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MAJOR SOLAR AND SOLAR INDUCED PHENOMENA DURING THE 20TH SOLAR CYCLE, II - CONDITIONS FOR EARLY DETECTION OF SOLAR PROTON EVENTS

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*The asterisks on the flare, SWF, and X-ray lines show times of reported maxima.

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1.0 SUMMARY AND RECOMMENDATIONS

1.1 GENERAL SUMMARY

This report summarizes the major solar events during the period 1964 through 1968 that meet one or more of the following conditions:

a. Flare with importance ≥ 3.

b. RF emission with peak flux ≥ 500 units at one or more of the observed frequencies between 2695 Mc/s and 3750 Mc/s.

c. A solar proton event observed by a satellite, deep space probe, a PCA based on Riometer observation, f_{min}, or forward scatter techniques.

This study is a continuation of the search for necessary and/or sufficient condition~ that a solar region will be the source of a solar proton event during its passage of the visible solar hemisphere. A total of 43 events were found that met one or more of the conditions to be classified as major solar events.

They included 11 solar proton events with PCA maximum absorption > 2 db; 8 proton events observed by satellites, deep space probes and/or with maximum PCA absorption ≤ 2 db.

The remaining major events were distributed as follows:

5 with flare importance ≥ 3

15 with RF bursts ≥ 500 units and flare importance < 3

4 with flare importance ≥ 3 and RF emissions ≥ 500 units

Three of the events included in our study may be considered as questionable; the great burst at 3000 Mc/s reported by Nedderhurst on 15

March 1966, an importance 3N flare on 9 October 1966, and an importance 3B flare on 11 January 1967. These events will be discussed in the subsequent sections of this report.

Two of the major proton events, including one that was detected by ground level neutron monitors could not be associated with a region on the visible solar hemisphere or with a region up to three days behind either the East or West Limb of the sun. The ground level event on 28 January 1967 and the PCA event on 2 February 1967 have been discussed in great detail in the literature. One of the small PCA events (11 March 1967) could not be associated with a solar region with a reasonable degree of confidence.

Eight of the 9 major PCA events with reliable solar region identification are associated with flares with importance $\geq$ 2B and RF bursts with peak flux $\geq$ 500 units (RF data for 2 of the 1968 events are not available at this time). The other PCA event is associated with a 1B flare at the West Limb.

All of the small PCA events are associated with minor flares and only one had a recorded RF $\geq$ 500 flux units. On the other hand all three of the satellites reported proton streams are associated with large RF bursts and two with major flares. The one minor flare occurred at the East Limb.

An analysis of the solar proton events sunspot classification shows that all but one of the major events was associated with magnetically complex spot groups. In fact, 5 of the 9 events are associated with regions classified as "δ" type on flare day. On the other hand, only one of the small or satellite reported proton events may have been associated with a $\beta\gamma$ spot group.

Only 2 of the major PCA events are associated with spots with maximum areas < 500 millionths, while 4 of the associated sunspot groups had areas > 500 millionths on flare day.

1.1.1 Sunspot Association

Our study confirms our earlier conclusions (Reference 18) of a high probability that the PCA flare will occur in a magnetically complex sunspot group. Eight of the nine major PCA events are definitely associated with flares from sunspot groups that on flare day were classified by Mt. Wilson as $\beta\gamma$ (2 cases), γ (1 case) or with a δ configuration (5 cases). The remaining flare associated major PCA event occurred in a β spot group that was classified as $\beta\gamma$ on 3 days during disk passage. On the other hand only two of the eight flare associated small PCA events occurred in magnetically complex spot groups (1 probably $\beta\gamma$, and 1 with a δ configuration) on flare day.

1.1.2 PCA Flare Association

Five of the flare associated major PCA events have a confirmed flare importance 3B, and three had importance 2B. The remaining flare associated PCA occurred at the West Limb with confirmed importance 1B. This flare was accompanied by spectral emissions Type II and Type IV with importance 3 over the frequency range 1500 to 400 Mc/s. The spot group probably had a δ type configuration.

All of the flares associated with major PCA events were accompanied by X-ray bursts in the wavelengths 2-12A°, or 8-20A°.

1.1.3 Time of Flare Maximum with Respect to the Time of RF Peak Flux

It was shown in Reference 20 for all non PCA events with flares with importance $\geq$ 3 and all non PCA flares with importance $\leq$ 2+, with RF

peak emissions ≥ 500 flux units, the time of the RF peak preceded the time of flare maximum in 83% of the cases.

Similarly it was shown for all major PCA events, the time of the RF peak f llowed the time of flare maximum in 61% of the cases.

While the number of events in the present analysis is small, it presents very strong evidence that the time relation or rate of increase of flare brightening and RF emission increase has a high probability of differentiating a PCA from a non PCA event during the very early stage of the event.

In the case of the 24 non PCA events of the present study, we find an 87% probability that the time of the RF peak intensity will precede the time of flare maximum. This compares very favorably with the previous study (Reference 20) where 83% of the 125 non PCA events, the time of RF peak intensity preceded the time of flare maximum.

Similarly in the case of the PCA events, the present study shows a probability of 64% that the time of RF peak will follow the time of flare maximum. Again this compares very favorably with the 61% probability of the previous study.

1.2 RECOMMENDATIONS

1.2.1 Analysis of High Resolution Sunspot Photographs

There is strong evidence that a detailed analysis of the growth and configuration changes of large and complex sunspot groups during the first three or four days after they cross the East Limb onto the visible disk may lead to a proton warning period of the order of a day or so. There is also evidence that there may be detectable rapid changes in the

sunspot configuration a few hours before the start of a major flare that may lead to the detection of a flare before the start is observed in the light of Hα , or make it possible to differentiate a PCA flare from a non PCA flare.

An analysis of high resolution reproductions of white light cinematographic pictures of several of the sunspots associated with the events of this study should make a valuable contribution to the early detection of proton events.

1.2.2 Videometer Analysis of Solar Flares

As seen in Table 2, nearly all of the flares associated with the events used in this study were reported with two or more times of flare maximum. In some cases the time differences are several minutes. In spite of these variations it was possible to make reasonable assumptions and compare the time difference of the flare maximum and RF peak. A detailed videometer analysis of the flares was not possible due to the delay in the development of the instrument. Consequently, our conclusions are based on a comparison of the RF time histories, the times of flare maximum, X-ray maximum, and the recorded time of the SWF maximum. There is a good correlation between the rate of increase in flare brightening, and the rate of increase of the RF and X-ray emissions. Additional investigation using the videometer should be carried out.

1.3 GENERAL STATISTICAL SUMMARY

A summary of the 43 major solar activity events for the years 1964 through 1968 used in this study is given in Table 1. We have included all solar activity normally associated with the active region at

the time of the flare, RF emission, or a solar proton stream. In addition, we have included where possible, flare day solar region data: sunspot magnetic class and area, and the Carrington longitude. The first 13 columns are self explanatory, the 14th column gives the time in minutes from reported time or times of flare maximum to the time of RF peak flux where a plus (+) indicates that the RF peak occurred after the flare maximum. Column 15 gives the delay time from the start of the associated flare to the reported onset of the PCA or in the case of satellite detected proton streams, to the start of the increased proton counting rate (E_p > 10 Mev).

A complete summary of the data used in the study is given in Tables 2, 2A, and 2B.

1.3.1 Central Meridian Distance of Major Solar Events

During our study of flare associated major PCA during the 19th solar cycle we found that 81% of the flares occurred after the associated sunspot had been on the visible disk at least 5 days. In the present study of PCA events since 1963 we find that all nine of the major PCA events with a reliable flare association occurred after the region had passed a Central Meridian distance of at least E30, or five days after crossing the East Limb. On the other hand the non PCA related major events gives a random distribution as shown in Table 3.

	E90 to E60	E60 to E30	E30 to CM	CM to W30	W30 to W60	W60
Flare ≥ 3 RF < 500	0	1	1	1	1	0
Flare ≥ 3 RF ≥ 500	1	2	1	0	0	1
Flare < 3 RF > 500	3	4	5	0	1	2

TABLE 3 THE CENTRAL MEREDIAN DISTANCE OF FLARES ASSOCIATED WITH NON PCA EVENTS

1.3.2 PCA Events and Associated Phenomena

The number of flare associated phenomena for the 9 major PCA events for which a reasonably reliable flare association has been found is given in Table 4. While the number of PCA events for the five years under study is statistically small, it follows very closely the distribution found earlier in the study of major PCA events during the 19th solar cycle.

Flare Imp	Flare No.	SWF	II	IV	cm RF	X-ray	All
1	1	1	1	1	?	1	1
2	0	0	0	0	0	0	0
2B	3	3	3	3	3	3	3
3	None						
3B	5	5	4	3	3	5	3
No Region	2						
	11	9	8	7	6	9	7

TABLE 4 ASSOCIATED PHENOMENA FOR MAJOR PCA EVENTS WITH ABSORPTION ≥ 2 db

Similar data are given in Table 5 for the 7 small PCA events or satellite detected proton streams.

In the case of the major PCA events, eight of the nine events have been associated with major flares (importance ≥ 2B) while 5 of the 7 small events have been associated with minor flares.

Flare Imp	No.	SWF	II	IV	cm RF	X-ray
1	2	2	1	2	2	1
2	3	2	2	2	0	2
2B	1	1	0	0	1	1
3B	1	1	1	1	1	1
No Region	1	0				
Total	8	6	4	5	4	5

TABLE 5 ASSOCIATED PHENOMENA FOR SMALL PCA EVENTS OR SATELLITE DETECTED PROTON STREAMS

All 9 of the major PCA events were associated with X-ray flares and all but one are classified as great bursts. This is shown in Table 6 where the major PCA events are listed in chronological order with the RF peak flux. (Peak RF flux for the last two events is not available at this time.) X-ray peak milliergs $(cm^2\ sec)^{-1}$ or the ratio to the quiet sun.

Date	Flare		RF	X-ray	PCA
	Imp	CMD	Peak	Max	db
7-07-66	2B	W48	4730	42 me	2.1
8-28-66	3B	E04	1200	70X	4.0
9-02-66	3B	W58	2100	60X	13
5-23-67	2B	E25	2300 8000	650 me 280 me	11
5-28-67	3B	W33	1540	320 me	3.5
6-09-68	3B	W08	907	18X	2-5
9-29-68	2B	W52	750	490 me	3.4
10-30-68	3B	W37	(1)	128 me	3.9
11-18-68	1B	W89	(1)	250 me	7.5

(1) Only Western Hemisphere RF Data Available at this Time.

TABLE 6 MAXIMUM VALUES FOR THE RF AND X-RAY BURSTS ASSOCIATED WITH THE MAJOR PCA EVENTS

The five small PCA or solar proton events that occurred during periods when space X-ray instrumentation was in operation have been associated with X-ray flares. This is shown in Table 7 where we have also shown the associated peak flux.

Date	Flare		RF Peak	X-ray Max	PCA db
	Imp	CMD			
3-16-64	1+	W73	680	No Obs.	0.3
2-05-65	2	W25	97	No Obs.	1.8
3-24-66	2N	W42	475	Small	1.6
6-05-67	2N	W58	11	5X	1.1
10-29-67	2B	W90	1110	34X	Satellite
7-06-68	1N	E89	940	280 me	Satellite
7-08-68	3B	E59	1630	320 me	Satellite

TABLE 7 MAXIMUM VALUES FOR THE RF AND X-RAY BURSTS ASSOCIATED WITH THE SMALL PCA EVENTS OR SATELLITE OBSERVED PROTON STREAMS

Table 8 summarizes the sunspot classification on flare day for the 9 major PCA events, the 4 small Riometer detected PCA's and the 3 events detected by satellites, but not observed by ground level techniques. As stated earlier all but one of the major PCA events are associated with flares from sunspot groups with a γ or $\beta\gamma$ magnetic classification on flare day, or with a "δ" configuration.

Year	Large PCA Flare Day			Small PCA Flare Day			Satellite Only	
	Mag Class	Area	db	Mag Class	Area	db	Mag Class	Area
1964				(β) (1)	(5)	0.3		
1965				α_P	(5)	1.8		
1966	βγ	805	2.1	(βγ)	464	1.6		
	(4) βγ	271	4.0					
	(4) δ	385	13.0					
1967	δ	1293	11.0	α_P	37	1.1	β_γ	81
	δ	710	3.5					
1968	γ	107	2.5				β_P	E.L.(2)
	β	70	3.4				β_P	944
	(δ)	1014	3.9					
	δ	W.L.(3)	7.5					

(1) Magnetic classification estimated.

