being final R_Z numbers except for the current year. Predictions shown are those made for one year after the latest available datum by the method of A. G. McNish and J. V. Lincoln (Trans. Am. Geophys. Union, 30, 673-685, 1949) modified by the use of regression coefficients and mean cycle values recomputed for Cycles 8 through 18. Cycle 19 began April 1954, when the minimum $\overline{R}$ of 3.4 was reached.

II SOLAR CENTERS OF ACTIVITY

Calcium Plage and Sunspot Regions -- The table gives particulars of the centers of activity visible on the solar disk during the preceding month. These are based on estimates made and reported on the day of observation and are therefore of limited reliability.

The 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; particulars of the plage at three times during its transit of the visible disk (first appearance, maximum development, last appearance): the date, the area, the central intensity; particulars of the associated sunspot group, if any, at analogous times: the date, the area, the spot count. The unit of area is a millionth of the area of a solar hemisphere; the central intensity of calcium plages is roughly estimated on a scale of 1=faint to 5=very bright.

Calcium plage data are available through the cooperation of the McMath-Hulbert Observatory of the University of Michigan and the Mt. Wilson Observatory. The sunspot data are compiled from reports from the U. S. Naval Observatory, Mt. Wilson Observatory, and from reports from Europe and Japan received through the daily Ursigram messages.

Coronal Line Emission Indices -- In the table are summarized solar coronal emission intensity indices for the green (Fe XIV at λ5303) and red (Fe X at λ6374) coronal lines. The indices are based on measurements made at 5° intervals around the periphery of the solar disk by the High Altitude Observatory at Climax, Colorado, and by Harvard University observers at Sacramento Peak (The USAF Upper Air Research Observatory at Sunspot, New Mexico, under contract AF 19(604)-146). The measurements are expressed as the number of millionths of an Angstrom of the continuum of the center of the solar disk (at the same wavelength as the line) that would contain the same energy as the observed coronal line. The indices have the following meanings:

G_6 = mean of six highest line intensities in quadrant for λ 5303.

R_6 = same for λ6374.

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

R_1 = same for λ6374.

The dates given in the table correspond to the approximate time of CMP of the longitude zone represented by the indices. The actual observations were made for the North East and South East quadrants 7 days before; for the South West and North West 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:

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

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 quarterly in the "Solar Activity Summary" issued by the High Altitude Observatory at Boulder, Colorado. In the same reports are given maps of the intensity distribution of coronal emission derived from all available Climax and Sacramento Peak observations, as well as other information on solar activity, such as maps made from daily limb prominence surveys in Hα and notes regarding the history of active regions on the solar disk.

Preliminary summaries of solar activity, prepared on a fast schedule, are issued Friday of each week from High Altitude Observatory in conjunction with CRPL and include solar activity through the preceding day. These are useful to groups needing information on the current status of activity on the visible solar disk, but are not recommended for research uses unless such a prompt schedule of reporting is essential. The same information is included in the subsequent quarterly reports, with extensive additions, corrections and evaluations.

III SOLAR FLARES

Optical Observations -- The table presents the preliminary record of solar flares as reported to the CRPL on a rapid schedule at the sacrifice of detailed accuracy. Definitive and complete data are published later in the Quarterly Bulletin of Solar Activity, I.A.U., in various observatory publications and elsewhere. The present listing serves to identify and roughly describe the phenomena observed.

Reporting directly to the CRPL are the following observatories: Mt. Wilson, McMath-Hulbert, U. S. Naval, Wendelstein, and Sacramento Peak. The remainder report through the URSIgram centers in Europe and Japan. Observations are in the light of the center of the H-alpha line unless noted otherwise. The reports from Sacramento Peak, New Mexico (communicated to CRPL by the High Altitude Observatory at Boulder) are from observations at the USAF Upper Air Research Observatory at Sunspot, New Mexico, by Harvard University observers, under contract AF 19(604)-146.

For each flare are listed the reporting observatory, date, times of beginning and ending of observing period, duration of flare (when known), total area in millionths of visible hemisphere, the McMath serial number of the region with which the flare is associated, the heliographic coordinates in degrees, the time of maximum phase, maximum intensity of flare, fractional area having nearly maximum brightness, and finally the flare importance on the IAU scale of 1- to 3+. A final column lists provisionally the occurrence of simultaneous ionospheric effects as observed on selected field strength recordings of distant high-frequency radio transmissions; a more nearly definitive list of these ionospheric effects, including particulars, appears in these reports after the lapse of a month (see below). All times are Universal Time (UT or GCT).

Ionospheric Effects -- SID (and GID--gradual ionospheric disturbances) may be detected in a number of ways: short wave fadeouts, enhancement of low frequency atmospherics, increases in cosmic absorption, and so forth. The table lists events that have been recognized on field strength recordings of distant high-frequency radio transmissions. Under a coordinated program, the staffs at the following ionospheric sounding stations contribute reports that are screened and synthesized at CRPL-Boulder: Puerto Rico, Ft. Belvoir, Va., and Anchorage, Alaska (CRPL Stations: PR, BE, AN); Huancayo, Peru, and College, Alaska (CRPL-Associated Laboratories: HU, CO); and White Sands, N. Mex., Adak, Alaska, and Okinawa (U. S. Signal Corps Stations: WS, AD, OK). McMath-Hulbert Observatory (MC) also contributes such reports. In addition, reports are volunteered by RCA Communications Inc.,

Marconi Wireless, Netherlands Postal and Telecommunications Services, Swedish Telecommunications, and others; these usually specify times of SID and the radio paths involved.

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

S-SWF: sudden drop-out and gradual recovery
Slow S-SWF: drop-out taking 5 to 15 minutes and gradual recovery
G-SWF: gradual disturbance; fade irregular in both drop-out and recovery.

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 widespread, ranging from 1 (possible) to 5 (definite). The times given in the table for the event are from the report of a station (underlined in table) that identified it with high confidence. The criteria for the subjective importance rating assigned by each station on a scale of 1- to 3+ include amplitude of the fade, duration and confidence; greater consideration is given to reports on paths near the subsolar point in arriving at the summary importance rating given in the table.
Note: The tables of SID observed at Washington included in CRPL F-reports prior to F-135 were restricted to events classed here as S-SWF.

IV SOLAR RADIO WAVES

The data on solar radio waves are from observations at 167 Mc and 460 Mc made at the Gunbarrel Hill (Boulder) station of the National Bureau of Standards. The half-width of the antenna lobe is appreciably greater than the solar disk. Polarization has not been determined. All times are in Universal Time (UT or GCT); when the observing period extends slightly into the next Greenwich day, the time scale is extended beyond 24 hours.

3-hourly and Daily Flux -- Flux is given in power units. These units are approximately 10^{-22} watt meter^{-2}(c/s)$^{-1}$ for both polarizations together. They will be subject to a correction factor when gain measurements of the antenna have been made. The median flux is measured for every one-hour period that contains a usable calibration and at least thirty minutes of usable record. A three-hour value of flux is obtained by averaging the available one-hour medians (at least two required). A daily value of flux is obtained by averaging all available one-hour medians (at least 4 required). A dash indicates that insufficient measurements were made to meet the above requirements or that the records were not of usable quality. Parentheses indicate that the value is somewhat doubtful because of atmospheric noise or local interference.

The variability index, given for each three-hour interval, is on a scale 0 to 3 defined as follows:

0 - The instantaneous flux did not drop below one-half the median level or exceed twice the median level at any time.

1 - The instantaneous flux made from one to ten excursions outside the range described above.

2 - The instantaneous flux made from ten to one hundred excursions outside the range described above.

3 - The instantaneous flux made more than one hundred excursions outside the range described above.

For the purpose of the variability index, an excursion whose maximum intensity is M times the median level is counted as M excursions. A dash is used to indicate that measurements were made for less than one hour during the period. Parentheses surround variability indices which are in doubt because of atmospheric noise or local interference.

