

# Relationship between different types of solar radio emissions and solar activity parameters during the period 1985-2003

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Spectral observations of solar radio emissions of different types are associated with solar activity parameters. In the present study we have made an attempt to correlate different types of radio emissions with solar activity parameters during the period 1985 to 2003, which covers minima and maxima of solar activity cycles 22 and 23. It is found that during the solar minima correlations are better than the maxima. Furthermore, it is observed that the level of correlation varies from one type of radio bursts to other. The observational results are discussed in the light of source region of various events.

## 1. Introduction

The most frequently observed solar phenomena at meter and decimeter wavelengths (usually of hours or days duration) consist of a long series of bursts called storm bursts, and the radiation at such time is called the noise storm or enhanced radiation [1]. The solar active region and associated processes produce a host of phenomena such as emission of soft thermal and hard non-thermal x-ray and different types of bursts in radio region, characterized by different frequency time evolution [2]. Spectral type I Radio bursts are prominent feature of solar activity at meter wavelength having narrow band- width (5-30 mega cycles per second), lasting from a fraction of second to a few minutes [3]. The large solar flares are frequently accompanied by out bursts at meter wavelengths lasting from 5-30 minutes are termed as type II radio bursts. The emission drifts from higher to lower frequencies at about 1MHz / second during the bursts [4,5]. The most frequent discrete radio events on the sun is known as type III radio bursts which are due to plasma oscillations in the meter and decameter range, lasting about 10 seconds [6]. The emission covering all wavelengths from microwaves to tens of meter and lasting an hour or so, are known as type IV radio bursts. These bursts are connected with emission of plasma from deep atmosphere of the sun [7,8]. Spectral type V radio bursts are the broadband emission of meter wavelengths lasting a few minutes.

Strong magnetic field are also necessary for the generation of type I storms since the latter are 100% circularly polarized at most times. There is close relationship between the size of a sunspot and associated magnetic field [9]. The noise storm varies with sunspot cycle, i.e. they are more frequent and intense during the maximum of the cycle, and are rare and weak during the minimum of the cycle. Therefore, it is clear that the existence of a sunspot or a group of sunspot is a necessary condition for the generation of noise storms. Two periods of low activity were identified in 1996, one in the month of May and other in the month of October, in the solar cycle 22 [ref 10]. In the present paper we have tried to verify the relationship between the different types of radio bursts (type I, II, III, IV, V & total no. of radio bursts also) and sunspot numbers, grouped solar flare & solar flux (10.7 cm) for the period 1985-2003 covering solar cycle 22 & 23.

## 2. Collection of data

Radio burst data from the various reporting stations have been taken from the spectral observations of solar radio emission published in the Solar Geophysical Data. The reporting stations were Bleien (47N 9E), Potsdam (52N 13E), Ondrejov (49N 14E), San Vito (41N 18E), Izmiran (55N 37E), Learmonth (22S 114E), Hiraiso (36N 140E), Culgoora (30S 150E), Palehua (21N 204E) and Sagamore Hill (42N 289E). The longitudinal distribution of the different observing stations is such that there is a continuous observation of the sun over a period of 24 hrs.

For the present study we have considered the monthly-observed number of different types of radio bursts (I, II, III, IV, & V) and total number of radio bursts also. Monthly mean values of solar parameters (sunspot numbers, grouped solar flare & solar flux (10.7cm)) for the solar cycle 22 & 23 have been taken and a detailed correlative study between solar parameters and monthly counts of radio bursts have been performed.

## 3. Results and discussion

In the present paper we have made an attempt to correlate the different types of radio bursts (RB) with various solar parameters such as sunspot numbers (SSN), grouped solar flare (GSF) & solar flux (SF) during the different phases of solar cycle 22 & 23. Table-1, represents the correlation coefficient between different types of RB & SSN for solar cycle 22 & 23. It is observed that there is poor correlation between different types of RB & SSN except for type III RB for both the cycles, whereas correlation between total numbers of RB & SSN are better in comparison to correlation between different types of RB & SSN separately (fig-1 & 2). The number of type III radio bursts is much higher than the other type of bursts. Due to their large number it has been shown along the total radio bursts on the secondary axis of the figure. From fig-1, it is observed that the regression lines for type IV, type II & type I RB are almost similar whereas type V, type III & total no. of RB shows different behaviour. In fact, the regression lines for cycle 22 signifies that for the particular value of sunspot activity (SSN=100), the observed number of different types of radio bursts I,II,III,IV,V & total RB are 15,10,450,5, 45 & 550 respectively. Similarly from fig-2, it can be seen that the regression lines for the type V, type IV, type II & type I RB are of similar type, whereas type III RB & total no. of RB shows similarity with regression line of different slope. The regression lines signifies that for the particular value of sunspot activity (SSN=100), the observed number of different types of radio bursts I,II,III,IV,V & total RB are 60,30,920, 5,20 & 1080 respectively for the solar cycle 23.

Correlation coefficient between total RB and SSN has been found to be  $\approx 0.86$ , during the year 1986 and 1997 and it is  $\approx 0.95$  for total RB and GSF and  $\approx 0.89$  for total RB and SF (table-2). Correlation coefficient between total RB & SSN, GSF, SF for ascending and descending phases of both the cycles 22 & 23 has also been shown in the table -3. It is found that the total numbers of RB are highly correlated with different solar activity parameters (SSN, GSF, SF) during the minima of the solar cycles 22 & 23 (1986,1997).