(2) Spot group reached a maximum area 1246 millionths.

(3) Spot group maximum area 614 millionths at E28.

(4) These 2 events are associated with the same spot group which had a maximum area 842 millionths.

(5) Sunspot area not available.

TABLE 8 SOLAR PROTON EVENTS, SUNSPOT CLASSIFICATION

1.3.3 Major Events Not Followed by Known PCA or Satellite Proton Events

The 24 major events included in the study that were not followed by a known PCA or satellite proton event are summarized in Table 8 with associated solar phenomena.

Flare Imp	Flare No.	SWF	II	IV	cm RF	X-Ray
1	8	7	7	2	8	5
2	2	2	2	2	2	1
2B	5	4	1	3	5	4
3	4	3	1	1	3	1
3B	5	3	2	2	1	3
Total	24	19	13	10	19	14

TABLE 9 MAJOR EVENTS WITH ASSOCIATED PHENOMENA, NOT FOLLOWED BY KNOWN PCA OR SATELLITE DETECTED PROTON EVENTS

Table 9 shows that only 4 of the flares with importance $\geq$ 3 were accompanied by RF bursts with a peak flux $\geq$ 500 units. In fact, three of these non PCA major flares with major RF bursts occurred in regions that produced one or more PCA events.

As stated earlier, three of the events included in Table 9 may be considered as questionable, one importance 1 flare with a major RF burst, one importance 3 flare and one importance 3B flare with no associated phenomena.

Flare Day Sunspot Magnetic Classification of the Non PCA Events

The flare day magnetic characteristics of the 24 non PCA events is shown in Table 10. This shows essentially the same trend that was found during the analysis of the 19th solar cycle major events. However, the "δ" type spot group classification was not introduced until after the earlier study was completed, consequently no comparison can be made at this time.

The magnetic distribution of the major and small PCA events is given for comparison in the last two lines of Table 10.

Type Major Event	Sunspot Magnetic Class					EL
	α	β	$\beta\gamma$	γ	δ	
Flare $\geq$ 3	3	0	1	0	1	0
RF $\geq$ 500 Units	5	2	2	0	5	1
Flare $\geq$ 3 and RF $\geq$ 500	0	0	3	0	1	0
Total	8	2	6	0	7	1
Major PCA	0	1	2	1	5	0
Small PCA	2	4	1	0	0	0

TABLE 10 SUNSPOT CLASSIFICATION FOR THE 40 MAJOR EVENTS ASSOCIATED WITH A SOLAR REGION

Non PCA Events from Flare Day "δ" Type Spot Groups

During the study of the non PCA events associated with "δ" type spot groups we found that 3 of the events with RF $\geq$ 500 units were from the

multiple event region that crossed the solar disk between 21 October and 4 November 1968. Two of the events occurred before and one after the major PCA on October 30.

The other two events with RF $\geq$ 500 units occurred in the large sunspot group that crossed the solar disk between 21 February and 5 March 1967. We will show later that this region had most of the characteristics of a PCA producing region and a solar proton stream would have been expected.

The major flare - major RF burst event from the "δ" type sunspot group occurred at the West Limb in a region 8461 that had produced two major PCA events. One near the Central Meridian where the spot group was classified as $\beta\delta$, the other at W58 on 2 September 1966. The spot group was classified as a "δ" type during the last six days on the visible disk.

The other non PCA "δ" type spot group was associated with the importance 3B flare on 16 November 1967 occurred in a spot group that crossed the solar disk between 12 and 24 November. This spot group was classified as a "δ" type from the 14th through the 24th (no Mt. Wilson observations 19 through 23 November). Increase in proton flux E_p (0.6-70 Mev) started on the 10th and continued through the 23rd. It is possible that the HF path phase advance which started at 0600 UT on the 12th may have been associated with East Limb activity of this region.

To summarize, we find that 4 of the non PCA events from sunspots "δ" type on flare day occurred in regions that produced major PCA events.

The other 3 non PCA events occurred in regions with other proton producing characteristics.

2.0 MULTIPLE EVENT REGIONS

Nineteen of the 43 major events that we have studied occurred in six solar regions.

Five of the multiple event regions produced 5 of the 11 major PCA events (maximum absorption $\geq$ 2 db) and 3 of the 8 small or satellite detected solar proton streams.

The other multiple event region had a "δ" configuration during most of the days during disk passage, and was the source of two major RF burst but no PCA events were reported.

2.1 MULTIPLE EVENT REGION 8704 WITH 2 MAJOR RF BURSTS BUT NO ASSOCIATED PCA EVENTS

The large complex spot group that crossed the solar disk between 21 February and 5 March 1967, was reported with a "δ" configuration on each of the 9 days between 23 February at E49 and 3 March at W59. The region which was active with surges, loops, and yellow emission lines at East Limb passage, was the return of a region 8760 which produced strong yellow line emissions at West Limb passage. The region was flare productive with 57 flares of importance $\geq$ 1 including 4 importance 2B flares on the 22nd and 23rd February.

Based on previous studies a PCA event would be expected during disk passage.

2.2 THE SOLAR REGION 8207 THAT CROSSED THE SOLAR DISK BETWEEN 15 AND 29 MARCH 1966

This, the first active region (McMath 8207) of the 20th solar cycle crossed the solar disk between March 15 and March 29, 1966 at N19. McMath reports that the region covered more than 30° in longitude. The

leading part of the region is primarily new while the following portion is probably the return of region 8174 that formed on the visible disk approximated three days east of the Central Meridian.

The region was the source of four major events; two major solar bursts associated with flares with importance 3N, one great burst associated with an importance 1N flare, and a small PCA that was observed by Riometers and satellites. The spot group, first seen on March 15 at N21 E82, increased rapidly in configuration and area to a maximum of 907 millionths on March 19, and was classified by Mt. Wilson as γ or $\beta\gamma$ on all days when it was observed. The region was flare productive with at least 17 flares of importance 2 or greater during disk passage.

The first major event was a great burst on the 15th at 3000 Mc/s with a peak of 4850 flux units may be subject to some doubt since both Ottawa at 2800 Mc/s and Sagamore Hill at 2694 Mc/s report peak values very much lower (95 and 365 flux units, respectively).

The next major event occurred on the 19th when an importance 3N flare was accompanied by a major RF burst at 3750 Mc/s when the RF peak flux preceded the flares maximum by at least one minute. This was followed the next day by another importance 3N flare, a major RF burst at 3000 Mc/s and an X-ray burst recorded by OGO-1 (Reference 5). The final event from this region occurred on the 24th at W42 when an importance 2N flare and a moderate RF burst at 3750 Mc/s and a small X-ray burst was followed in about 35 minutes by a small PCA and a large increase in proton counting rate recorded by OGO-1.

The spectral plots of the RF emissions on the 19th, 20th, and 24th are given on Figure 3. This clearly shows the "U" type characteristic that has been found for many of the bursts associated with PCA flare events. Consequently, a proton event should be expected sometime during the disk passage of the region. (References 7, 22, and 23)

2.3 THE TWO SMALL SATELLITES OBSERVED SOLAR PROTON EVENTS ASSOCIATED WITH REGION 9503

The large sunspot group which crossed the solar disk between 6 July and 19 July 1968 was the source of 32 subflares, 11 minor flares, 3 flares importance 2B and the 3B flare on July 8, all classified as confirmed. The importance 1N flare associated with the major RF burst on 6 July (Figure 8) and the importance 3B flare with the great RF burst at 2695 Mc/s and 2800 Mc/s on 8 July (Figure 9) were followed by satellite observed proton events. These flares were also accompanied by great X-ray bursts 2-12A° observed by Explorers 33 and 35.

It is possible that the solar proton event on the 6th might be associated with the 2B flare at 0714 UT in the same region as the importance 1N flare we have chosen based on the major RF burst and Type IV association. Manila reports a narrow profile impulsive burst at 2695 Mc/s with onset at 0716 UT and peak of 422 flux units at 0716.8 UT. The bursts at other frequencies were all very small and no Type II or Type IV were reported. No X-ray burst was observed by Explorers 33 or 35 at the time of the 2B flare.

The sunspot was well developed when first seen by Sacramento Peak at 1438 UT, July 7 and reached maximum area of 1246 millionths on the 9th indicating a potential proton region. In addition, the spectral plot of the major RF emissions on the 6th and 8th had the "U" shape characteristic

associated with many RF proton events. However, none of the other flares from this region are associated with major RF bursts (although complete RF data is not available at this time) and no flares with importance $\geq$ 2B were reported after 9 July when the spot group reached its maximum area and was at E41.

2.4 THE VERY ACTIVE REGION 9740 THAT CROSSED THE SOLAR DISK BETWEEN 21 OCTOBER AND 4 NOVEMBER 1968

This large complex spot group was reported as a $\beta\gamma$ spot 23 through 26 October and with a "δ" configuration 27 October through 2 November with a maximum area of 1014 millionths on 30 October.

This region is the return of 9692 that was the source of an importance 2B flare and great burst at 2695 Mc/s on 28 September. The returning region was the source of at least three major bursts at centimeter wavelengths with great X-ray bursts, and one flare with importance 3B.

This importance 3B flare was followed about 13 hours later by a PCA which reached an absorption of 3.9 db on the Thule Riometers. This proton event was also recorded by the Vela and OGO satellites. The event continued through 2 November with several resurgences due to flares in the region.

The RF bursts on the 27th, 29th and 31 October are shown on Figures 11, 12, and 13. All three of these bursts show strong PCA type characteristics. The spectral plots, Figure 14, show similar characteristics often found with radio noisy regions, however, a clear U shape is not present in the available data. (RF data associated with the 3B flare and associated major PCA are not available at this time.)

2.5 THE MULTIPLE EVENT REGION 8818 THAT CROSSED THE SOLAR DISK BETWEEN 18 MAY AND 1 JUNE 1967

This multiple event region was the source of major RF bursts, on 20 and 21 May. A great RF and X-ray burst on the 23rd associated with a 2B flare followed by the largest PCA absorption since the start of the 20th solar cycle. The final major event from this region occurred on May 28, when an importance 3B flare, major RF burst and a large X-ray emission was followed in about an hour by a PCA event.

A detailed discussion of this region is given in Reference 23 and will not be repeated here.

2.6 THE MULTIPLE EVENT REGION 8461 THAT CROSSED THE SOLAR DISK BETWEEN 23 AUGUST AND 4 SEPTEMBER 1966

This multiple event region was the source of 2 flares with importance 3B, large RF bursts, and X-ray emissions. Both of these flares were followed in less than an hour by major PCA's. The second event was followed in 2 days by an importance 3N flare and major RF burst at the West Limb.

The area of the sunspot group increased slowly to a maximum area of 842 millionths on 31 August then decreased rapidly as it approached the West Limb. A "β" configuration was first reported on 30 August and the configuration probably persisted through 4 September at the West Limb.

2.6.1 The PCA Event 28 August 1966

The RF time history at 2800 Mc/s on 28 August is shown on Figure 5 together with the times of associated phenomena. All but one of the reporting observation give a time of flare maximum following the time of the RF peak flux by 2, 3, 10, and 11 minutes. X-ray data from Explorer 33 give the time of peak emission, 4 minutes after the time of RF peak.

2.6.2 The PCA on 2 September 1966

The second major event started with the importance 3B flare at 0541 on 2 September followed in about 20 minutes by a PCA with the greatest absorption since the event on 12 July 1961. One observatory reported a time of flare maximum 4 minutes before the time of the RF peak. The other reported times of flare maximum were 1, 2, 6, 7, and 16 minutes after the time of the RF peak flux, while the time of the X-ray maximum followed the time of the RF peak by 2 minutes.

2.6.3 The Importance 3N Flare and Major RF Burst on 4 September 1966

This final event associated with Region 8461 started with an importance 3N flare at 0405 UT and the RF burst at 3750 Mc/s starting before 0410. No X-ray emission was reported from Explorer 33. The four observatories that reported the flare gave times of flare maximum 1, 8, 13, and 20 minutes after the reported time of RF peak flux.