Outstanding Events -- A separate table lists the occurrences that are not adequately described by the three-hourly values of median flux and variability. These are classified in general accordance with the system described and illustrated by Dodson, Hedeman, and Owren (Ap. J. 118, 169, 1953). The categories of events are identified in the table by numbers, which do not necessarily indicate the magnitude of the event:

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 -- Bursts 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.

5 - Noise storm ends -- A noise storm (see 6) which ceases at some time during the observing period.

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.

9 - Major burst and second part -- A double rise in flux, the first part of which is a major burst. The second part may consist of a rise in base level, a group or series of bursts, or the onset of a noise storm.

Starting times and durations are enclosed in parentheses when they are limited by the period of observation. The maximum instantaneous flux (Inst. Flux) is measured from the sky level as are the hourly medians. The maximum smoothed flux (Smd. Flux) is that obtained by taking the difference of the maximum value of a smooth curve drawn through the outstanding occurrence with a smoothing period of 20 percent to 50 percent of the total duration, and the value of the interpolated hourly median at that same time had the event not occurred, both measured from the sky level.

V GEOMAGNETIC ACTIVITY INDICES

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

This table is made available by the Committee on Characterization of Magnetic Disturbance of IAGA, IUGG. The Meteorological Office, De Bilt, Holland collects the data from magnetic observatories distributed throughout the world, and compiles C and selected days. The Chairman of the Committee computes the planetary and equivalent amplitude indices. The same data are also published quarterly in the Journal of Geophysical Research along with data on sudden commencements (sc) and solar flare effects (sfe).

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

Kp is the mean standardized K-index from 12 observatories between geomagnetic latitudes 47 and 63 degrees. The scale is 0 (very quiet) to 9 (extremely disturbed), expressed in thirds of a unit, e.g. 5- is 4 2/3, 5o is 5 0/3, and 5+ is 5 1/3. This planetary index is designed to measure solar particle-radiation by its magnetic effects, specifically to meet the needs of research workers in the ionospheric field. A complete description of Kp has appeared in Bulletin 12b, "Geomagnetic Indices C and K, 1948" of the Association of Terrestrial Magnetism and Electricity (IATME), International Union of Geodesy and Geophysics.

Ap is a daily index of magnetic activity on a linear scale rather than on the quasi-logarithmic scale of the K-indices. It is the average of the eight values of an intermediate 3-hourly index "ap," defined as one-half the average gamma range of the most disturbed of the three force components, in the three-hour interval at standard stations; in practice, ap is computed from the Kp for the 3-hour interval. The extreme range of the scale of Ap is 0 to 400. The method is described in IATME Bulletin No. 12h (for 1953) p. viii f. Values of Ap (like Kp and Cp) have been published for the Polar Year 1932/33 and for the years 1937 onwards.

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 -- The graph of Kp by solar rotations is furnished through the courtesy of Dr. J. Bartels, Geophysikalisches Institute, Göttingen.

VI 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 usually expressed on a scale that ranges from one to nine. Indices of four or less are generally taken to represent significant disturbance. (Note that for geomagnetic K-indices, disturbance is represented by higher numbers.) The adjectival equivalents of the integral quality indices 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

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

P - forecast quality equal to observed

S - forecast quality one grade different from observed

U - forecast quality two or more grades different from observed when <u>both</u> forecast and observed were $\geqslant 5$, or both $\leqslant 5$

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

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

The quality figures represent a consensus of experience with radio propagation conditions. Since they are based entirely on monitoring or traffic reports, the reasons for low quality are not necessarily known and may not be limited to ionospheric storminess. For instance, low quality may result from improper frequency usage for the path and time of day. Although, wherever it is reported, frequency usage is included in the rating of reports, it must often

be an assumption that the reports refer to optimum working frequencies. It is more difficult to eliminate from the indices conditions of low quality for reasons such as multipath or interference. These considerations should be taken into account in interpreting research correlations between the Q-figures and solar, auroral, geomagnetic or similar indices.

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

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

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

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

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

(c) Advance forecasts, issued twice weekly by the NARWS (CRPL-J reports) and applicable 1 to 3 or 4 days ahead, 4 or 5 to 7 days ahead, and 8 to 25 days ahead. These forecasts are scored against the whole-day quality indices.

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

A chart compares the short-term forecasts with Qa-figures. A second chart compares the outcome of advance forecasts (1 to 3 or 4 days ahead) 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.

Ranges of useful frequencies on the North Atlantic radio path are shown in a series of diagrams, one for each day. Time is the angular coordinate and radio frequency in Mc is the radius vector. The shaded area indicates the range of frequencies for which transmissions of quality 5 or greater were observed. The blacker the diagram, the quieter the day has been; a narrow strip indicates either high LUHF, low MUF or both. These diagrams are based on data reported to CRPL by the German Post Office through the Fernmeldetechnischen Zentralamtes, Darmstadt, Germany, being observations every one and a half hours of selected transmitters located in the eastern portion of North America.

Note: Beginning with data for September 1955, Qa has been determined from reports that are available within a few hours or at most within a few days, including for the first time, the CRPL observations. Therefore these are the indices by which the forecasters assess every day the conditions in the recent past. Over a period of several years, they have closely paralleled the former Qa indices which included CRPL observations and included three additional reports received after a considerable lag. Qa was first published to the nearest one-third of a unit at the same time.

North Pacific Radio Path -- The CRPL quality figures, Qp, are compiled by the North Pacific Radio Warning Service (NPRWS), the CRPL forecasting center at Anchorage, Alaska, from radio traffic data for moderately long transmission paths in the North Pacific equivalent to Seattle-to-Anchorage or Anchorage-to-Tokyo. These include reports to CRPL by the Alaskan Communications Service, Aeronautical Radio, Inc., U. S. Air Force and Civil Aeronautical Administration. In addition, there are CRPL monitoring, direction-finder observations and field strength measurements of suitable transmissions.

