ORIGINAL RESEARCH PAPER

Physics

SUNSPOT NUMBER INFLUENCING RAINFALL OVER JAIPUR CITY

KEY WORDS: e-resources knowledge, attitude towards using social media and college students.

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ABSTRACT

This study has undertaken the data during the Year 1952 to 2012 AD for the investigation on the correlation amongst the rainfall, sunspots in north-western part of India (specifically in the city of Jaipur). We have computed the annual average sunspots, rainfall data and tried to find inter dependence in context of extraterrestrial influence apart from the anthropogenic activities. During maximum and minimum solar activity, rainfall at Udaipur has been found to be more than average rainfall which indicated that solar activity helped in precipitation of clouds in the monsoon seasons after condensation and nucleation.

Introduction

Jaipur, the capital city of the Indian state of Rajasthan is situated in the eastern border of Thar Desert, a semi-arid land. This state is one of the biggest of the country which shares the international boundary with Pakistan on the western side. Jaipur is popularly known as the pink city and is one of the well-planned cities in India, apparently, also the first. It is positioned at an altitude of 1417 feet above the sea level. On three sides, the city is enclosed by the Aravali hills and this is why, it is safeguarded from the rough desert. In the north, it is surrounded by Sikar and Mahendragarh district; in the south by Tonk; in the east by Alwar, Dausa and Sawai Madhopur and in the west by Nagaur and Ajmer district. (Vibhuti Sachdev, 2002)

The total length of Jaipur extending from east to west is about 180 km whereas the width from north to south is about 110 km. About 28.65 million cubic meter ground water resources are available in Jaipur. To provide the drinking water to the old city, there is Ramgarh dam on the River Ban Ganga.

Figure-5.1: Political map of India highlighting Jaipur city.

Figure-5.2: Political Map of Rajasthan highlighting Jaipur city.

5.2 – Climate of Jaipur

Jaipur has a hot semi arid climate under the Koppen climate classification receiving over 650 millimeters (26 in) of rainfall annually but most rains occur in the monsoon months between June and September. Temperatures remain relatively high during summer from April to early July having average daily temperatures of around 30 °C (86 °F). During the monsoon there are frequent, heavy rains and thunderstorms, but flooding is not common. The winter months of November to February are mild and pleasant, with average temperatures ranging from 10–15 °C (50–59 °F) and with little or no humidity and cold waves lead to temperatures near freezing. Jaipur has resides on 26ş 55'E latitude and 75ş 52'E longitude in the geographical map. (Churu's Marwari, Nand Kishore Chaudhary's).

5.3 – Data Analysis

In this study we have examined 60 years (1952-2012) data of the sunspot number and variability of the monsoon rain fall in Udaipur for periodic analysis. We have collected the sunspot number data from Udaipur Solar Observatory (USO), Udaipur and rainfall data from meteorological department (Airport Authority of India, Udaipur). All the rainfall data are available in mm in monthly and annual series.

In the present analysis we have strategically placed monthly data into 4 specific seasons i.e. as Pre-Monsoon, Monsoon, Post-Monsoon and winter. Clarifying the seasons Pre-Monsoon considered as Month of March, April & May; Monsoon as the Month of June, July, August & September; Post Monsoon as the month of October & November; finally winter as December, January & February. For similar set of year we have collected the sunspot data by using 12 months data and computed annual mean of sunspots.

In order to understand the solar and galactic cosmic radiation effect on rainfall by comparing our sunspot number data with the season wise rainfall data. During 11 years sunspot activity cycle become effective for 5.5 years period for solar activity maxima and minima, which cause more annual rainfall during monsoon season.

Table-5.1: Data computed between SSN and Rainfall in Pre-monsoon Season (Mar, Apr &May).

Year	Mean	Avg	SSN
1952	2.84±0.02	-7.0836	31.41
1953	0.4±.03	-9.52	13.85
1954	0.33±.02	-9.58667	4.41
1955	2.43±0.02	-7.48667	37.95
1956	8.27±0.06	-1.65333	141.71
1957	7.8±0.05	-2.12	189.86
1958	1.2±0.01	-8.72	184.59
1959	23.13±0.18	13.21333	158.75
1960	6.1±0.07	-3.82	112.28