3.0 ANALYSIS OF SELECTED ISOLATED MAJOR EVENTS

3.1 THE VERY LARGE SUNSPOT GROUP THAT CROSSED THE SOLAR DISK BETWEEN 27 MARCH AND 9 APRIL 1966

This very large magnetically complex sunspot group was extremely flare productive but produced no flares with importance 2B or greater and only one major RF burst. The RF burst with a peak flux of 1550 units at 2695 Mc/s on 30 March is shown on Figure 2 together with related phenomena and reported times of flare maximum. The 2N flare at N28 E50, also produced a small X-ray burst with the time of maximum coinciding with the RF peak and flare maximum. The sunspot group reached a maximum area of 1323 millionths on 3 April and was classified as γ or $\beta\gamma$ throughout disk passage.

It is felt that a detailed analysis of the sunspot group would be very profitable in the search for clues that may distinguish proton producing region from those that do not.

3.2 THE MAJOR PCA EVENT ON 7 JULY 1966

Svestka (Reference 28) summarized several of the papers that were presented at the 35th IAU Symposium that were devoted to the development of the region and the flare responsible for the proton event on 7 July 1966. The papers presented at the Symposiums will be published in Volume 3 of the IQSY Annals.

The RF time histories at 2400, 2700, and 3750 Mc/s are shown on Figure 4 together with the data for the related phenomena.

The spot group first seen on 30 June at E27, remained very small until 3 July when a rapid increase in area began reaching an area of 682

millionths reported by Sacramento Peak. On the other hand, ESSA, Solnechnyi Dannyi, Rome, and the U.S. Naval Observatory report areas between 800 and 1000 millionths on the 6th increasing to approximately 1300 millionths on the 8th, with a "β" configuration forming on July 4 and July 5 when the spot was at about N34 W15, Carrington Longitude 210.

The proton event on the 7th is associated with an importance 2B flare at N35 W48 starting at 0020 UT, with reported maximums ranging from 0030 to 0052 UT. The onset of the PCA was observed at Shepherds Bay at 0120 reaching a maximum absorption of 2.5 db by 1300 UT. Protons E > 100 Mev were detected at balloon altitude at 0110 UT, while a possible ground level effect may have started at about 0113 UT (Reference 6). The proton event observed by Riometers vertical soundings and VLF propagation had decreased to less than 0.3 db by 2345 UT on 8 July.

Castelli (Reference 7) shows a U shaped spectrum. The sunspot group was relatively quiet during the first six days after it developed on the visible hemisphere with only sub-flares and flares with importance < 2 and very minor radio activity. Except for the very rapid growth starting on the 4th and the development of a "β" configuration, the PCA and small ground level effect on the 7th would have been a complete surprise.

This event is a case where observations of the growth and configuration changes in the spot group lead to a successful warning that an important event might occur. Sawyer (Reference 27) has compared the development and decay of this spot group with the group that produced the PCA events on 28 August and 2 September 1966. A more detailed analysis

of the sunspot configuration changes from a few hours before to a few hours after the flares responsible for the proton events could be very valuable.

3.3 THE IMPORTANCE 3B FLARE 28 JULY 1966

This major flare occurred in a small α_p type sunspot group that was a return of the large spot group which was the source of the PCA flare on July 7 during the previous rotation. The importance 3B flare on 28 July was accompanied by a moderate RF burst at 3750 Mc/s (415 flux units) and a small X-ray burst. Both the flare and the X-ray burst had a slow rise to maximum intensity and a long slow decay while the RF rise time was approximately 4 minutes with the time of the RF peak preceding the time of flare maximum by more than 19 minutes.

3.4 THE SMALL SOLAR PROTON EVENT ON JUNE 6, 1967

Masley and Goedeke (Reference 25) and Hultiquist (Reference 17) associate the PCA on June 6, 1967 with onset at 0620, with an importance 2N flare at 1858 June 5 in the Southern Hemisphere region, 8829 which had crossed the Central Meridian on 13 June. The small α_p sunspot group at Carrington, Longitude 139, has an area of only 37 millionths on the day of the flare. The flare was accompanied by a very small burst at 2695 and 2800 Mc/s a weak X-ray burst, a possible weak SWF and no reported Type II or Type IV spectral emissions.

Neither the region or the flares had the characteristics generally associated with a proton producing region. On the other hand the Northern Hemisphere region 8831 which crossed the Central Meridian on June 4th at N26 contained two small and one large complex sunspot group.

The large spot at Carrington Longitude 111 reached a maximum area greater than 849 millionths on June 4 with a γ magnetic classification. This spot group was classified as γ or $\beta\gamma$ on five of the six days it was observed by Mt. Wilson between E13 and W50. The large spot group was the source of 14 confirmed subflares. None of the flares caused a SWF with importance $\geq$ 2, and only one flare (importance 1N, at 0226, June 3) was accompanied by an RF burst $\geq$ 200 flux units (240 units, at 3750 Mc/s) in the frequency range 2695 to 3750 Mc/s. This was also the only flare with a Type II and Type IV spectral emission.

While neither the Southern or Northern solar hemisphere produced activity generally considered necessary for a solar proton event, it is probable that the northern region was the source of the small proton ($E_p > 10$ Mev) increase detected by Explorer 34, at approximately 0900 on 3 June and the increases recorded for $E_p > 60$, $E_p > 30$, and $E_p > 10$ Mev at about 0700 on June 6. The PCA event on June 6 had a maximum absorption of 1.1 db on the 30 Mc/s Riometers.

This is another case where a detailed analysis of the spot group at N24 could be very profitable.

3.5 THE LARGE COMPLEX SUNSPOT GROUP THAT CROSSED THE SOLAR DISK BETWEEN JULY 23 AND AUGUST 4, 1967 WITH NO MAJOR EVENTS

The plage region 8905 first seen at the East Limb with a large and complex sunspot group on July 21, showed all of the characteristics of an active and probable proton flare region.

An area of 749 millionths and a "δ" configuration was reported on the 23rd and two importance 2B flares were reported at 1621 and 2020 UT on the 24th. These flares were accompanied by very small RF bursts

at centimeter wavelengths. By Central Meridian passage 111 subflares, 37 minor flares were reported in addition to the two importance 2B flares. The sunspot area had increased to 1668 millioths at 1434 UT on the 27th at E11. The spot slowly decreased in area during the next four days but remained relatively flare productive with a "δ" configuration. Importance 2B flares were reported on July 31 and August 1. The flare on the 31st was accompanied by weak RF emissions at centimeter wavelength while a burst at 2800 Mc/s with a peak of 225 flux units at 1731.5 accompanied the 2B flare on the 1st. The peak flux preceded the times of the flare maximum by one to ten minutes based on the four reported times of flare maximum.

Again we have a situation where a detailed analysis of the growth and configuration changes of the spot group should be very valuable.

A summary of flare activity and sunspot changes is given in Table 11. The plage 8905 combined with three smaller plages during passage of the far side of the sun and returned to the East Limb on 18 August as one of the largest plage region of the 20th solar cycle (plage 8942).

3.6 THE VERY LARGE PLAGE REGION THAT CROSSED THE SOLAR DISK BETWEEN AUGUST 18 AND SEPTEMBER 2, 1967

The plage region 8942 was the largest to cross the solar disk since September of 1963, it was a return of four plages that had crossed the solar disk during the previous rotation.

The new plage contained six small spot groups with life times ranging from 4 to 10 days and one large magnetically complex spot group at Carrington Longitude 87. The spot, classified by Mt. Wilson as a $\beta\gamma$ on five days, γ one day and δ type on four days was the return of a large group in plage 8905.

	Flare Importance				MTW16440		SACP 838
Date	1-	1	2	2B	Mag. Type	Area	Type
7-21	13	4	0	0			
7-22	8		1				
7-23	6	1	0	0	δ	749	F
7-24	11	6	0	2	-	1358	E
7-25	17	13	1	0	$\beta\gamma$	1354	E
7-26	24	3	2	0	-	1429	E
7-27	23	5	0	0	δ	1668	F
7-28E	4	1	0	0	δ	1617	F
7-28W	7	0	0	0			
7-29	20	5	0	0	-	1510	F
7-30	10	5	0	0	δ	1297	F
7-31	10	5	0	1	δ	1193	F
8-1	6	2	0	1	δ	848	F
8-2	0	3	0	0	$\rho\delta$	368	F
8-3	5	1	0	0	-	249	F
8-4	1	3				13	A
East West	111 59	33 24	4 0	2 2			
Total	170	57	4	4			

TABLE 11 SUMMARY OF FLARE DATA AND SUNSPOT CHANGES IN THE REGION 8905

The region was extremely flare productive from the time it crossed the East Limb on the 18th. During the first three days most of the flares were reported in the neighborhood of Carrington longitudes 95 and 89 with approximately 35 subflares, 8 minor flares, and one flare with importance 2B at the East Limb. The importance 1N flare at the East Limb on the 18th caused a major RF burst at 2700 and 2800 Mc/s with a large X-ray burst reported by Explorer 33. Slow drift bursts (Type II) were reported from meter to dekameter wavelengths. The flare was reported with maxima ranging from 1958 UT to 2140 UT. Lockheed also reported a flare maximum at 2215 UT, while Haleakala reported an early maximum as a subflare at 1912 UT.

At 1610 UT on 20 August Sacramento Peak reports an importance 2N flare at N20 E64 (L88) from this spot group with an explosive phase at 1611 and partial umbral coverage.

The flare activity continued to increase with both subflares and minor flares concentrated around Carrington Longitudes 87 and 80. Several importance 2B and 1B flares were reported in the large spot group on the 29th and 30th, but none produced associated major events. The complex sunspot group at longitude 87 reached a maximum area of 945 millionths - while the other spot group (L80) remained very small.

3.7 THE MAJOR RF BURST ON OCTOBER 29, 1967

The RF burst on October 29th is associated with an importance 2B at the West Limb in a sunspot group that crossed the East Limb on the 18th at N11 Carrington Longitude 26. The spot group was small at the East Limb and increased in area very slowly until it approached the West Limb when rapid growth started reaching an area of 724 millionths on the

27th, at W54 (Carrington Longitude 32) the importance 2B flare at 2347 UT on the 29th at the West Limb was accompanied by major bursts at 17,000, 9400, and 3750 Mc/s with an impulsive increase to peak flux of 1110 units at 3750 Mc/s. Flare maximum were reported ranging from 2405 to 2415 UT, following the time of RF peak by a minimum of 18 minutes to a maximum of 28 minutes.

An X-ray burst 34 times background was recorded by Explorer 33, starting at 2330, with a complex structure and peak at 2404 UT. A short wave fade with sudden onset at 2342, maximum importance 2 at 2346 UT.

Another major RF burst started at 0046 on the 30th (3750 Mc/s) with a peak flux 540 units at 0115 UT. The region remained very active as it crossed the West Limb with loop prominence and bright yellow line corona emissions and minor limb flares through the 31st.

This region was probably the source of the minor proton event which began at approximately 0750 UT on November 2 when the region was about 30 degrees behind the West Limb of the sun.

3.8 THE MAJOR RF BURST ON 2 JANUARY 1968

This major RF burst reported by the Manila Observatory is associated with an importance 1B flare at the East Limb. Van Allen (Basic Data 2, IER-FB-287) reported a great X-ray burst with the maximum at 0524, approximately one minute after the RF peak and flare maximum. This X-ray burst was the most intense since the May 1967 events. The RF burst time history with times of the other phenomena are shown on Figure 6.

The flare occurred in a large sunspot group that reached a maximum area of 783 millionths on the 6th. The spot was classified as

"δ" type on the 4th, 5th, and 6th. However, the region did not produce any major activity during disk passage.

3.9 THE MAJOR RF BURST AT 2695 Mc/s ON 29 JANUARY 1968

The RF burst associated with an importance 1B flare at N14 E28 was the only outstanding activity from the very large sunspot group that crossed the solar disk between 24 January and 5 February. The spot was classified as a "δ" type on 31 January and $\beta\delta$ on 2, 3, and 4 February. This was the largest sunspot group to date in the 20th solar cycle with a maximum area 2229 millionths on 2 February. A peak flux of 710 units was reported by Sagamore Hill at 2695 Mc/s while Ottawa at 2800 Mc/s and Pennsylvania at 2700 Mc/s, reported lower peaks of 450 and 398 flux units, respectively. A small X-ray burst was observed by Explorers 33 and 35 with the time of maximum approximately 4 minutes after the flare maximum and RF peak.