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

03-12 hours UT	5.33
09-18	5.33
18-03	6.00
00-24	5.67

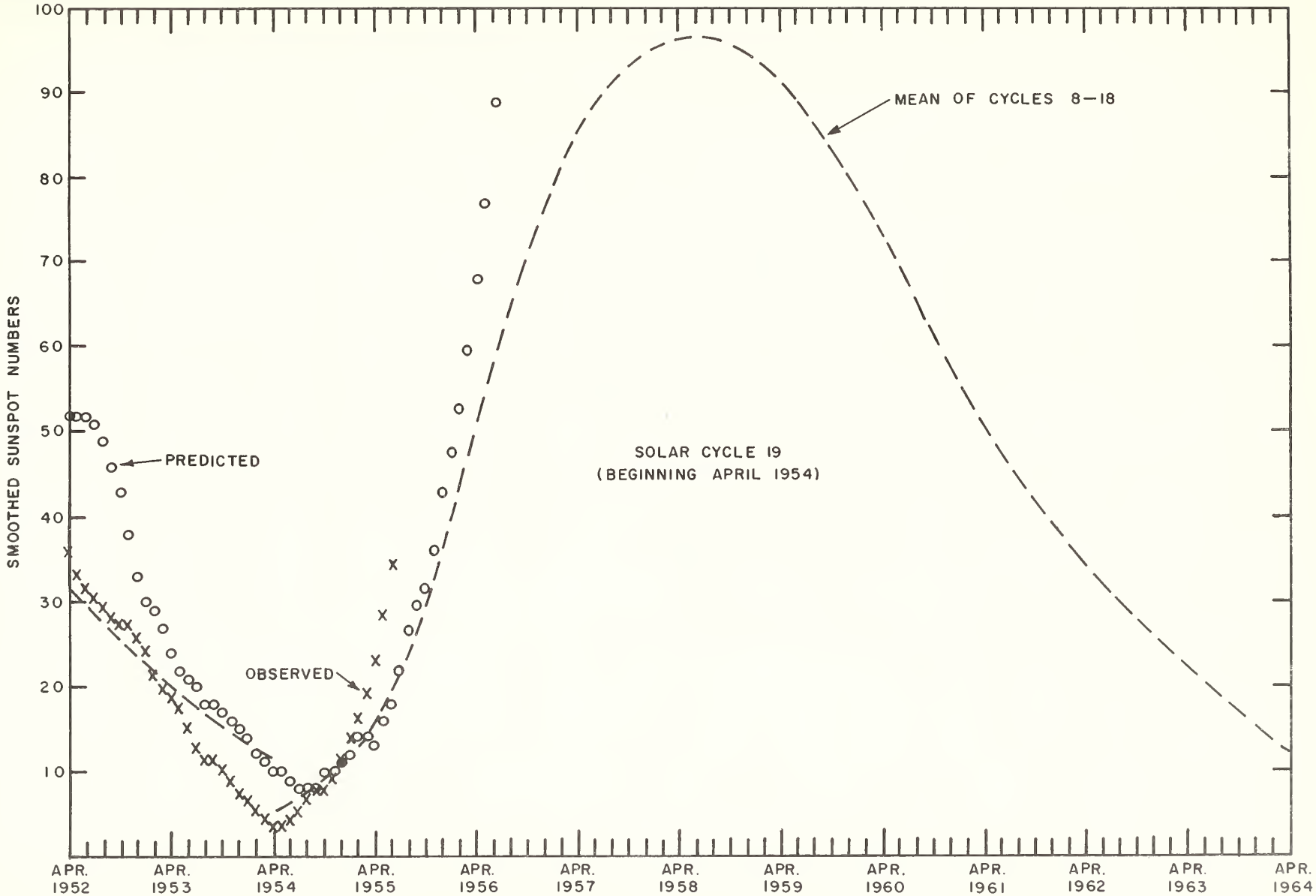
The 9-hour and 24-hour indices Qp are determined separately. Each index is a weighted mean, where the CRPL observations have unit weight and the others are weighted by the correlation coefficient with the CRPL observations.

The table, analagous to that for Qa, includes the 9-hourly quality figures; whole day quality figures; short term forecasts issued by NPRWS three times dailv at 02^h, 09^h, and 18^h UT, applicable to the stated 9-hour periods; advance forecasts issued twice weekly by NPRWS (CRPL-Jp report); and half-day averages of geomagnetic K indices from Sitka.

The chart compares the outcome of advance forecasts, on the same basis as the similar chart for the North Atlantic Radio Path.

American Relative Sunspot Numbers November 1955	
Date	R_A'
1	103
2	88
3	66
4	58
5	53
6	51
7	64
8	85
9	105
10	125
11	122
12	121
13	98
14	108
15	108
16	81
17	74
18	71
19	84
20	67
21	54
22	40
23	68
24	68
25	67
26	78
27	80
28	90
29	88
30	95
Mean:	82.0

Zürich Provisional Relative Sunspot Numbers December 1955	
Date	R_Z
1	99
2	87
3	75
4	86
5	100
6	100
7	84
8	72
9	60
10	74
11	86
12	79
13	71
14	63
15	75
16	76
17	70
18	85
19	89
20	92
21	105
22	85
23	64
24	51
25	53
26	61
27	62
28	65
29	72
30	81
31	70
Mean:	77.2



PREDICTED AND OBSERVED SUNSPOT NUMBERS

CALCIUM PLAGE AND SUNSPOT REGIONS

DECEMBER 1955

CMP Dec. 1955	Lat.	McMath Plage Number	Return of Region	Calcium Plage Data Date-Area-Intensity			Sunspot Data Date-Area-Count		
				First seen	Maximum	Last seen	First seen	Maximum	Last seen
3.6	N22	3342	3320	26-2000-1	02-8000-4	08-5700-3	27-150 -1	01-990 -20	10-200a-x
4.7	S28	3343	3321	28-3000-3	30-6000-3	11-2000-2	28-290 -1	29-920 -2	10-200a-x
5.0	N31	3344	New	28-2000-3	02-2500-3	11-2000-3			
5.0	N07	3345	New	29-1000-2	---------	04- 400-1.5			
7.6	S20	3347	3322,25	04-1000-2	07-2000-1	11- 600-2	03- 10 -x	07-200a-x	10- 50a-x
9.1	S17	3348	New	04-1600-3	04-1600-3	11- 800-2.5	06- 50a-x	06- 50a-x	07- 50a-x
9.1	N18	3349	3331	04-1200-2	---------	11- 800-2			
9.9	N28	3350	3323	04-3000-3	07-8000-3	16-5000-3.5	05- 50a-x	13-900 -14	15-390 -3
11.0	S27	3351	3324	04-1000-2	12-5700-2	16-4300-2.5	09- 50a-x	11-170 -3	13- 50 -1
12.6	N25	3353	3326	07-3400-2	13-8000-3	19-2000-2			
12.7	S30	3352	New	10-1100-2.5	16-2700-2	18-2000-2			
16.0	N22	3354	3330	10-3800-2	20-5000-3	22-4000-3	13- 10 -x	19-750 -5	22- 10 -x
17.3	N24	3355	New	11-2000-3	17-4800-4	22-4700-3	11-440 -1	13-510 -6	21- 70 -1
18.4	N28	3356	New	13- 300-1	16-2700-3	21-1200-3	12-270 -2	12-270 -2	16-110 -4
19.8	S31	3357	New	12-1400-1	16-7600-3.5	22-4500-3	13-360 -2	14-360 -3	23-200a-x
21.1	N27	3358	New	15-1700-2.5	18-2000-2	22-1100-2*	21- 10 -x	21- 10 -x	22- 10 -x
17.2	S20	3359	New	17- 500-1.5	20-1500-2.5	22- 800-3*	18- 50a-x	19-120 -2	20- 70 -2
23.7	S20	3360	3337	17-4000-1	22-6000-3	28-1400-2	17-140 -1	21-880 -10	29-200a-x
24.2	N26	3361	3338	18-1500-2.5	21-2000-2.5	22-1500-2.5*	20- 80 -2	21- 80 -3	23- 50a-x
25.8	N23	3362		19-2000-3	28-4000-2	30-1400-1	21- 20 -1	28- 80 -1	30- 50a-x
27.2	N34	3363	3339?	21-1500-3	---------	22-1500-3*	21- 10 -x	26- 50a-x	26- 50a-x
28.1	N21	---**		27-1400-2	---------	02-2000-3	26-180 -4	26-180 -4	02- 10 -x
31.4	N23	3364	3342	27-4000-3	03-11400-4	06-6000-3	26-140 -3	27-390 -6	06- x -1

* : No plage observations, Dec. 23 to Dec. 27.