1961	1.13±0.09	-8.78667	55.15
1962	7.63±0.5	-2.28667	37.6
1963	5.33±0.39	-4.58667	27.89
1964	27.43±0.24	17.51333	10.2
1965	7.16±0.4	-2.75333	15.07
1966	8.76±0.75	-1.15333	46.88
1967	13.7±0.11	3.78	93.67
1968	3.1±0.02	-6.82	105.89
1969	8±0.07	-1.92	105.56
1970	5.1±0.4	-4.82	104.69
1971	20.06±0.18	10.14667	104.69
1972	0	-9.92	68.93
1973	0.9±0.05	-9.02	38.15
1974	1.53±0.01	-8.38667	34.41
1975	4.86±0.39	-5.05333	15.46
1976	25.73±0.19	15.81333	12.55
1977	24.6±0.23	14.68	27.48
1978	5.2±0.4	-4.72	92.66
1979	24.96±0.22	15.04667	155.28
1980	2.97±0.19	-6.95333	154.65
1981	12.53±0.09	2.61333	140.45
1982	29.17±0.27	19.24667	116.3
1983	58.63±0.48	48.71333	66.64
1984	0.1±.09	-9.82	45.85
1985	42.1±0.35	32.18	17.94
1986	7.33±.6	-2.58667	13.4
1987	20.03±0.18	10.11333	29.23
1988	2.97±0.3	-6.95333	100
1989	0	-9.92	157.8
1990	5.57±0.05	-4.35333	142.3
1991	0.83±0.08	-9.08667	145.8
1992	0.8±.07	-9.12	94.48
1993	0.43±.04	-9.48667	54.73
1994	10.07±.18	0.14667	29.87
1995	2.97±0.25	-6.95333	17.5
1996	4.33±.37	-5.58667	8.63
1997	13.4±.02	3.48	21.48
1998	2.57±.3	-7.35333	64.21
1999	3±.04	-6.92	93.18
2000	12.57±.15	2.64667	119.5
2001	19.67±.20	9.74667	34.37
2002	5.37±.45	-4.55333	14.33
2003	0.5±0.03	-9.42	3.45
2004	11±0.09	1.08	3.33
2005	12.47±0.10	2.54667	3.04
2006	19.46±.15	9.54667	19.56
2007	14.3±0.10	4.38	55.21
2008	17.53±0.09	7.61333	63.45
2009	9.13±.08	-0.78667	103.7
2010	0.8±0.6	-9.12	74.9
2011	3±0.17	-6.92	58.95
2012	5.43±.39	-4.48667	31.72

The above table shows the compiled data of rainfall and sunspot number chronically arranged from the year 1952-2012 over Jaipur city. Column three is filled with average data of rainfall in pre-monsoon of Jaipur city.

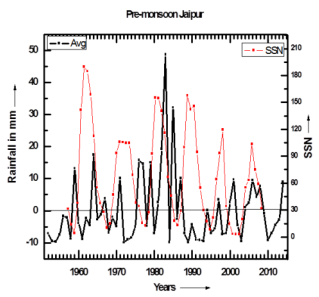

Figure-5.3: Plot of rainfall, SSN as a function of year 1952-2012 (Mar, Apr & May).

The premonsoon in Jaipur city is seems to be very weak about 9.92 mm rainfall. But there is some remarkable excess rainfall in the year 1959, 1964, 1976, 1978, 1982, 1986, 2001 and 2006.

Table –5.2 Data computed between SSN and Rainfall in Monsoon Season (Jun, Jul, Aug & Sept).