A detailed analysis of this spot group as well as the group responsible for the major RF burst on 2 January should be carried out.

3.10 THE PROTON EVENT ON 9 JUNE 1968

The small but complex sunspot group that crossed the solar disk between 2 and 13 June 1968 reached a maximum area of only 373 millionths on the 4th. Except for the importance 3B flare and PCA on the 9th, the region was the source of very little activity during disk passage.

The RF time history is shown on Figure 7. Figure 7A show a plot of the hourly average of the proton counting rate from Explorer 34 for proton energies >10 Mev, >30 Mev, and >60 Mev. This shows an extremely sharp rise starting at 1000 UT, 9 June approximately 90 minutes after the start of the flare.

Two of the observatories reported the flare maximum time before the time of the RF peak while 6 observatories gave flare maximum 3, 4, 6, 13, and 14 minutes after the RF peak time.

3.11 THE MAJOR RF BURST ON 28 SEPTEMBER 1968

This major RF burst at 2695 Mc/s with onset at 0747.5 UT, September 28, is associated with an importance 2B flare that started at 0720 with reported times of maximum intensities ranging from 0740 to 0815 and late maximum at 0843 and 0859. No spectral Type II or Type IV was reported. A small X-ray burst was reported by Explorers 33 and 35 with a peak value 13 times the quiet sun with a very slow rise and decline. This event is associated with a small α_p spot group with a maximum area of 309 millionths on the 30th at E37. Neither the spot group or the region activity had any of the characteristics generally associated with a proton producing region.

3.12 THE PCA AND HIGH ENERGY PROTON EVENT ON 29 SEPTEMBER 1968

This proton event has been associated with an importance 2B flare in a sunspot group with a maximum area of 462 millionths on 22 September reported by Sacramento Peak, while the Rome Observatory gives an area of 708 millionths on the 20th. The spot started breaking up into a string of small spots by the 26th and the area had decreased to 70 millionths on the 29th. The RF time history at 2695 Mc/s and 2800 Mc/s is shown on Figure 10 together with the associated solar phenomena. While the first reported time of flare maximum (5 minutes after the start of the flare and X-ray burst) coincides with the time of the RF peak flux, the X-ray burst has a relatively slow rise to peak intensity, one minute

after the second reported time of flare maximum.

The first indication of a proton event came from a balloon flight over Iceland where protons > 100 Mev were reported starting at 1650, less than 40 minutes after the start of the flare. This was followed by an increase in proton flux by OGO-3 at 1700. Alaskan Riometers observed the start of the PCA at 2000 UT with a maximum absorption of 3.4 db at 2140 and recovery at 0400 the next day, while OGO-3 still recorded protons ≥ 20 Mev 3X normal background at 0645 UT.

3.13 THE LARGE POLAR CAP ABSORPTION EVENT ON 18 NOVEMBER 1968

The sunspot group that was the probable source of this PCA event and an increase in the neutron monitor count at Deep River was relatively quiet until it approached the West Limb. The spot group increased rapidly in area to a maximum area of 614 millionth at E28 on 9 November with a fairly constant area through the 13th (data not available 14 through 16 November). Mt. Wilson reports a "β" configuration from the 8th through the 17th.

The increase in neutron monitor count, the proton counting rate by the Vela satellite, and deep space probes Pioneer 8 and 9, started between 20 and 50 minutes after the start of the optical flare. A maximum absorption of 7.5 db reported by the Fort Churchill Riometer at 2000 UT on the 19th with a return to normal approximately 24 hours later. A detailed analysis of this event including the growth of the sunspot region should be very valuable when sufficient data becomes available.

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TABLE 1 SUMMARY MAJOR SOLAR ACTIVITY 1964-1968

Date	Flare	SWF	II	IV	RF	X-Ray	PCA	Plage	Mag Class	Area	Max Area	L	Δt	ΔT
1964														
3/16	1* N05 W75	1/1	Dkm/1 m/3	Dkm/1+ m/1	680* 2800 Mc/s	No Report	RIOM* Satellite 0.3 db	7182	(β)	Not Available		194	+14	$1^h\ 10^m$
1966														
7/29	1 N00 W25	No	Dkm/2	Dkm/1 m/3	97 2800 Mc/s	No Report	Sat.* Mariner 1.8 db	7661	(αp)	96	151 +1	165	+18	$1^h\ 10^m$
1/17	2B N19 E27	No	No	No	980* 3000 Mc/s	No	No	8131 New	δ or βγ	288	323	226	+25 to -13	NA
3/15	1N N20 E75	S/1	m/3 Dkm/2	No	4850* 3000 Mc/s	No	No		αp	133			-1	NA
3/19	3N* N21 E33	S/3	No Syd. Observing	No	845* 3750 Mc/s	No	No		βγ	873	907	146	-1 to -5	NA
3/20	2B, 3N* N21 E16	S/3	No	No	1875* 3000 Mc/s	53 me	No	8207	βγ	816			+1 to -15	NA
3/24	2N N20 W42	S/2+	m/1	m/1	475 3750 Mc/s	Small	RIOM Satellite 1.6 db		βγ	7464			-5 to	$0^h\ 35^m$
3/30	2N N29 E50	S/3	Dkm/3	Dkm/2	1550* 2695 Mc/s	No	No	8223	βγ	767	1323	336	+1 to -5	NA
7/07	2B N35 W48	S/3	m/2	Dkm/3 m/-	4730* 3750 Mc/s	42 me	RIOM 2.1 db	8362	βγ	805	805	209	+8 to +2	$0^h\ 53^m$
7/28	3B* N36 E33	No	Dkm/2	Dkm/2+	415 3750 Mc/s	13X	No	8413 Ret. 8362	αp	102	137	207	-19 to -84	NA
9/28	3B* N22 E04	S/3+	M/3+ Dkm/3	m/3 Dkm/2	1200* 2800 Mc/s	70X	RIOM 4 DB		βγ	271		184	0 to -16	$1^h\ 00^m$
9/02	3B* N22 W58	SL/3	m/2	No	2100* 3750 Mc/s	60X	RIOM 13 db	8461	δ	385	842	183	+4 to	$0^h\ 19^m$
9/04	3N* N20 W90	S/3	m/3	m/w	905* 3750 Mc/s	No	No		δ	110		185	+1 to -20	NA
10/09	3N* N21 E00	No	No	No	35 3000 Mc/s	No	No	8530	βγ	120	162	359	-1 to -5	NA
1967														
1/11	3B* S26 W47	No	No	No	4 3750 Mc/s	No	No	8632	αp	11	Seen 11 to 13 only	244	-79	NA
1/12	1F N16 W90	SL/2	m/2	No	550* 3750 Mc/s	6X	No	8631	αp	61	195 -8	274	?	NA
1/28	No Reasonable Solar Region						16% inc* Neutron 7 db PCA							NA
2/02	No Reasonable Solar Region						2.5*							NA
2/13	3B N21 W10	0/1+	m/3	Dkm/2	50 2800 Mc/s	12X	No	8687	αp	3	Seen 12, 13 only	132	-11 to -21	NA
2/27	2N N27 E02	S/2+	m/3	Dkm/3	560* 2800 Mc/s	31X	No	8704	δ	1390	1387 +1	299	+6 to -24	NA
3/04	1B N24 W68	S/1+	m/2	No	530* 2695 Mc/s	No	No	8704	(δ)	292			0 to -2	NA
3/11	No Reasonable Solar Region						VLF* HF 1.2 db PCA							NA
3/22	3B* N24 E68	S/3	No	No	1100* 1500 2800 Mc/s	13X	No	8740	βγ β	104 60	60 0	288 286	-1	NA

TABLE 1 SUMMARY MAJOR SOLAR ACTIVITY 1964-1968 (CONT'D)

Date	Flare	SWF	I1	IV	RF	X-Ray	PCA	Plagr	Mag Class	Area	Max Area	L	Δt	ΔT
1967 (cont'd)														
5/20	1B N25 E51	S/1	m/3	Dkm/3	730 2800 Mc/s	5X	No		αp	144	208 +2	243	+1 to +7	NA
5/21	2B N24 E39	S/2	m/3	m/3	830* 2800 Mc/s	180 me	No		αp	163	186 +5	244	-2	NA
5/23	2B N30 E25	SL/3 S/3	m/3 Dkm/3	m/3 Dkm/3	2300* 8000 2800 Mc/s	650 me 280 me	11db* Sat.	8818	δ	1293	1381	223	+0 to -4	0h 51m 4h 28m
5/28	3B* N28 W33	S/3	Dkm/2	No	1540* 3750 Mc/s	320 me	3.5 db* Sat. F.S.		δ	710	1381 -4	223	+3 to	1h 15m
6/05	2N S18 W58	-/1	No	No	11 2800 Mc/s	5X Complex Structure	RICM* Sat. (6/06) 1.1 db	8829	αp	37	279 -7	139	+17 to -3	12h 00m
8/18	1N N25 E90	S/2+ SL/2	m/2	No	740* 2800 Mc/s	18X	No	8942	E.L.					
10/29	2B N10 W90	S/2	No	No	1110* 3750 Mc/s	34Y	Satellite	9034	βf	81	724 -2	28	-4 to -28	
11/16	3B* N12 E35	S/2	No	No	26 2700 Mc/s	No	No	9073	δ	687	691 +1	38	-19 to -26	
1968														
1/02	1B S22 E89	S/2	dkm/2	No	1728* 2695 Mc/s	460	No	9145	βf	383	403	91	-2 to -8	NA
1/29	1B N14 E28	S/1+	m/3	No	710* 2695 Mc/s	12X	No	9184	βp	1864	2229	165	0 to -1	NA
6/09	3B* S14 W08	SL/3	No	m/3 dkm/-	907* 2695 Mc/s	18X	RICM Exp. 34 2.5 db	9429	γ	107	373 -5	246		1h 30m
7/06	1N N14 E89	SL/2+	No	m/3	940* 2695 Mc/s	280 me	Exp. 34	9503	βp	EL	1246	159	+5.9 to -7.2	6h 17m
7/08	3B* N13 E59	S/3+	m/3	m/3 dkm/3	1630* 2695 Mc/s	320 me	Small Exp. 34	9503	βp	944			-11 to -21	12h 55m
9/28	2B S18 E38	SL/3	No	No	2350* 2695 Mc/s	13X	No	9692	αp	244	305	178	+12 to -67	NA
9/29	2B N16 W52	S/2	dkm/3	dkm/3	750* 2695 Mc/s	490 me	RICM Sat. 3.4	9678	β	70	462	251	0 to	0h 44m
10/27	1B 2B S17 E16 S18 E18	SL/3 SL/3+	No	m/2 m/3	700* 710* 2695 Mc/s	57 me 88 me	No		δ	829			0 to -35 -1 to -40	
10/29	1N S14 W14	No	No	m/3	3900* 2800 Mc/s			9740 Ret.	δ	719	1014	172	-5 to	1h 35m
10/30	3B* S14 W37	SL/2+	m/2 dkm/2	m/1		128 me	Sat. RICM 10/31 3.9 db	9692	(δ)	1014				13h 21m
10/31	2B S14 W50	SL/1+	No	m/3	890* 2700 Mc/s	79 me	PCA cont. to 11/02		δ	858			-1 to -2	
11/18	1B N21 W89	S/3	dm/3	dm/3	Not Available	250 me	RICM Satellite Pioneer 7.5 db	9760	(δ)	WL	614	345		0h 20m