** : No McMath observations of this region; values from Mt. Wilson.

CORONAL LINE EMISSION INDICES

DECEMBER 1955

CMP Date 1955	North East Quadrant (observed 7 days earlier)				South East Quadrant (observed 7 days earlier)				South West Quadrant (observed 7 days later)				North West Quadrant (observed 7 days later)			
	G_6	G_1	R_6	R_1	G_6	G_1	R_6	R_1	G_6	G_1	R_6	R_1	G_6	G_1	R_6	R_1
Dec.																
1	43	79	14	38	7	8	8	11	11	15	11	11	36	45	18	25
2	63[a]	94[a]	13[a]	30[a]	8[a]	15[a]	7[a]	10[a]	13	22	17	20	52	64	17	36
3	79	120	19	28	17	23	10	14	X	X	X	X	X	X	X	X
4	80	130	24	28	23	34*	12	16	43	96	26	65	57	104	37	54
5	51	83	30	41	37	53	20	25	50	104	24	60	56	96	32	54
6	X	X	X	X	X	X	X	X	41	64	13	25	33	49	19	36
7	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8	X	X	X	X	X	X	X	X	54	79	18	38	44	53*	36	72
9	X	X	X	X	X	X	X	X	40	49	19	39	72	120	38	65
10	X	X	X	X	X	X	X	X	40	53	17	23	80	120*	35	60
11	X	X	X	X	X	X	X	X	36	53	18	39	78	120	25	36
12	36	75	26	44	37	65	19	40	44	64	18	39	70	104	20	29
13	64	104	24	39	41	98	21	25	X	X	X	X	54[a]	85[a]	20[a]	36[a]
14	57	96	23	31	31	35	21	22	X	X	X	X	X	X	X	X
15	37	60	22	41	16	18	16	20	X	X	X	X	X	X	X	X
16	40	72	19	28	13	15	14	16	X	X	X	X	X	X	X	X
17	X	X	X	X	X	X	X	X	23	30	21	25	66	160	42	65
18	39	79*	23	37	27	43	22	32	22	40	8	11	46	90	14	21
19	32	53	20	46	42	75	28	50	32	64	20	29	18	25	12	18
20	29	53	13	22	28	45	13	19	38	80	13	30	17	22	6	12
21	28	53	X	X	34	49	15	21	50	72	17	20	20	27	11	14
22	20	30	20	32	53	83	18	30	33[a]	49[a]	11[a]	22[a]	11[a]	13[a]	11[a]	14[a]
23	21	28	25	43	61	104	20	26	23	34	13	23	14	17	13	16
24	34	49	21	36	36	79	16	36	32	53	10	19	14	22	13	22
25	51	79	22	34	25	45	13	20	29	42	11	16	47	67	23	31
26	52	83	26	52	19	34	17	20	14	17	7	9	66	110	19	28
27	75	101	22	28	X	X	X	X	8	13	7	8	67	130	21	28
28	X	X	X	X	X	X	X	X	6	7	6	8	61	97	19	28
29	X	X	X	X	X	X	X	X	X	X	15	19	101	113	27	60
30	X	X	X	X	X	X	X	X	4	8	13	18	61	72	24	54
31	85	130	35	86	34	58	18	19	9	20	X	X	88	137	X	X

* Yellow line observed

a Index computed from low weight data

SOLAR FLARES

DECEMBER 1955

Observatory	Date Dec. 1955	Time Observed Start UT	Time Observed End UT	Duration Min.	Total Area Mill.	McMath Plage Region Number	Approx. Position Lat.	Approx. Position Mer. Dist.	Time Max. Phase UT	Max. Int. Arb.	Rel. Area of Max. Tenths	Importance	Provis. Ionospheric Effect
Wendel	02	b0922	0936	14		3342	N23	E21	0922			1	
Wendel	02	1321	1445	84		3342	N23	E18	1330			2+	G-SWF
Wendel	03	1112	1137	25		3342	N23	E09	1112			3	S-SWF
McMath	04	b1515				3342	N22	W13				1+	Slow S-SWF
Wendel	07	1130	1146	16		3350	N33	E33	1132			1	

Subflares noted as follows:

Region 3342: Dec. 7, 1715 UT.
Region 3349: Dec. 7, 1741 UT.
Region 3350: Dec. 8, 2050 UT; Dec. 14, 1730 UT; Dec. 16, 1640 UT.
Region 3354: Dec. 10, 1917, 2015, 2110 UT.
Region 3348: Dec. 12, b1515 UT.
Region 3355: Dec. 12, 1845, 1925, 2145 UT.
Region 3356: Dec. 16, 2035 UT.
Region 3360: Dec. 20, 1540 UT (Sac. Peak and McMath), Dec. 23, 1800 UT.
No region assignable: Dec. 24, 2155 UT (S22, E48).
Region 3364: Dec. 25, 1900 UT, Dec. 26, 1640 UT, Dec. 27, 1710, 1810 UT, Dec. 29, 1610, 1820 UT.
Region 3367: Dec. 27, 1730 UT, Dec. 30, 1650 UT.
Region 3363: Dec. 29, 1525 UT.

Notes: All subflare observations are from Sac. Peak unless otherwise stated.

Subflares for October were listed with times of maxima; November and subsequent months are listed with beginning times.

NOVEMBER 1955

Nov. 1955	Start UT	End UT	Type	Wide-spread Index	Impor-tance	Observation stations
2	1851	1900	S-SWF	2	1	AN, HU, MC, PR
3	1950	2005	Slow-S-SWF	5	1	AN, BE, HU, MC, PR
4	1645	1725	G-SWF	1	1-	AN, MC, PR
	1755	1835	G-SWF	1	1-	AN, MC
7	1558	1632	G-SWF	5	2	BE, HU, MC, PR
	1825	1900	S-SWF	1	1-	AN, MC
	1951	2007	G-SWF	5	1	AN, BE, HU, MC, PR
8	0247	0305	S-SWF	1	1-	OK
	1435	1505	Slow S-SWF	5	1+	BE, HU, MC, PR
	1850	1930	Slow S-SWF	5	1	AN, BE, HU, MC, PR
9	1320	1332	S-SWF	5	1+	BE, HU, MC, PR
10	1845	1905	Slow S-SWF	4	1	AN, BE, HU, MC
12	1127	1150	S-SWF	4	2+	BE, HU, PR
15	0441	0509	S-SWF	5	2	OK, Japan*, RCA**
	1253	1307	G-SWF	4	2-	BE, HU, PR
	1735	1757	S-SWF	5	2+	AN, BE, HU, MC, PR
16	1940	1955	G-SWF	4	1	AN, BE, HU, PR
17	1542	1558	Slow S-SWF	3	1	HU, MC, PR
	1830	1840	Slow S-SWF	4	1-	AN, HU, MC, PR
18	0240	0300	S-SWF	5	1+	OK, Japan*
	0425	0448	S-SWF	1	1+	OK
	1445	1505	S-SWF	5	1	BE, HU, MC, PR
	1618	1630	S-SWF	3	1-	HU, MC, PR
	1720	1838	G-SWF	4	2-	AN, BE, MC, PR
19	0330	0430	Slow S-SWF	1	1+	OK
	1505	1520	S-SWF	3	1-	HU, MC, PR
27	1713	1802	G-SWF	3	2-	HU, PR
28	2230	2425	S-SWF	3	3-	AN, CO
29	2140	2158	G-SWF	2	1	AN, PR
30	2043	2053	Slow S-SWF	2	1	AN, PR

* Hiraiso Radio Wave Observatory, Japan

** RCA Communications, Inc. at Point Reyes, California

SOLAR RADIO WAVES (BOULDER) -- 167 MC
3-HOURLY AND DAILY FLUX

DECEMBER 1955

	Flux					Variability					Observed Periods
	Hours UT					Hours UT					
Dec. 1955	12 15	15 18	18 21	21 24	Daily	12 15	15 18	18 21	21 24	Daily	Hours UT