**Table1.** Correlation - coefficient between different types of RB & SSN

Solar cycle	Type I	Type II	Type III	Type IV	Type V	Total RB
22	0.341	0.634	0.745	0.591	0.601	0.751
23	0.644	0.753	0.820	0.224	0.509	0.817

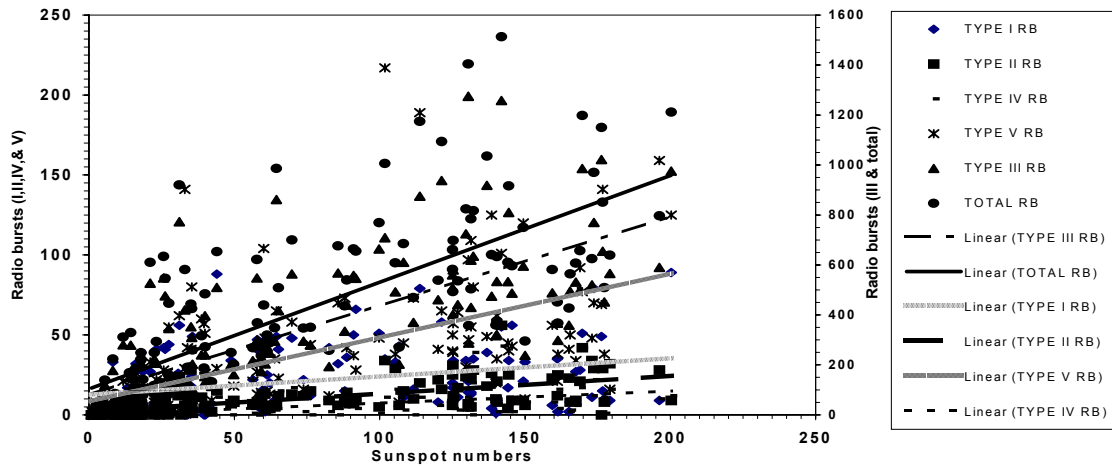


Figure 1. Shows the cross-plot between the sunspot numbers and different types of radio bursts (I,II,III,IV,V & total RB) for solar cycle 22 (1985-96).

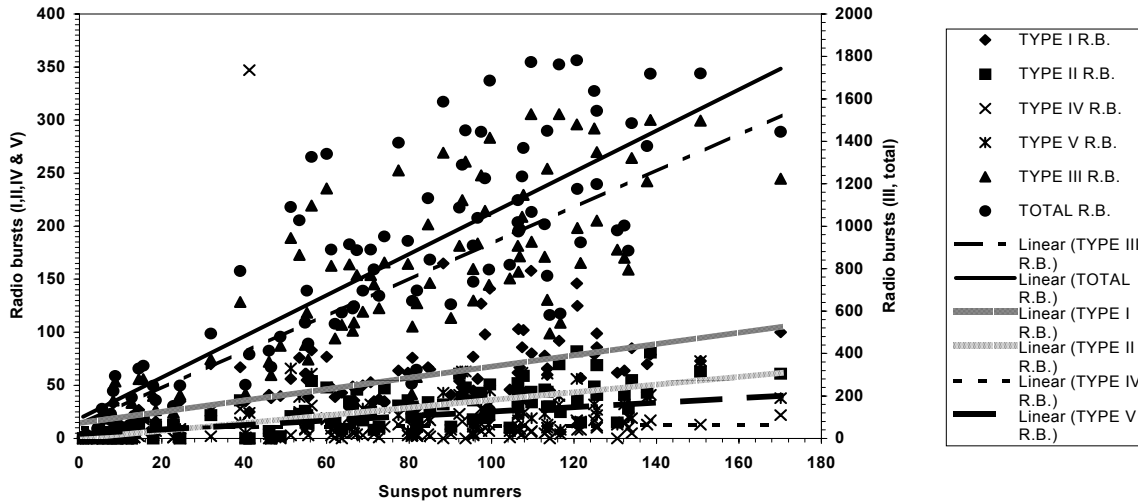


Figure-2. Shows the cross-plot between sunspot numbers and different types of radio bursts (I,II,III,IV,V, & total RB) for solar cycle 23 (1996-2003).

**Table-2.** Maximum correlation - coefficient during the year of solar cycles 22&23.

Year	Total RB& SSN	Total RB& GSF	Total RB&SF
1986	0.8601	0.944	0.894
1997	0.861	0.904	0.816

**Table-3.** Correlation - coefficient during the ascending and descending phases of solar cycles 22& 23

Correlation coefficient c(t)			
Phases of solar cycle	Total RB& SSN	Total RB& GSF	Total RB& SF
Ascending 22	0.7705	0.7796	0.7463
Descending 22	0.7332	0.7932	0.7233
Ascending 23	0.7980	0.7662	0.7702

#### 4. Conclusions

The total number of different types of radio bursts represent complete outcome of particular solar active regions producing different type of solar flares and associated phenomena. Since, the particular type of radio bursts are associated with phenomena taking place at different heights of solar atmosphere, hence do not depict the whole outcome of particular sunspot group, showing poor correlation with solar activity parameter. It is concluded that the different spectral type radio emissions (radio bursts) cannot be used to define the solar cycle in relation to other solar parameters (SSN, GSF, SF, SFI, CI) on the long-term basis. However, different types of radio bursts can be considered for the study of particular events on the short-term basis. Moreover, observational results for different type of solar radio emissions provide us the clue for further study of the generation mechanism operating at different level of solar atmosphere during the events.

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