TABLE 2 MAJOR POLAR EVENTS 1964 - 1968, BASIC DATA

		FLARE DATA					SWF	II	IV	X-RAY
Type of Major Activity	Date	Start	Max / Imp		Duration	Position	Start/Max Type/Imp/Dura.	Onset/Obs. Durat/Imp. Freq Range	Onset/Obs. Durat/Imp. Range	Onset/Max/QX/M-ergs
	1964									
Major RF event 3000 Mc/s small proton event.	3/16	1553	1600 OTTA 1+ 1608 HUAN 1+ 1608 CLMX 1 1611 MCMA 2 1645 MCMA 2 HAUT 1 MERA 2+ UCCL H	1+	102	N05 W73	1556/1625 SL/3/94	1557.5/B 30/1 21-41 1557.7/M 10.3/3 220- 50	1604.5/B 77.5/1+ 20-41 1605/M 3/1 320-180	
	1965									
Small polar cap absorption.	2/05	1750	1806 SACP 2 1810 MCMA 2+ 1810 CLMX 2	2	134	N08 W25		1800/2 17/2 14-41	1800/M 100/3 320-100 1810/B 55/1 22-41	
	1966									
Major RF burst at 3000 Mc/s reported by HOH and MED.	1-17	1029	1045 CATA 1B 1109 ATHN 2B 1113 WEND 3B 1123 ONDR 2F -- KANZ 2B -- MEUD 2 -- HUAN 1F	2B	141	N19 E27	None Rep. A spectral diagram for this event based on 19 single frequency bursts 23 Mc/s to 9500 Mc/s shown Fig. (Inf. Bul. No. 20)	No Obs.	No Obs.	None Reported.
Large RF burst reported by MED at 3000 Mc/s peak flux may be questionable but region very active and the source of the next three events.	3-15	1636	1638 HUAN 1N 1638 OTTA 2B 1638 CLMX SN 1638 MCMA 1B 1653 HALF SN 1712 SACP 3F	1N	60	N23 E75	1638/1642 S/1/17	1640/M 3.5/3 310-110 1647/B 5/2 31-41	None Rep.	None Reported. Probably no observations.
Large RF burst 3750 Mc/s importance 3N flare.	3-19	0337	0344 SIBE 2N 0347 KODA 3B 0348 HANT 3N 0348 CULO 4B	3N	110	N21 231	0340/0357 S/3/35	None Rep. Sydney Obs.		None Reported. Probably no observations
Large RF burst 3000 Mc/s.	3-20	0924	0955 ATHN 2B 0957 ARCE 3B 0957 CATA 2B 0958 ONDR 2N 1000 KIEV 3B 1003 LOCA 3N 1011 WEND 3B -- MERA 3 KANZ 2B	3N	158	N21 E16	0955/1002 S/3/25	No Obs.	No Obs.	0952/0957/-/530
Small PCA 1.6 db Onset 0300 UT. Also observed by OGO and Imp satellites	3-24	0125	0236 KODA 2N 0238 MITK 2B 0242 MANI 3B -- VORO 2F	2N	109	N20 W42	0225/0235 S/2+/30	0234/CULO 19/1 70-250	0030/CULO 293/1 70-250	0228/0238/-/48
Major RF burst at 2700 Mc/s (SCMR)	3-30	1241	1249 HUAN 2N 1250 MONT 1B 1252 ATHN 2B 1255 HUAN . 1327 HERS 1N 1333 SACP 2N 1340 LOCA 1N	2N	106	N28 E50	1245/1253 S/3/50	1253/BOUL 8/3 19-41	1307/BOUL 103/3 19-41	No observations.
PCA event and great burst at 3750, 2700 and 2400 Mc/s.	7-07	0020	0030 HALE 3B 0036 LOCK 2N 0041 MANI 2B 0043 SACP 2B 0047 IKOM 2B 0052 CULO 2B	2B	139	N35 W46	0025/0026 S/3/184	0038/CULO 36/2 10-250	0053/BOUL 70/3 20-41 0042/CULO 78/- 10-250	0025/0042/28/42
Flare importance B.	7-28	2213	2240 MCMA 3B 2305 SACP 3B 2310 MANI 3B 2325 MCMA 3B 2332 HALE 2B 2345 IKOM 2B	3B	156	N36 E33	None Rep.	2338/BOUL 13/2 20-29	2330/BOUL 100/2+ 19-41	2215/2324/13/- Long decay
Major RF burst at CM wavelength.	8-20	1522	1527 ATHN 2B 1529 MCMA 3B 1530 LOCA 2B 1530 LOCK 2B 1530 LOCY 2B 1537 SACP 3F 1538 WEND 4B	3B	278	N22 E04	1524/1530 S/3+/96	1531/HARV 17/3+ 150- 25 1530/BOUL 27/3 14-11	1527/HARV 13/3 320- 50 1547/BOUL 122/2+,2 41-21-11	1522/1531/70/-
Flare importance 3B, great burst at 3000 and 3750 Mc/s.	9-02	0341	0551 TACH 3N 0557 MANI 2B 0558 ABST 3B 0602 CAPS 3B 0603 CATA 3B 0611 CULO BB	3B	255	N22 W58	0535/0543 SL/3/135	0554.5/SYD 19.5/2 250-10	None Rep.	0546/0558/601-
Flare importance 3B, and major burst at 3750 Mc/s.	9-04	0405	0419 MANI 3B 0426 HALE 0431 TACH 2F 0438 CULO 1N	3N	74	N20 W90	04[illegible]/0412 S/3/129	0413.0/SYD 28/3 250-10	0413.5/SYD 44.5/Weak 250-10	None Reported Explorer 33.
Importance 3N flare.	10-09	1045	1101 KIEV 3N 1102 WEND 3N 1105 CATA 2B CAPS 3N ARCE 2B ONDR 1F ATHN 2N KHAR 1N	3N	90	N21 E00	None Rep.	No Obs.	No Obs.	No Report.
	(1) 1967									
Small PCA with max. absorption [illegible]th onset at 0620 UT on 6 June.	6/05	1839	1844 SACP -1 1933 HONS 2N 1937 MCMA 2B 1938 LOCK 2F 1939 SACP 2B -- HUAN 2N	2N	118	S18 W58	1857/- -/1/25	None Rep.	None Rep.	1839/1945/5X/- Complex Structure.
Large RF Burst at 2800 and 2700 Mc/s.	8/18	1902	1912 HALE -N 1958 LOCK 2N 1958 MCMA -N			N24 E89	1958/2021 0/2+/61			
		2002	2026 HALE 1N 2027 SACP 1N 2056 HALE 1N 2100 LOCK 2N 2105 SACP 1N	1N	243	N25 E86		2130/HARV 21/2 2133/CULO 7.5/1 30-300	None Rep.	
		2131	2136 SACP -N 2135 MCMA 1B 2140 LOCK 2N 2215 LOCK 2N			N25 E91	2120/2131 SL/2-/120	2136/BOUL 23.2/2 28-41		2120/2133/18/-

(1) Detail Data For Major Events Jan thru May 1967. Given in MSD Report : CO.1145

TABLE 2A RF ACTIVITY ASSOCIATED WITH EVENTS TABLE

1966	f	Obs.	Start	Peak	Dura. Min.	Peak Flux	Δ ϕ Min.
1-17	3000	HHID	1010	1110	270	980	+25 to -13
		NEDH	1032	1111	175	918	
3-15	3000	NEDH	1636.5	1637.1	3.5	4850	-1
	2800	OTTA	1636.5	1637.4	3	95	
	2694	SGMR	1636.3	1637	32	365	
3-19	3750	NAGO	0338	0342.8	20	845	-1.2 to -5.2
3-20	3000	NEDH	0952.7	0955.8	17	1875	+0.8 to -15.2
3-24	3750	NAGO	0226	0230.7	14	475	-5.3 to -11.3
3-30	2800	OTTA	1248	1250	>70	500	+1 to -5
	2695	SGMR	1245	1249.9	25.25	1550	
	2690	PENN	1244.3	1247.5	179.5	Great Burst	
	3750	NAGO	0026	0037.5	33	4730	+7.5 to -14
	2700	OTTA	0025.9	0037.8	33.5	2650	
	2400	HOUS	0025.5	0037.5	33.5	3420	
7-07	3750	NAGO	0059	0102.4	14	770	
	2700	OTTA	0059.5	0103	13	680	
	2400	HOUS	0059	0102	Sunset	1200	
	3750	NAGO	0113	0129.3	36	815	
	2700	OTTA	0112	0120	37	770	
	2400	HOUS	Sunset				
7-28	3750	NAGO	2214	2221.1	150	415	-19 to -84
	2800	OTTA	2214	2218	105	135	
8-28	3000	NEDH	1521.4	1526	59	1000	0 to -16
	2800	OTTA	1522	1527	53	1200	
	2700	PENN	1521.4	1527.1	108.7	608	
	2695	SGMR	1521.8	1526.8	95.2	965	
9-02	3750	NAGO	0544	0556	46	2100	+4 to -16
	3000	NEDH	0545.5	0555	115	2300	
9-04	3750	NAGO	~0410	0417.5	>17	905	-1.5 to -20.5
10-09	3000	NEDH	1045	1059.6	18	35	-1.4 to -5.4
1967							
1-05	2800	OTTA	1840	1841	2	7	-3
	2800	OTTA	1915	1950	195	11	
	2695	SGMR	1917.7	1941.5	121	13	
8-18	2800	OTTA	2120	2129	16	740	-7 to -11
	2700	PENN	2119.3	2129	12.6	575	
	2695	SGMR	2125	2125.9	6.5	90	

TABLE 2 MAJOR SOLAR EVENTS 1964 - 1968, BASIC DATA (CONT'D)

Type of Major Activity	Date 1967 (Con't)	Start	FLARE DATA: Max	Obs	Imp	Duration	Position	SWF: Start/Max Type/Imp/Dura.	II: Onset/Obs. Durat/Imp. Freq.Range	IV: Onset/Obs. Durat/Imp. Range	X-RAY: Onset/Max/QX/M-ergs
Large RF burst at 3750 Mc/s.	10/29	2346	2351	LOCK	2B			2342/2346 S/2/86	None Rep.	None rep.	2330/2344/ju/-. Complex structure.
			2405	CRON	-N						
			2410	CRON	-N	69	N10 W90				
			2412	HALE	2B						
			2415	LOCK	2B						
Flare importance 3B	11/16	2124	2143	HALE	3B			2137/2150 S/2-/3B	None Rep. CULG Observing	None Rep.	None Reported.
			2144	BOUL	3B						
			2144	HOUS	2B	114	N12 W35				
			2202	BOUL	3B						
			2202	HOUS	2B						
Major RF burst at 2695 Mc/s large X-ray burst.	1968 1-02	0515	0523	CRON	1B			0521/0522 S/2/51	0521/CULG 15/2 30-10 Mc/s	None Rep.	0520/0524/100/460 Explorer 33,35
				CULG	1N						
			0531	ABST	1B	29	S22 E89				
				MANI	2B						
				TACH	1N						
Major RF burst at 2675 Mc/s.	1-29	1537	1539	CANR	1N			1538/1544 S/1+/21	1540/HARV 7/3 300-30	None Rep.	1537/1543/12/- Explorer 33,35
				JURI	2B						
			1540	HUAN	1B	21	N14 E28				
		1531	1532	CANR	1-						
			1542	HTFR	1B	29	N14 E12				
Flare importance 3B, increased proton count by Explorer 34, and PCA absorption at Alaskan Stations.	6-09	0830	0848	ISTA	2B			0840/1000 S1/3/?	None Rep.	0839/WEIS 61/3 580-300	0834/0901/18X/-
			0850	MANI	2N						
			0854	CROM	3B					0900/SGMR 10.3/- 30-10	
			0855	HTFR	3B						
			0855	MONT	3B	170	S14 W08				
			0857	CATA	4B						
			0904	LUCA	2B						
			0905	KHAR	4N						
				UCCL	4B						
Major burst at 2695 Mc/s and great X-ray burst Explorer 33, 35. Solar protons >10 Mev Explorer 34.	7-06	0943	0944	CANR	-N			0948/1010 S1/2+/32	None Rep.	0944.6/WEIS 19.4/3 580-300	0941/0950/120X/280
			0946								
			0954	ARCE	2F	87	N14 E89				
			0955	CATA	1B						
			0957	CANR	1B						
			0957	CAPS	2B						
Importance 3B flare, great RF burst 2695, 2700, 2800 Mc/s. Great X-ray burst.	7-08	1705	1723	HALE	3B			1706/1710 S/3+/205	1710/HARV 22/3 580-10	1708.6/WEIS 36.4/3 300-30	1708/1721/150X/320
			1725	MCMA	3B						
			1725	CANR	3N	220	N13 E59				
			1727	BOUL	3B						
			1728	HOUT	3B						
			1733	WEND	3B						
									1708.6/WEIS 36.4/3 300-30	1730/HARV 16/3 580-30	
									Also dkn BOUL and SGMR		
Major RF burst at 2695 Mc/s	9-28	0720	0740	CRON	2B			0735/0830 SL/3/150	None Rep., WEIS Observing 0640 to 1715 UT		0718/0829/13/- Very slow rise and decline.
			0753	TACH	2N						
			0800	CANR	1N						
			0804	ABST	3B						
			0805	TACH	2N	195	S18 E38				
			0806	ONLR	2N						
			0812	CRON	2B						
			0815	CATA	2B						
			0843	CAPE	2B						
			0859	MONT	2B						
			0740	CRON	2B						
Major RF burst 2800, 2700, and 2695, PCA and Satellite solar protons.	9-29	1616	1621	HUAN	2B			1619/1621 S/2/59	1626/SGMR 10/- 10-30	1636.2/BOUL 13.8/3 10-300	1619/-/-/490 Explorer 37, 8-20A°. Event lasted 12 minutes, time of max. not given.
			1623	HOUT	2B						
			1623	SACP	2B	96	N16 W52				
			--	MCMA	2B						
			--	HALE	2B						
			1626	CANR	1N				1626.6/BOUL 10/3 10-300		1616/1624/22/- Explorer 33, 35. C-42A°
Major RF burst at 2695 and 2800 Mc/s.	10-27	1232	1236	CRIM	2B			1236/1241 S/3/-	None Rep.	1307/WEIS 147/2 300-580	1234/1243/24/57
			1236	CANR	-N						
			1237	HTFR	1B						
			1238	ABST	1B						
			1239	CATA	2B	208	S17 E16	1235/1335 SL/3+/190		1312/BOUL 219/3 30-300	1307/1341/34/88 Slow rise, slow decline.
			1251	CANR	-N						
			1255	CATA	-B						
			1303	CANR	-N						
			1311	CRIM	2B						
		1240	1321	CANR	2N			1235/1335 SL/3+/190		1330/HARV 300/3 30-580	
			1323	HTFR	2N						
			1327	WEND	3B	180	S18 E18				
			1340	SACP	2B						
			1400	CATA	2B						
Great burst 2695, 2800 Mc/s.	10-29	1515 1558	1521	SACP	-N			None Rep.	None Rep.	1515.7/WEIS 23.3/3 580-300	
			1603	BOUL	1N	73	S14 W14				
			1605	SACP	1N					1516/HARV 31/3 580-300	
										1516/HARV 22/3 300-30	
Importance 3B flare PCA and solar protons.	10-30	2339	2356	HALE	3B			2353/2355 SL/2+/198	2359/CULG 6/2 30-300	2402.5/CULG 32.5/1 300-30	2341/2417/42/128
			2412	MANI	3B						
			2413	MITN	3B		S14 W37		2400/CULG 5/2 10-30		
Major RF burst 2700 Mc/s.	10-31	2229	2244	[illegible]				2246/2317 SL/1+/31		2247/HARV 28/2 580-300	2236/2308/22/79
			2302	HALE	3B		S14 W50				
			2303	MONT	3B					2247/HARV 20/3 300-30	
Solar protons and PCA event.	11-18	1027	1030	CATA	1B			1026.5/WEIS 38.5/3 400-1500	1026.5/WEIS 23.5/3 400-1500		1026/1057/110/250
			1035	MONT	1B	N21 W89	1028/1029 S/3/86				