Radiometer Inoperative

SOLAR RADIO WAVES (BOULDER) -- 460 MC

3-HOURLY AND DAILY FLUX

DECEMBER 1955

Dec. 1955	Flux: Hours UT 12-15	15-18	18-21	21-24	Daily	Variability: Hours UT 12-15	15-18	18-21	21-24	Daily	Observed Periods: Hours UT
1	--	34	35	--	35	--	(0)	0	(0)	(0)	1402-2320
2	--	44	38	--	40	--	0	0	0	0	1403-2320
3	--	40	38	--	38	--	0	0	0	0	1404-2320
4	--	37	35	--	36	--	0	0	0	0	1405-2320
5	--	36	35	--	36	--	(0)	0	0	(0)	1406-2320
6	--	33	34	--	34	--	0	0	(0)	(0)	1407-2319
7	--	34	34	--	34	--	0	(0)	(0)	(0)	1408-2319
8	--	33	34	--	34	--	(0)	(0)	(1)	(1)	1616-2319
9	--	34	32	--	33	--	(0)	(0)	(0)	(0)	1409-2319
10	--	33	32	--	32	--	0	0	0	0	1410-2319
11	--	36	35	--	35	--	0	0	0	0	1411-2320
12	--	34	33	--	34	--	(0)	(0)	0	(0)	1412-2004, 2033-2320
13	--	34	35	--	34	--	(0)	0	(0)	(0)	1413-2320
14	--	33	--	--	--	--	0	(0)	0	(0)	1414-2320
15	--	32	--	--	32	--	0	(0)	0	(0)	1414-2320
16	--	32	--	--	32	--	(0)	0	(0)	(0)	1415-2320
17	--	32	32	--	32	--	0	1	0	1	1416-2321
18	--	38	--	--	--	--	1	0	0	1	1416-2321
19	--	32	--	--	--	--	0	0	0	0	1417-2322
20	--	33	33	--	33	--	0	0	0	0	1417-2322
21	--	32	33	33	33	--	1	0	1	1	1418-2322
22	--	30	30	30	30	--	0	0	0	0	1418-2323
23	--	30	29	31	30	--	0	0	0	0	1418-2323
24	--	--	--	--	--	--	--	0	0	0	1650-2324
25	--	--	--	--	--	--	0	0	0	0	1420-2325
26	--	--	30	29	30	--	0	0	0	0	1420-2325
27	--	--	--	32	--	--	(0)	0	0	(0)	1420-2326
28	--	--	--	--	--	--	0	0	0	0	1421-2327
29	--	--	--	37	--	--	0	1	0	1	1421-2327
30	--	34	--	31	32	--	0	0	0	0	1421-1808, 2100-2328
31	--	32	31	31	32	--	0	0	0	0	1422-2329

SOLAR RADIO WAVES (BOULDER) -- 167 MC
OUTSTANDING EVENTS

DECEMBER 1955

Dec. 1955	Type	Start UT	Duration Hrs:Mins	Maximum Time UT	Maximum Inst. Flux	Maximum Smd. Flux	Remarks

Radiometer Inoperative

SOLAR RADIO WAVES (BOULDER) -- 460 MC
OUTSTANDING EVENTS

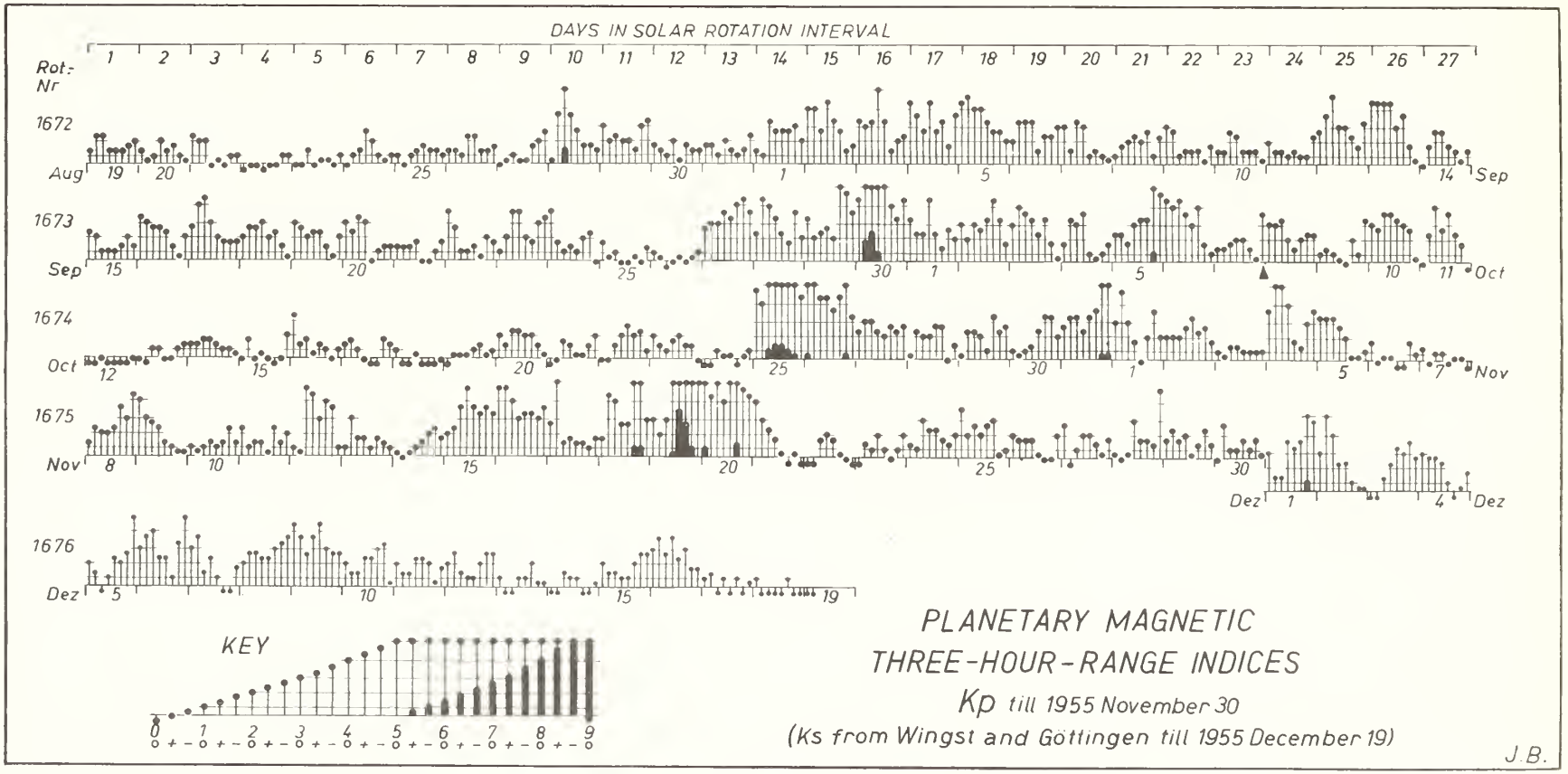
DECEMBER 1955

Dec. 1955	Type	Start UT	Duration Hrs:Mins	Maximum Time UT	Maximum Inst. Flux	Maximum Smd. Flux	Remarks
2	6	(1403)	(09:07)	~1600	--	15	
5	3	1512	00:00.2	1512	82	--	
7	2	1638	00:13	1643	46	3	
8	8	2101	00:38	2114.6	110	16	
16	1	(1415)	(09:05)	1451.1	150	--	
17	1	(1416)	(09:05)	1947.1	76	--	
17	2	1943	00:15	1947.1	76	8	
18	6	(1416)	(09:05)	~1700	--	9	
19	1	(1417)	(09:05)	2025	60	--	
21	1	(1418)	(09:04)	1534.5	230	--	
22	1	(1418)	(09:05)	*	42	--	*Several bursts
29	3	1807.6	00:00.2	1807.7	140	--	