TABLE 2A RF ACTIVITY ASSOCIATED WITH EVENTS TABLE (cont'd)

1967 (cont'd)	f	Obs.	Start	Peak	Dura. Min.	Peak Flux	Δ t Min.
10-29	3750	NAGO	2343	2346.6	35	1110	-4.4 to -28.4
	3750	NAGO	2446	2515	190	540	
11-16	2700	PENT.	2134	2134.2	10	26	-8.8
1968							
1-02	2695	MANI	0521.4	0522.7	15.6	1728	0 to -8
1-29	2800	OTTA	1537	1539	5	450	0 to -1
	2700	PENN	1536.3	1538.8	4.3	398	
	2695	SGMR	1537.9	1538.8	7.9	710	
6-09	2695	MANI	0839.7	0851.4	30	907	+3 to -13
7-06	2695	SGMR	0942.8	0949.8	25.5	860	+5.8 to -7.2
		MANI	0941.5	0944.9	12.5	940	
7-08	2800	OTTA	1704	1712	43	1380	-11 to -21
	2700	PENN	1705.6	1712.2	32.2	990	
	2695	SGMR	1702-5	1712	46.5	1630	
9-28	2695	MANI	0747.5	0751.5	12.5	2350	+12 to -67
9-29	2800	OTTA	1616	1621	34	580	0 to -2.5
	2700	PENN	1615.2	1620.6	17.2	445	
	2695	SGMR	1615.9	1620.5	26.1	750	
10-27	2800	OTTA	1232	1236	20	570	+4
	2695	SGMR	1231.6	1236	23.4	700	
	2800	OTTA	1306.0	1319.5	25	610	+40
	2695	SGMR	1306.2	1318.8	28.8	710	
10-29	2800	OTTA	1515.7	1523	80	3900	+2
	2700	PENN	1515.8	--	60.8	819	
	2695	SGMR	1515.9	1519.2	37.4	6040	
10-30	Data Not Available						
10-31	2700	PENT	2247	2252	10	570	+8
			2257	2301	18	890	-2
11-18	Data Not Available						

TABLE 28 BASIC SOLAR REGION DATA

	SOLAR PROTONS	FLARE DAY PLAGE				FLARE DAY SUNSPOT DATA									
Date 1966		McM.	Area	Position	CMP	MtW	Max Type	Position	SACP	Area	No Spots	Type	Position	Long	Remarks
1-17	None Reported.	8131 New	3500	N18 E28	1/19.7	15985	No observations Jan. 15-20 Classified γ on 1/14 $\beta\gamma$ on 1/21		222	288	36	E	N19 E28	226	Reported max. sunspot area 323 millionths at 2323 Jan. 17
3-15	None Reported.	8207 This is the return of 8174.	5200	N20 E80	3/22.1	16000	αp	N19 E76	237	133	1	H	N21 E73	146	The spot group reached a minimum area 907 millionths on March 17. Classified as a γ or $\beta\gamma$ by Mt. Wilson on the days observed (except 3/15).
3-19	None Reported.	8207	9300	N19 E55	3/22.1	16000	No observations at Mt. Wilson. Probably $\beta\gamma$		237	873	55	F	N18 E27	146	Only one other spot observed on the sun (area 10, at N28 W50).
3-20		8207	8400	N20 E21	3/22.1	16000	$\beta\gamma$	N18 E11	237	816	56	F	N17 E11	147	
3-24	Observed by OGO-1 Onset 0250 UT. PCA reported onset 0300 UT.	8207	8700	N20 W36	3/22.1	16000	No observations.		237	464 No Sec.P observations on March 24 or 25.	7	G	N17 W40	148	Spot probably γ or $\beta\gamma$
3-30	None Reported.	8223	4300	N25 E52	4/3.8	16004	$\beta\gamma$	N26 E50	241	767	20	F	N27 E47	336	Spot max. area 4/03/1530. 1323 millionths, γ or $\beta\gamma$ throughout disk passage.
7-07	PCA Reported.	8362	3200	N32 W54	7/3.4	16067	$\beta\gamma$	N34 W45	316	805	36	F	N35 W47	209	Spot born on the disk at E35. Growth very low until the 4th.
7-28	None Reported.	8413 This is a return of region 8362.	3900	N33 E37	7/31.9	16091 Mt. W. reports αp at 0015 UT 7/29		N34 E26	355	102	3	J	N35 E26	207	This small sunspot group reached a maximum area of 137 millionths at 2335 two days after the flare. The flare occurred approximately 7° east of the J type spot.
8-28	Riometer 4 db.	8461	3000	N22 E09	8/29.1	16114	$\beta\gamma$	N22 E02	386	271	41	D	N23 E02	184	Spot group max. area 842 millionths at 1410 UT 8/31.
9-02	Riometer 13 db.	8461	3100	N23 W60	8/29.1	16114 δ (probably) No Mt. W. obs. reported 8/30, through 9/04.			386	385	23	E	N22 W58	183	
9-04	None Reported.	8461	2000	N24 W84	8/29.1	16114	δ	WL	386	110	8	D	N21 W85	185	
10-09	None Reported.	8530	6400	N21 W05	10/2.4	16143	$\beta\gamma$	N20 W05	420	126	17	C	N22 W03	359	This small sunspot group reached a maximum area 162 on Oct. 5.
1967	(1)														
6-05	Small PCA reported 6/06 by Hultquist. Max absorption 1.1 reported Nasley & Goedeke.	8829	2200	3.5 N20 E03	6/01.3	16384	αp	S19 W55	762	37	2	J	S21 W58	139	Maximum area 279 at 0012, May 30.
8-18	None Reported.	8942	3200	.0 N20 E03	8/26	16466 Spot magnetically complex, δ type 23rd, 25th-28th, $\beta\gamma$ 28th through 31st.	No Obs. 8/18		880	East Limb 8/18			N24 E90	87	Plage is a return of 4 plages that grew together during passage of the far side of the sun. The spot is the return of the very large spot (16440) that crossed the disk between July 23 and Aug. 4. Reached a maximum area 1668 millionths on July 27 at N28 E11.
10-29	Protons >10 Mev observed Explorer 34 ~ 0600 10/30.	9034	4000	3.5 N12 W73	10/24.1	16529	$\beta\gamma$	N11 W38	981	81	3	D	N04 W82	28	Sunspot reached maximum area 724 millionths Oct. 27. Classified δ type Oct. 26.
11-16	Pioneer VII reported increased fluxes 0.6 to 70 Mev starting at 2123. HF phase advance started 0600 on Nov. 12.	9073	7100	3.0 N15 E30	11/19.9	16557	δ	N10 E31	1020	687	36	G	N10 E34	38	Increased flux Explorer 34 >10 Mev started on the 11th, continued through 23rd.

(1) Detail Data For Major Events Jan thru May 1967. Given in ESD Report 00.1145

TABLE 28 BASIC SOLAR REGION DATA (CONT'D)

	SOLAR PROTONS	FLARE DAY PLAGE				FLARE DAY SUNSPOT DATA									
Date 1958		McM.	Area	Bright Post	CMP	MtW	Mag Type	Position	SACP	Area	No Spots	Type	Position	Long	Remarks
1-02	No proton increase reported by Explorer 34.	9145	E.L.	-- S20 E83	1/9.4	16640	βx	S24 E87	1008	383	7	D	S22 E88	91	No observations by Mt. W. or Sac.P. on the 2nd. Position given on the 3rd corrected to flare time, other values from reports for the 3rd. Spot given δ classification on 4th-6th. Max. area reported Sac.P.,783 millionths at 1745 UT on the 6th.
1-29	No proton increase reported by Explorer 34.	9184	Not available.	N14 E20	1/31.0	16670	βp	N12 E14	1120	1864	39	F	N13 E12	165	No sunspot observations at Sac.P. on Jan 27-29. Position corrected from Jan. 30 data. Other data based on observations at Rome, Italy Monthly Bulletin 122. Mt.W. reports a β configuration on Jan. 31. This is the largest sunspot group so far this 20th cycle.
2-09	Riometer onset 1000, Max 2100 UT 2db Paxson 2db College 5db Ft. Yukon Explorer 34 onset >1000 UT >30 Mev max. 1400 >30 Mev max. 1400 >10 Mev max. 0600 June 10	9429	3200	3.0	6/9.0	16847	γ	S13 W08	1324	107	11	D	S14 W07	246	This small but complex sunspot group had an area of 176 millionths on the 6th. No Sac.P. observation on the 7th or 8th, Rome gives a max. area of 373 on the 4th and an area of 271 on the 6th (Rome No. 5070). Except for the importance 3B flare on the 9th. The region produced only 18 minor and subflares and only 31 small or unconfirmed flares.
7-08	Solar protons 10 Mev started to arrive at Exp. 34 by 1600 UT Protons 60 Mev by 1500 UT.	9503	4000	3.5 N10 E81	7/13.0	16878 16877	βp αp	N13 E89 N08 E84	1368	East Limb				159	Sac.P. sunspot group includes the two Mt.W. spots 16878 and 16877. The flare occurs in sunspot 16878, the corresponding Rome group numbers are 5103 and 5102, respectively.
7-08	A second increase in counting rate. Ep > 10 Mev starts 0600 7/09. Peak ~ 0000, 7/11	9503	7000	3.5 N11 E58	7/13.0	16878 16877	βp βp	N13 E55 N11 E52	1368	944	26	F	N12 E57	158	Sunspot max. area reported Sac.P. 1206 millionths at 1424 UT July 09. The Rome combined area on 7/08 at 0630 UT is 1326 millionths which is also the reported maximum. The combined total area on 7/09 at 0629 UT is 1252. In good agreement with the Sac.P. area.
9-28	None Reported.	9692	3200	2.5 S15 E35	10/1.1	17000	αp	S17 E34	1525	244	8	H	S15 E37	178	Sunspot maximum area 309 millionths, Sept. 30.
9-29	Protons >100 Mev observed by balloon, Iceland. Start increase 000-3 at 1700. Alaska riometers 2000 UT Max. Shepherd's Bay 1.7 db at 2100 Max. Alaska 3.4 db at 2140 UT	9678	4300	3.5 N17 W51	9/25.7	16992	β	N16 W45	1507	70	9	D	N17 W55	251	Sac.P. reports a maximum area of 462 millionths on Sep. 22 at 1452 UT. The spot group started breaking up by 1450 UT on the 27th. On the other hand Rome (No. 5197) reports an area of 708 millionths on the 20th, breaking up into a group of small spots by the 26th.
10-27	News Reported.		7800	S15 E11			δ	S16 E14		829	25	H	S15 E15		Spot group $\beta\delta$ 23-26, δ 23 Oct. Through Nov. 2.
10-29	None Reported		7700	4.0 S15 W16			δ	S16 W14		719	60	H	S15 W12		
10-30	PCA 3.9 db max. Thule between 1500 and 1600 Oct. 31, increase in protons Vela and 000-3. PCA continued through 2000 Nov. 02.	9740 Return of 9692	7000	4.0 S15 W32	10/28.4	17033	No Mt.W. data probably δ		1568	1014	40	H	S15 W29	172	
10-31	PCA that started at 1300 UT continued Nov. 02 with several resurgences due to flares in the region 9740.		6500	3.5			δ	S16 W44		858	43	D	S15 W43		
11-18	PCA onset 1050 max. 7.5 db Ft. Churchill at 2000 UT Nov. 19. Observed Vela, Pioneer and 000-3.	9760	1000	3.5 N19 W86	11/11.5	17045	Sunspot behind the West limb. δ type 8-17th.		1588	Spot behind the West Limb. Area 345 at 1554 Nov. 17 Type H.				345	Maximum reported area 614 at 1601 UT Nov. 9 area nearly constant through 13th. No area available 14-16th.

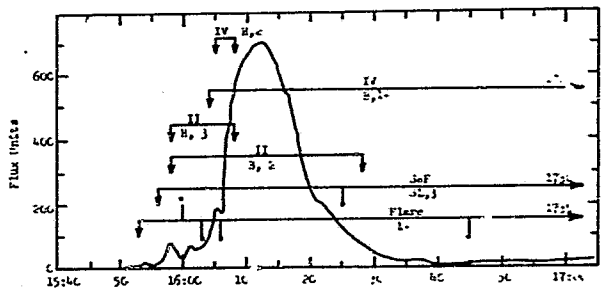

FIGURE 1 RF BURST 2600 Mc/s 15 MARCH 1966 WITH RELATED SOLAR PHENOMENA

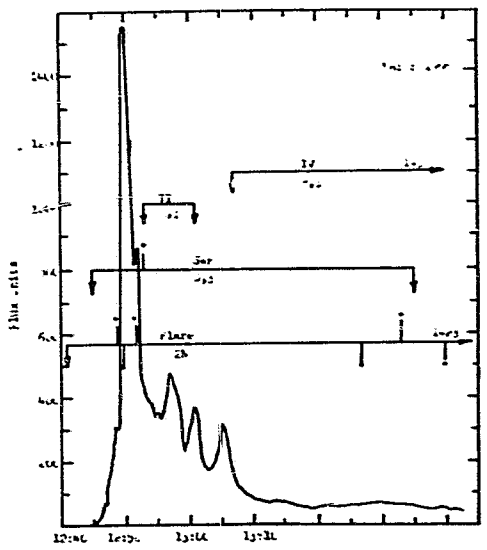

FIGURE 2 RF BURST 2695 Mc/s, 30 MARCH 1966 WITH RELATED SOLAR PHENOMENA

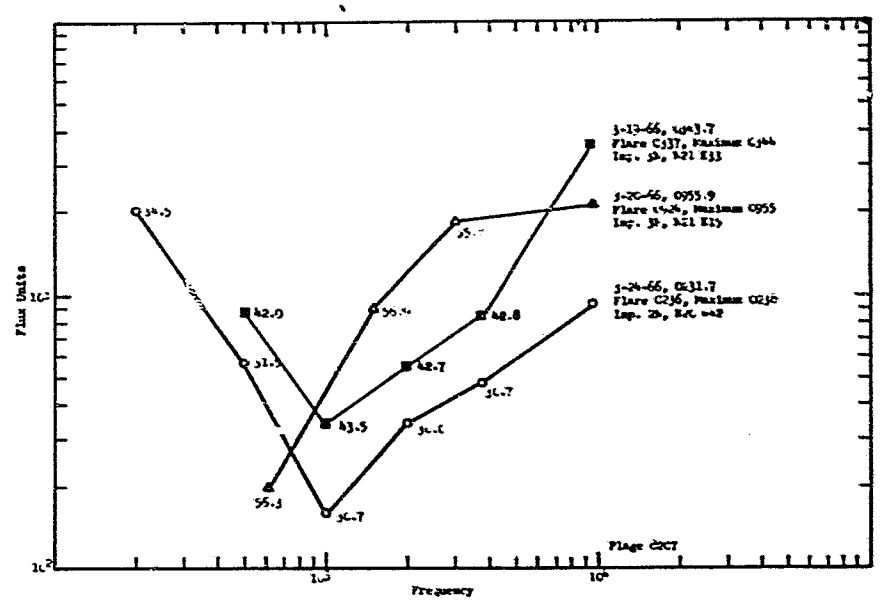

FIGURE 3 SPECTRAL CHARACTERISTICS RF BURSTS ON 19, 20, AND 24 MARCH 1966, FLARES IN PLAGE 5907

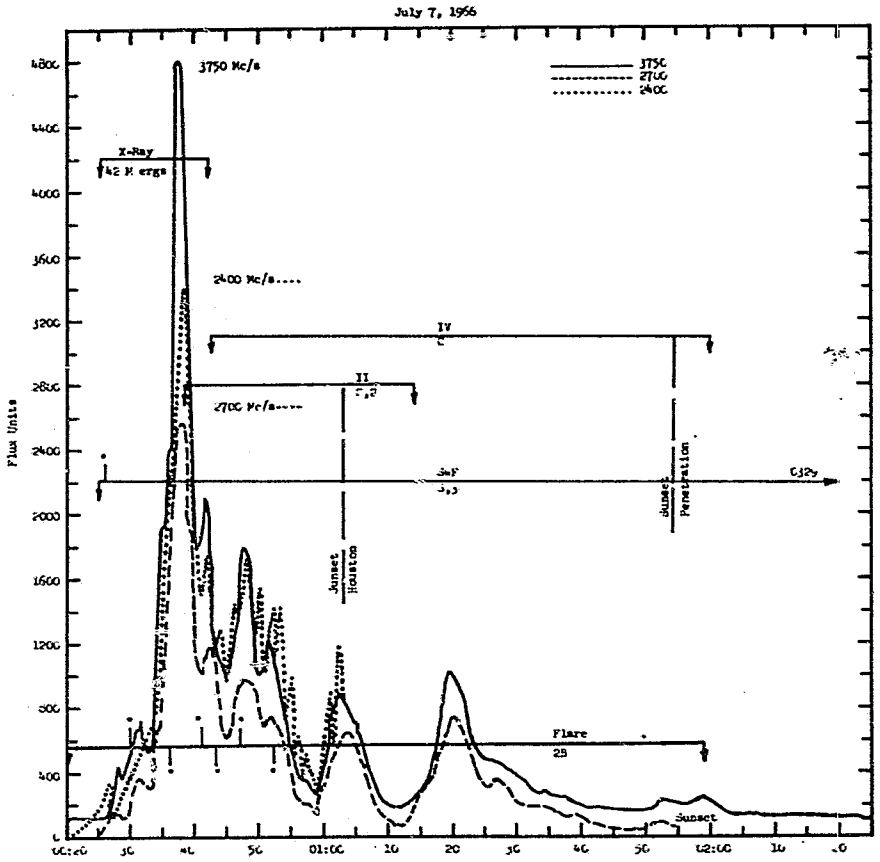

FIGURE 4 RF BURSTS 2400 Mc/s (HOUSTON) 2700 Mc/s (PENTICTON) AND 3750 Mc/s (NAGOYA) 7 JULY 1966, WITH RELATED SOLAR PHENOMENA