GEOMAGNETIC ACTIVITY INDICES

NOVEMBER 1955

Nov. 1955	C	Values Kp Three-hour Gr. interval 1	2	3	4	5	6	7	8	Sum	Ap	Final Selected Days
1	0.9	3o	5-	3o	2-	0+	2o	4-	2o	20+	14	Five
2	0.7	2o	2o	2o	3-	3+	2+	3-	2-	19-	10	Quiet
3	0.1	1o	1-	1+	1+	1o	1o	1o	1o	8+	4	
4	1.1	4-	5o	5o	4o	2-	1+	3o	4-	27+	24	3
5	0.4	3+	3+	3+	3-	2o	1-	1-	1o	17o	10	6
												7
6	0.1	2-	0+	1-	1-	0o	0o	2-	1o	6o	3	22
7	0.0	1+	0+	1o	1o	0+	1-	1-	0o	5+	3	23
8	1.1	1+	2+	2o	2o	2+	4-	3o	4+	21o	13	
9	0.7	4o	3o	3-	2+	1+	1o	1-	1-	16-	10	
10	0.3	1o	1-	1o	1+	1o	1+	2+	1+	10o	5	
11	0.4	2+	1o	1+	1+	1-	2+	1+	2o	12+	6	Five
12	1.0	1o	1-	5-	4+	3o	4o	4-	1o	22+	18	Disturbed
13	0.2	1o	3o	2-	2-	1o	2-	1+	1o	12+	6	
14	0.2	1-	0+	1-	1o	1+	2o	2+	2-	10o	5	4
15	1.2	2o	2+	4-	5-	4-	3+	4-	3+	27-	20	16
												18
16	1.2	5-	5-	4o	3o	3+	3+	3o	4-	30-	24	19
17	0.6	3-	5o	1+	2-	1+	1+	1o	2-	16o	11	20
18	1.6	2-	4+	4o	3-	3-	6-	6-	3o	30-	30	
19	1.9	3o	2o	3o	5+	8-	7o	6-	5o	39-	65	
20	1.7	6-	4+	5o	4o	5o	6o	5-	4+	39o	47	
21	0.4	4o	3o	2+	2-	1-	0o	1-	0o	12+	8	Ten
22	0.1	0o	0o	2-	2o	2-	1-	0+	0o	6+	3	Quiet
23	0.1	0o	1+	1o	2o	1o	0+	1o	2o	9-	4	
24	0.3	1+	1o	3o	2+	2+	2-	1+	2o	15o	8	3
25	0.7	4-	2o	3-	2o	3-	3o	1-	1o	18-	10	6
												7
26	0.2	2o	2-	2-	2-	1-	0+	0+	2o	10+	5	10
27	0.2	3-	0o	1o	2o	2o	1+	1-	2-	11+	6	14
28	0.8	1-	0+	1-	3o	2-	2-	1+	5-	14o	10	22
29	0.3	2-	2+	2-	2o	1-	1+	2+	1+	13+	6	23
30	0.2	0+	3-	1o	1o	2-	1o	2-	1-	10o	5	26
												27
Mean:	0.62									Mean:	13	30


DAYS IN SOLAR ROTATION INTERVAL
Rot.-Nr
1672
Aug
Sep
1673
Sep
Oct
1674
Oct
Nov
1675
Nov
Dez
1676
Dez
KEY
PLANETARY MAGNETIC
THREE-HOUR-RANGE INDICES
Kp till 1955 November 30
(Ks from Wingst and Göttingen till 1955 December 19)
J.B.

CRPL RADIO PROPAGATION QUALITY FIGURES AND FORECASTS
NORTH ATLANTIC
NOVEMBER 1955

Nov. 1955	North Atlantic 6-hourly quality figures				Short-term forecasts issued about one hour in advance of:				Whole day index	Advance forecasts (J-reports) for whole day; issued in advance by:			Geomagnetic K_{Ch}	
	00 to 06	06 to 12	12 to 18	18 to 24	00	06	12	18		1-4 days	4-7 days	8-25 days	Half Day (1)	Half Day (2)
1	5o	6-	7o	6o	6	4	7	7	6o	7	7		3	2
2	6-	6o	7-	7-	6	6	7	7	6+	7	7		2	2
3	6o	7-	7+	7o	6	6	7	7	7-	7	7		1	1
4	6o	6-	7+	6+	7	6	7	7	6+	7	7		(4)	2
5	6-	6o	7o	6+	5	5	7	7	6+	7	7		3	1
6	7-	6+	7o	7-	6	6	7	7	7-	7	7		1	0
7	6o	6o	7o	7-	7	6	7	7	7-	7	7		1	1
8	6+	6+	7+	7-	6	6	7	7	7-	6	7		2	3
9	6-	6+	7+	7o	5	6	7	7	7-	6	7		3	1
10	6+	6o	7+	7-	6	6	7	7	7-	6	7		1	1
11	7+	6+	7+	7o	6	6	7	7	7o	7	6		2	1
12	7o	6+	7+	7o	7	6	7	7	7o	7	6		3	3
13	6+	6+	7o	7o	7	5	7	7	7-	7	6		2	1
14	7-	7-	7o	7-	6	6	7	7	7-	7	6		0	2
15	6+	6+	7o	7-	7	6	7	6	7-	7	6		3	3
16	6-	6-	7o	6o	6	4	6	6	6+	7	5		(4)	2
17	5+	6-	7+	7-	6	5	7	7	6+	7	5		3	1
18	6+	6o	7o	6-	6	6	7	7	6+	7	7		3	3
19	6-	6-	6-	6-	4	4	5	4	6-	7	7		3	(6)
20	4+	4o	6+	4+	4	4	5	6	5-	6	6		(5)	(4)
21	5o	5+	7-	7-	4	4	6	6	6+	4	4	x	3	0
22	7-	6-	7-	6o	6	6	7	6	6+	6	4	x	1	0
23	5o	6-	7o	7-	6	6	7	7	6+	6	4	x	1	1
24	6+	6-	7-	7-	6	6	7	7	7-	6	6		2	1
25	6+	6+	7+	7-	6	6	7	7	7-	6	6		3	2
26	7-	6+	7o	7-	7	6	7	7	7-	6	6		2	1
27	6+	6+	7o	7-	6	7	7	6	7-	6	6		2	1
28	7-	6o	7-	7-	7	6	7	7	6+	6	6		1	2
29	6+	7-	7-	6+	6	6	7	7	7-	7	6		2	1
30	6o	7-	7o	6+	6	6	7	6	7-	7	6		2	1

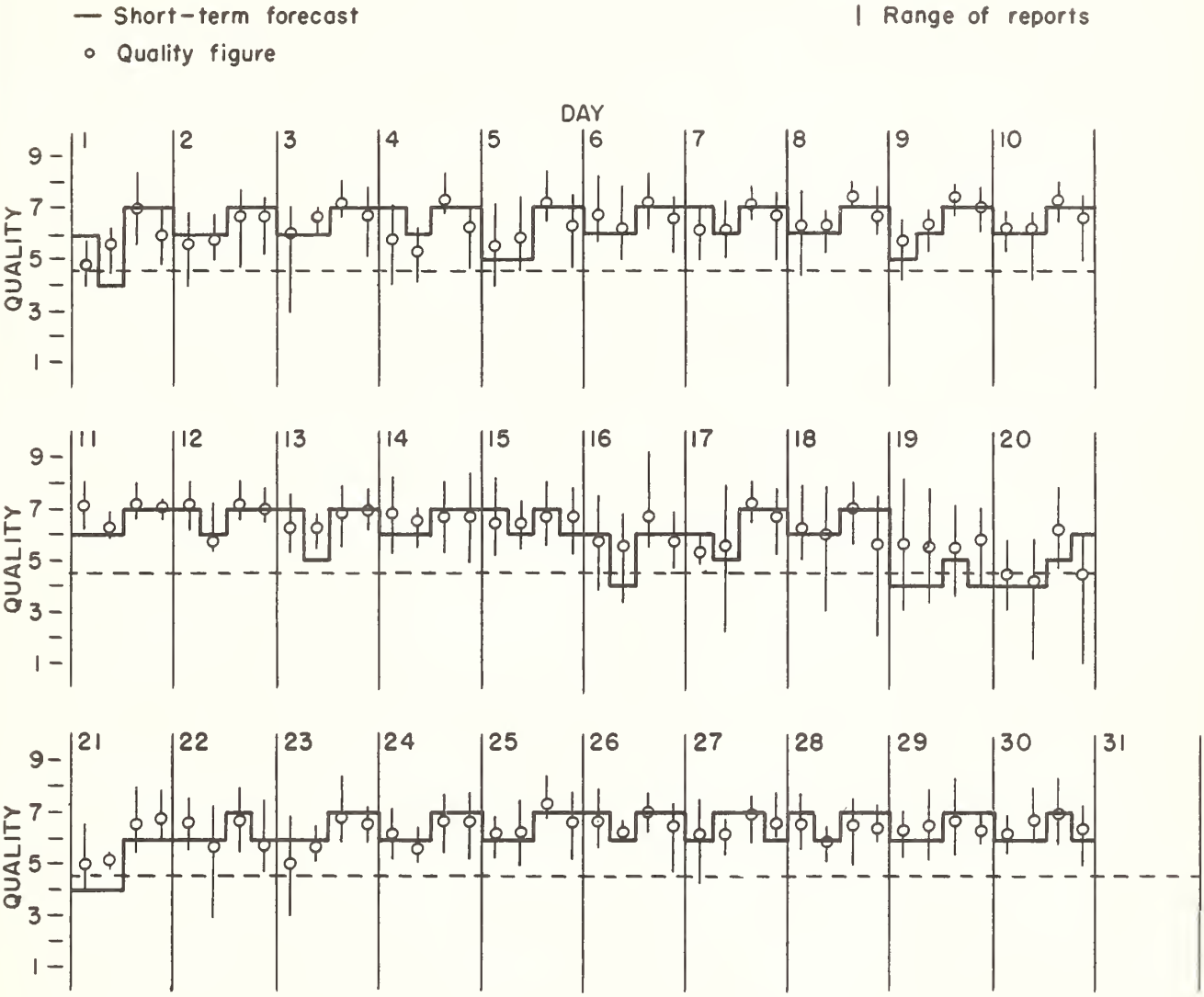
Score:			00	06	12	18	1-4 days	4-7 days
Quiet Periods	P		14	17	26	20	13	7
	S		14	9	4	8	16	20
	U		0	0	0	0	0	0
	F		1	3	0	1	1	3
Disturbed Periods	P		1	1	0	0	0	0
	S		0	0	0	0	0	0
	U		0	0	0	0	0	0
	F		0	0	0	1	0	0