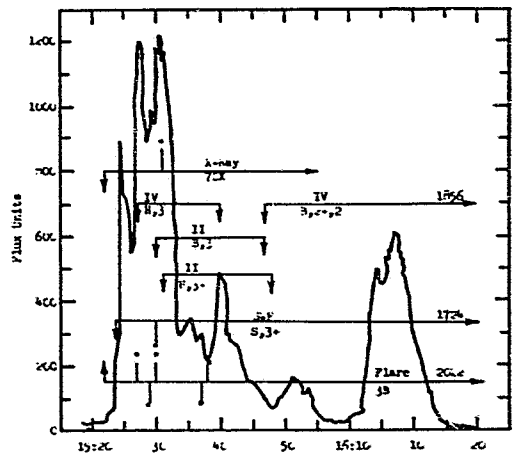

FIGURE 5 RF BURST 2800 Mc/s 26 AUGUST 1966 WITH RELATED SOLAR PHENOMENA

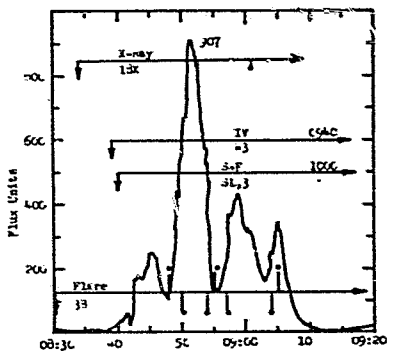

FIGURE 7 RF BURST 2695 Mc/s (MAUNA OBSERVATORY) 9 JUNE 1966, WITH RELATED SOLAR PHENOMENA

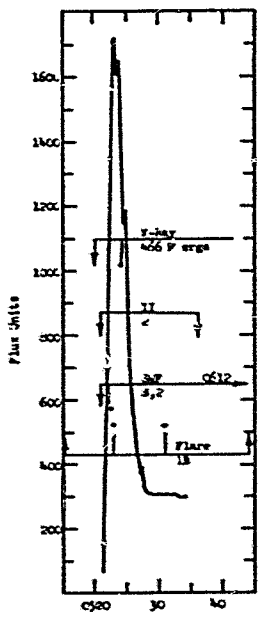

FIGURE 6 RF BURST 2695 Mc/s (MAUNA) 2 JANUARY 1968, WITH RELATED SOLAR PHENOMENA

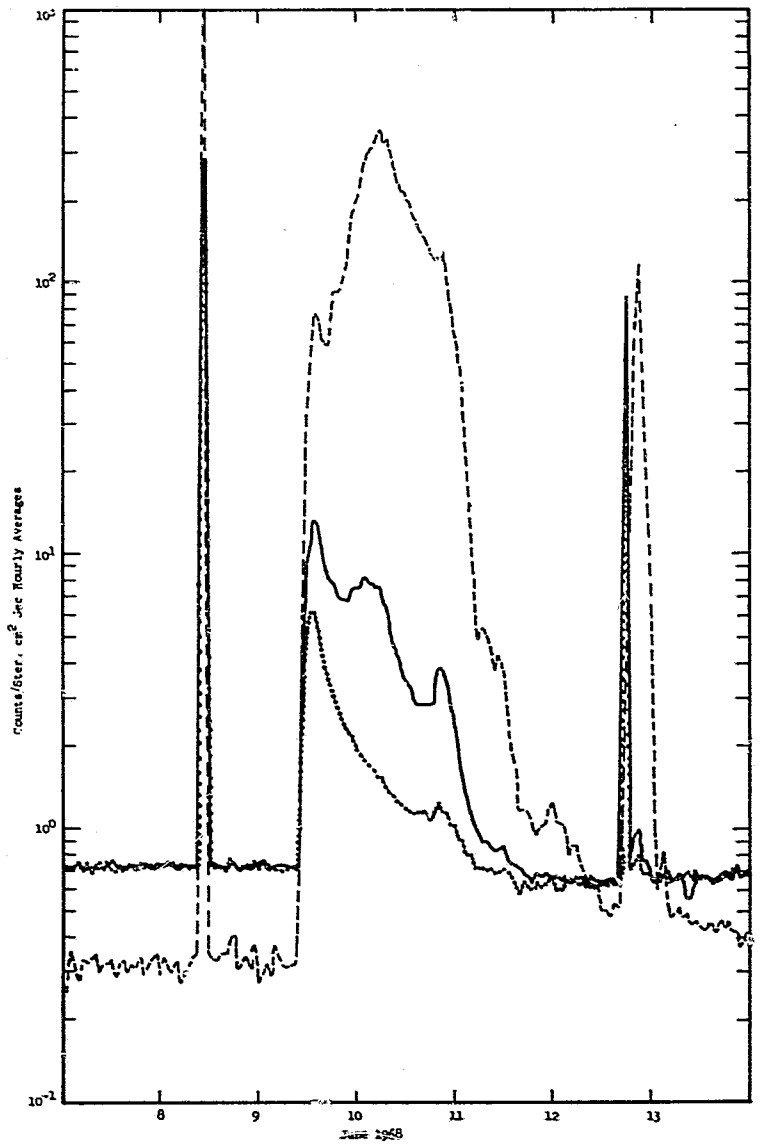

FIGURE 7A SOLAR PROTON COUNTING RATE, EXPLORER 34, JUNE 1968
——P_E>10 Mev, ...P_E>30 Mev, _____P_E>60 Mev

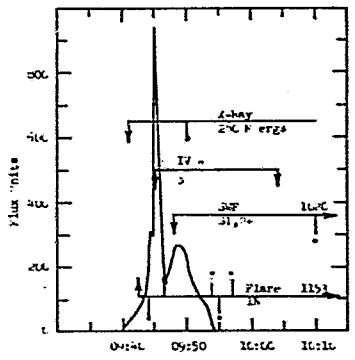

FIGURE 8 RF BURST 2695 Mc/s (MANILA), 6 JULY 1968, WITH RELATED SOLAR PHENOMENA

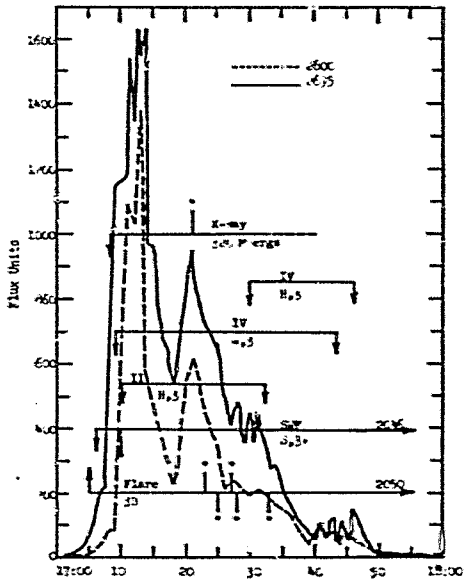

FIGURE 9 RF BURST 2695 AND 2800 Mc/s, 8 JULY 1968 WITH RELATED SOLAR PHENOMENA

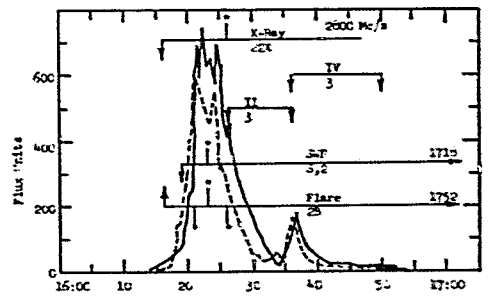

FIGURE 10 RF BURSTS 2695, AND 2800 Mc/s, 29 SEPTEMBER 1968, WITH RELATED SOLAR PHENOMENA,
------ 2800 Mc/s, _____ 2695 Mc/s

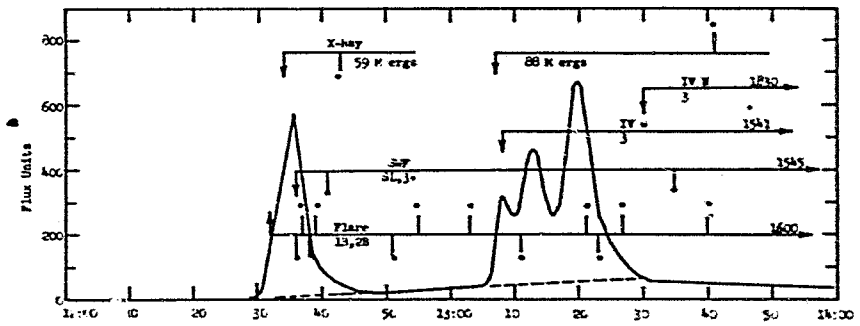

FIGURE 11 RF BURST 2800 Mc/s, 27 OCTOBER 1968, WITH RELATED SOLAR PHENOMENA

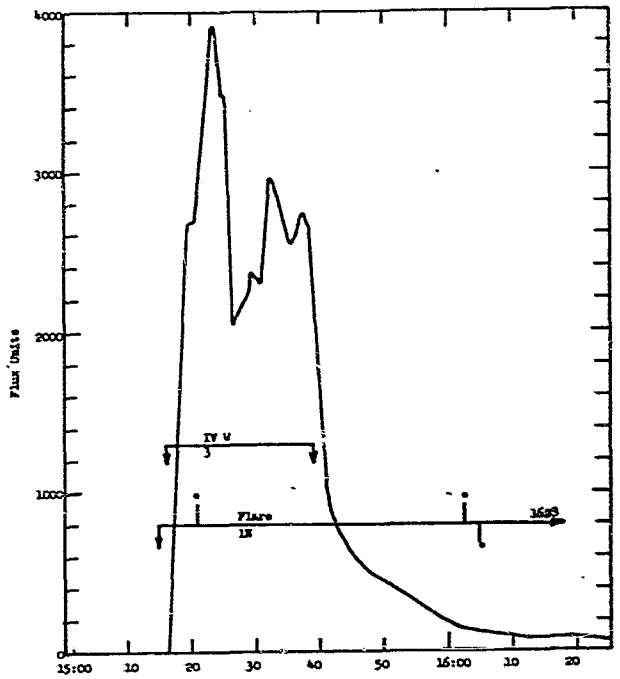

FIGURE 12 RF BURST 2800 Mc/s, 29 OCTOBER 1968, WITH RELATED SOLAR PHENOMENA

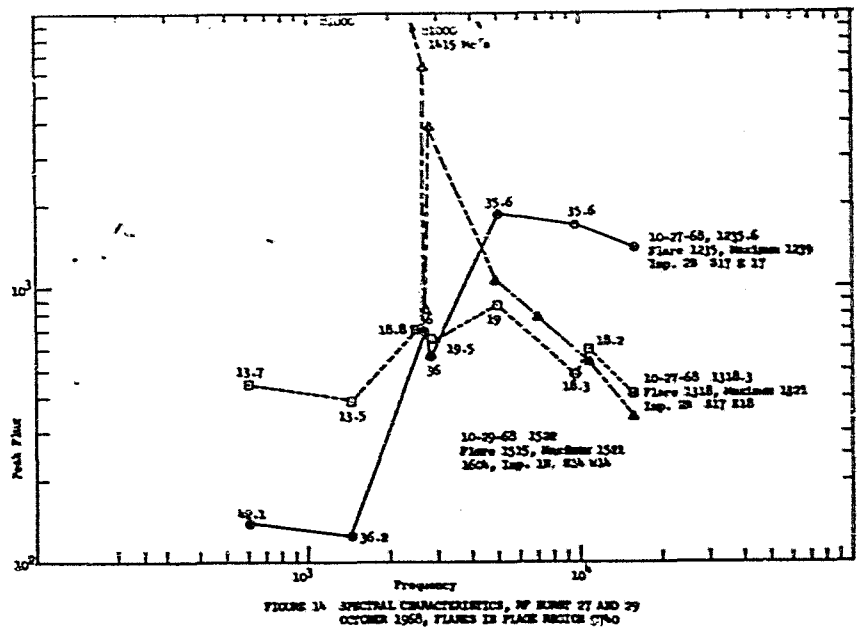

FIGURE 14 SPECTRAL CHARACTERISTICS, RF BURST 27 AND 29 OCTOBER 1968, FLARES IN PLAGE REGION 9740

FIGURE 13 RF BURST 2700 Mc/s (PENTICTON OBSERVATORY), 31 OCTOBER 1968, WITH RELATED SOLAR PHENOMENA

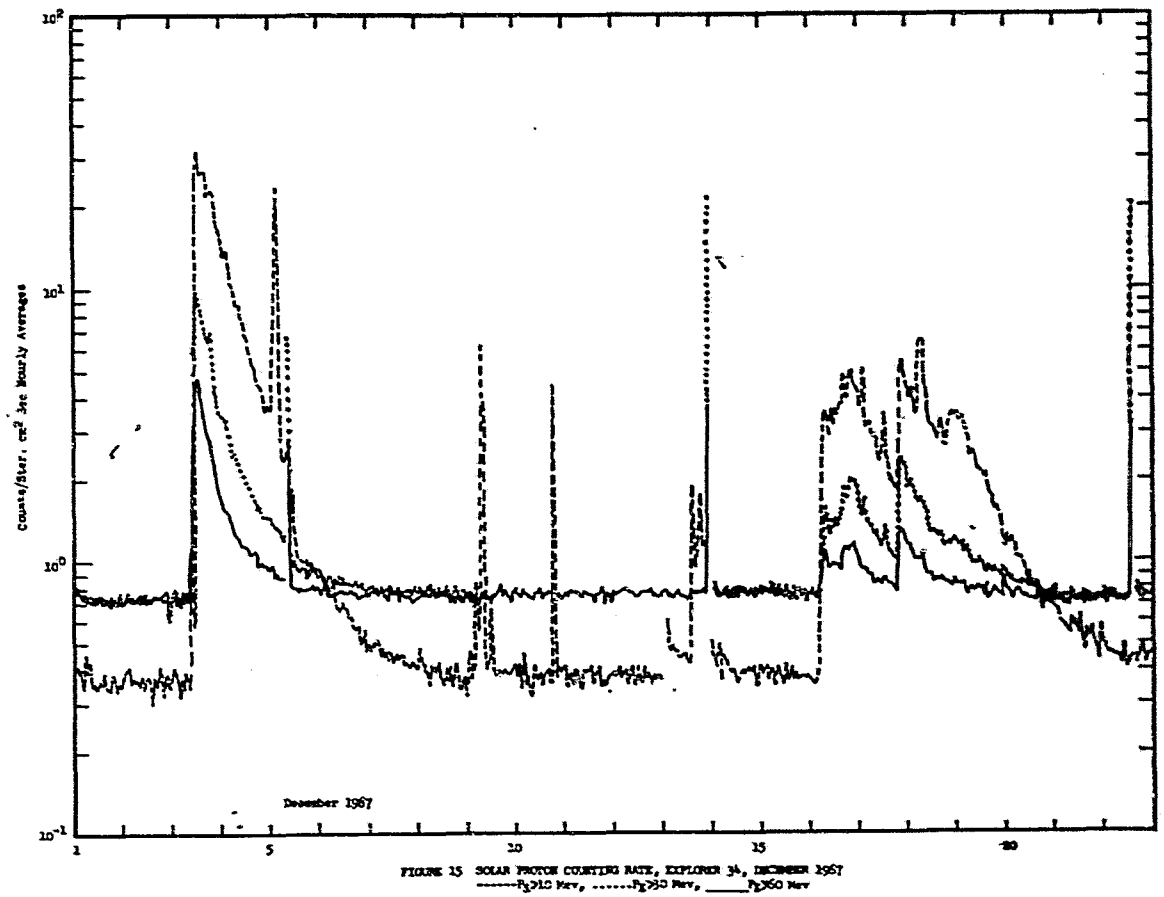

FIGURE 15 SOLAR PROTON COUNTING RATE, EXPLORER 34, DECEMBER 1967
-------P_1>10 Mev, ...P_2>30 Mev, _____P_3>60 Mev