( ) represent disturbed values

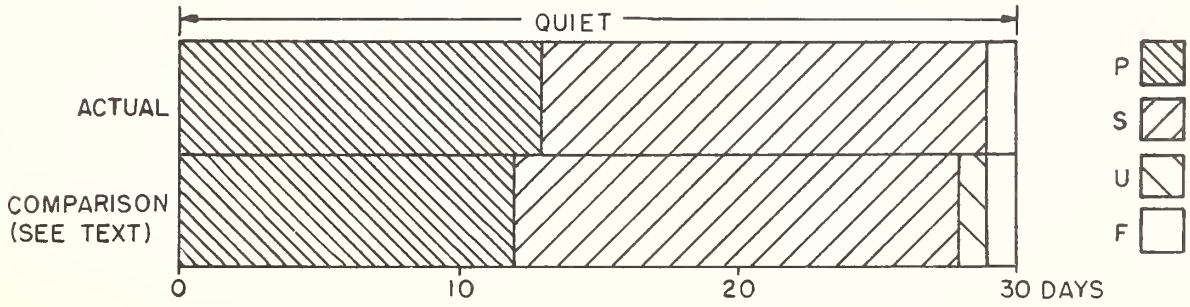
CRPL RADIO PROPAGATION QUALITY FIGURES AND FORECASTS

NORTH ATLANTIC

NOVEMBER 1955

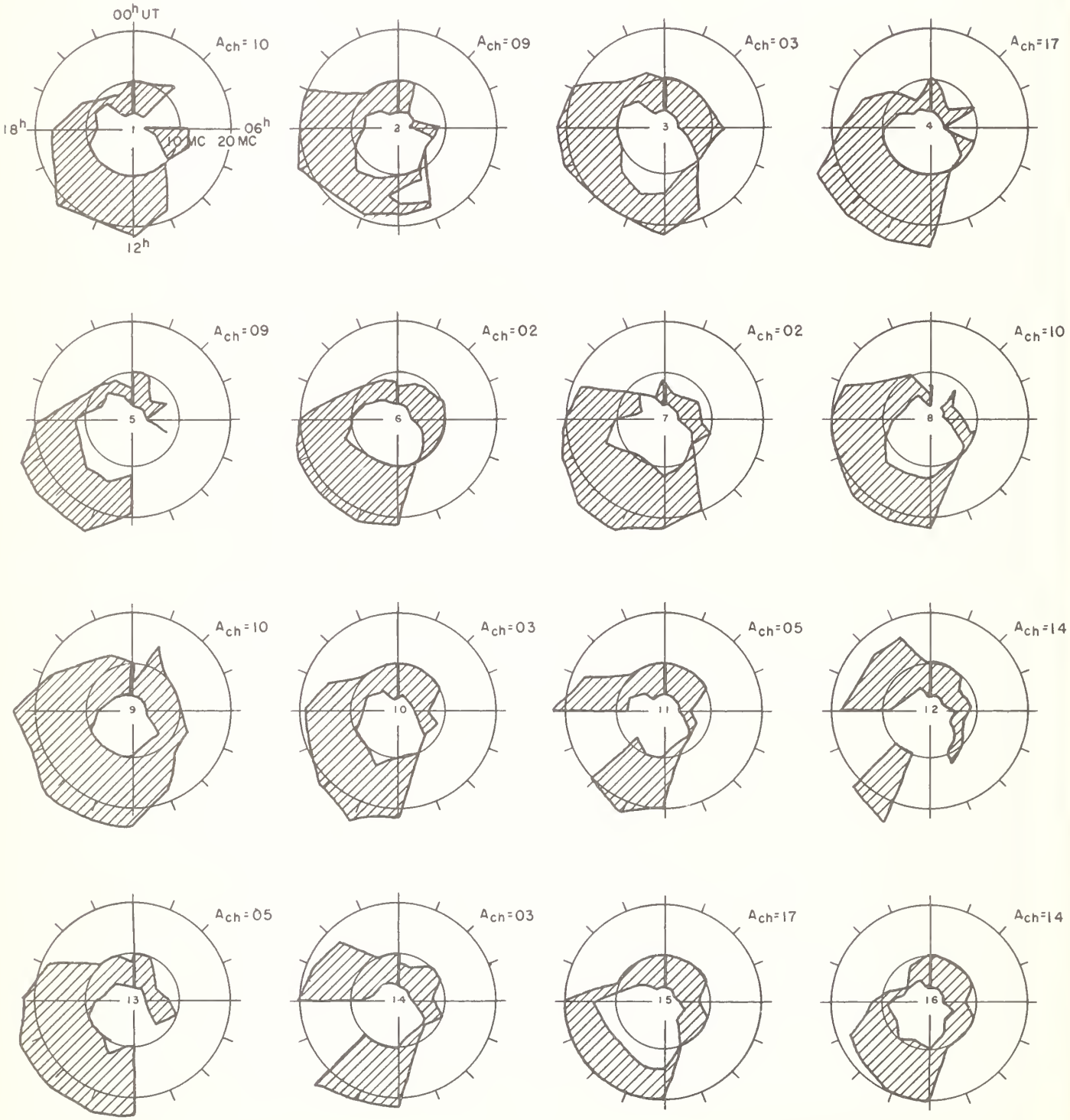


OUTCOME OF ADVANCE FORECASTS (1 TO 4 DAYS AHEAD)

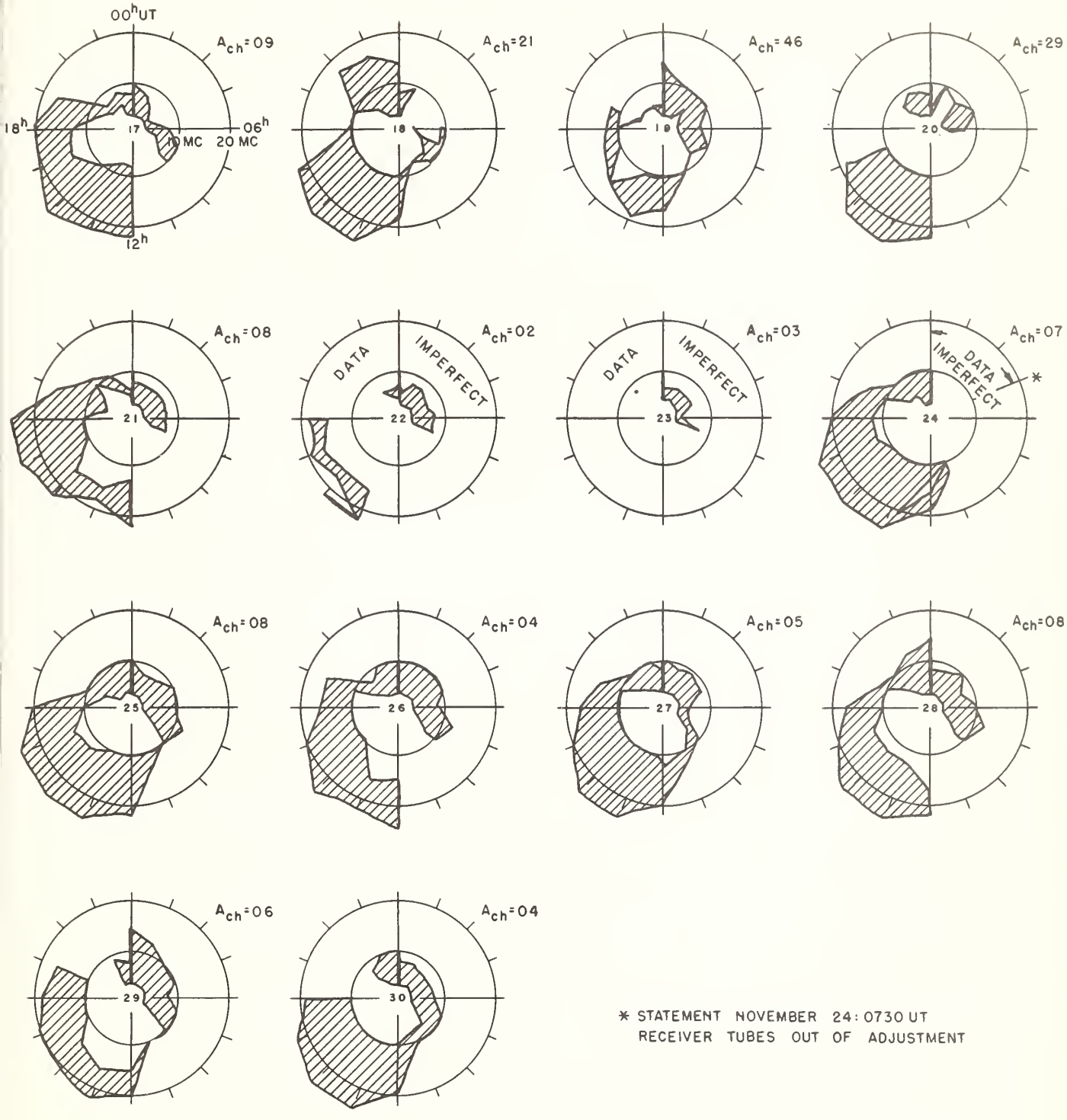


USEFUL FREQUENCY RANGES -- NORTH ATLANTIC PATH

NOVEMBER 1955



NOVEMBER 1955



* STATEMENT NOVEMBER 24: 0730 UT
RECEIVER TUBES OUT OF ADJUSTMENT

Adapted from Observations by Deutschen Bundespost

CRPL RADIO PROPAGATION QUALITY FIGURES AND FORECASTS

NORTH PACIFIC

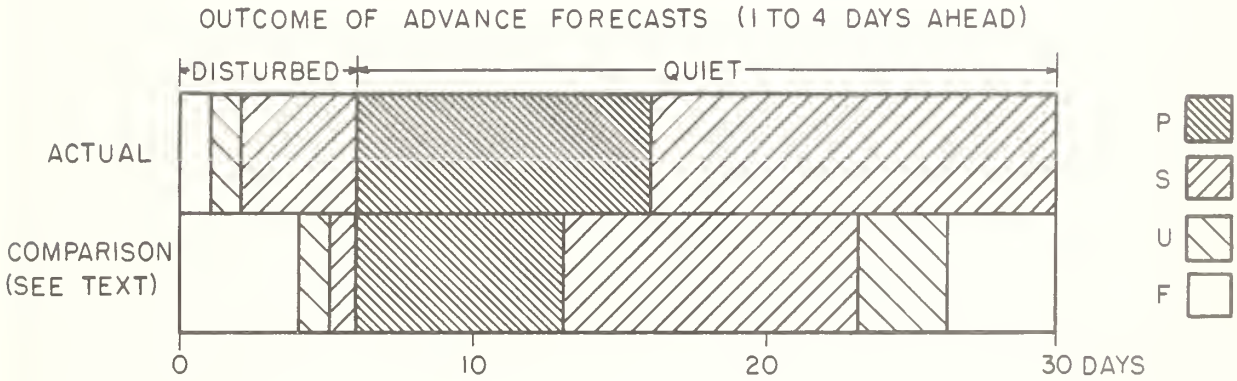
NOVEMBER 1955

Nov. 1955	North Pacific 9-hourly quality figures			Short-term forecasts issued at			Whole day index	Advance forecasts (Jp reports) for whole day; issued in advance by:			Geomagnetic K_{Si}	
	03 to 12	09 to 18	18 to 03	02	09	18		1-4 days	4-7 days	8-25 days	Half day (1)	Half day (2)
1	5	5	6	6	5	6	6	5	5		3	1
2	5	5	7	6	5	6	6	5	5		2	3
3	5	5	6	6	5	6	5	6	6		0	1
4	5	5	6	6	5	6	6	6	7		(4)	2
5	5	6	6	6	5	6	6	6	6		3	1
6	6	6	6	6	5	6	6	5	5		1	0
7	6	6	6	6	5	6	6	5	5		2	0
8	6	6	7	6	6	6	6	6	6		2	3
9	6	6	8	6	5	7	7	6	6		2	1
10	6	6	7	6	6	6	6	6	6		0	1
11	6	6	6	6	6	7	6	6	6		1	1
12	6	6	6	6	5	6	6	7	6		3	2
13	6	6	6	6	5	7	7	6	6		1	1
14	5	5	7	5	5	7	5	6	6		0	2
15	6	6	7	5	6	6	6	5	6		3	3
16	5	5	6	5	4	6	6	5	5		(4)	3
17	5	5	7	5	5	7	6	5	6		2	1
18	5	5	4	5	4	4	5	6	6		3	(5)
19	3	2	2	4	4	3	(2)	4	6		3	(7)
20	2	2	1	3	2	3	(1)	4	6		(5)	(5)
21	1	2	5	4	3	6	(2)	3	3	x	2	1
22	3	5	6	5	4	5	(4)	3	3	x	2	1
23	4	5	5	5	5	6	5	5	4	x	0	1
24	4	5	6	4	5	6	5	5	5		2	2
25	3	4	6	5	5	5	(4)	5	5		2	2
26	4	4	5	5	5	6	(4)	5	5		2	1
27	4	5	5	4	5	5	5	5	5		1	2
28	4	4	5	5	5	6	5	5	5		1	2
29	5	5	6	5	5	5	5	5	6		2	1
30	5	5	7	5	5	6	6	5	5		1	1

Score: Quiet Periods	P	14	15	12	10	10
	S	6	9	15	14	14
	U	0	0	0	0	0
	F	0	0	0	0	0
Disturbed Periods	P	2	1	1	0	0
	S	5	4	1	4	4
	U	2	1	1	1	0
	F	1	0	0	1	2

( ) represent disturbed values

CRPL RADIO PROPAGATION QUALITY FIGURES AND FORECASTS

NORTH PACIFIC

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