Year	Mean rainfall(mm)	Avg Rainfall	SSN
1952	89.85±8.49	47.8996	31.41
1953	136.72±10.41	-1.015	13.85
1954	137.42±12.97	-0.315	4.41
1955	143.42±13.22	5.685	37.95
1956	206.6±19.22	68.86	141.71
1957	192.32±16.67	54.585	189.86
1958	148.05±6.88	10.31	184.59
1959	208.85±13.05	71.11	158.75
1960	135.65±16.21	-2.09	112.28
1961	156.47±8.24	18.735	55.15
1962	130.5±10.85	-7.24	37.6
1963	151.95±14.17	14.21	27.89
1964	148.12±16.06	10.385	10.2
1965	60.77±3.38	-76.965	15.07
1966	122.9±11.26	-14.84	46.88
1967	140.77±6.15	3.035	93.67
1968	103.62±12.10	-34.115	105.89
1969	104.45±7.23	-33.29	105.56
1970	159.22±11.40	21.485	104.69
1971	226.67±13.38	88.935	104.69
1972	86.8±7.75	-50.94	68.93
1973	181.27±22.13	43.535	38.15
1974	157.07±17.14	19.335	34.41
1975	229.22±13.69	91.485	15.46
1976	131.25±6.08	-6.49	12.55
1977	248.02±11.11	110.285	27.48
1978	221.55±17.11	83.81	92.66
1979	76.92±5.98	-60.815	155.28
1980	104.22±6.98	-33.515	154.65
1981	276.05±25.7	138.31	140.45
1982	83.17±8.69	-54.565	116.3
1983	161.2±15.77	23.46	66.64
1984	180.3±7.38	98.34	45.85
1985	120.55±12.97	-17.19	17.94
1986	96.75±11.68	-40.99	13.4
1987	59.6±5.6	-78.14	29.23
1988	152.95±13.17	15.21	100
1989	118.27±16.39	-19.465	157.8
1990	150.62±10.95	12.885	142.3
1991	57.82±3.97	-79.915	145.8
1992	61.57±5.75	-76.165	94.48
1993	119.92±3.02	-17.815	54.73
1994	165.15±9.43	27.41	29.87
1995	195.85±20.5	58.11	17.5
1996	185.95±5.75	48.21	8.63
1997	111.22±9.48	-26.515	21.48
1998	143.2±9.90	5.46	64.21
1999	49.67±3.99	-88.065	93.18
2000	94.5±8.73	-43.24	119.5
2001	132.95±13.59	-4.79	34.37
2002	28.4±3.04	-109.34	14.33
2003	113.65±3.9	-24.09	3.45
2004	154.2±18.11	16.46	3.33
2005	97.05±6.8	-40.69	3.04
2006	97.55±3.7	-40.19	19.56
2007	116.1±8.14	-21.64	55.21
2008	120.57±5.20	-17.165	63.45
2009	84.85±4.59	-52.89	103.7

2010	185.25±15.24	47.51	74.9
2011	168.72±4.48	30.985	58.95
2012	189.47±16.23	51.735	31.72

The above table represents the data computed between SSN and rainfall. The average rainfall 137.75 mm observed from 1952-2012 over Jaipur city during monsoon season. The corresponding graph is shown in Figure- 5.4.

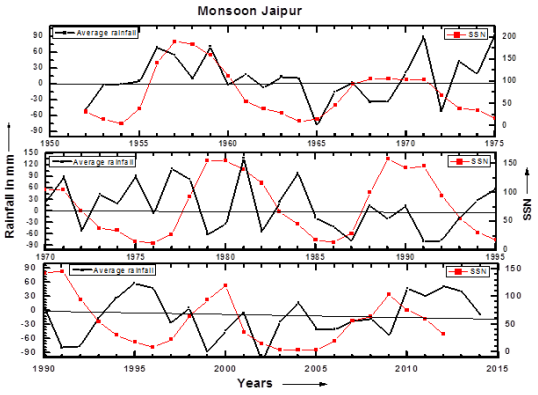

Figure-5.4: Plot of rainfall, SSN as function of year 1952-2012 (Jun, Jul, Aug & Sept).

The above graph shows the clear systematic trend of rainfall versus sunspot number i.e. the rainfall is above average during the solar maxima and solar minima.

Table-5.3: Data computed between SSN and Rainfall in Post-Monsoon Season (Oct & Nov).

Year	Rainfall(mm)	Avg Rainfall	SSN
1952	0	-12.9	31.41
1953	1.06±.09	-11.839	13.85
1954	18±1.2	5.1	4.41
1955	53.2±3.6	40.3	37.95
1956	107.65±9.8	94.75	141.7
1957	8±.75	-4.9	189.9
1958	8.7±.67	-4.2	184.6
1959	24.7±.26	11.8	158.8
1960	0	-12.9	112.3
1961	16.85±1.1	3.95	55.15
1962	0	-12.9	37.6
1963	0	-12.9	27.89
1964	0	-12.9	10.2
1965	10.55±1.7	-2.35	15.07
1966	9.05±1.6	-3.85	46.88
1967	0.9±1.5	-12	93.67
1968	1.9±.09	-11	105.9
1969	0.25±.02	-12.65	105.6
1970	3.75±.36	-9.15	104.7
1971	6.6±0.55	-6.3	104.7
1972	1.15±.98	-11.75	68.93
1973	0.35±.04	-12.55	38.15
1974	50.9±.45	38	34.41
1975	6.25±0.21	-6.65	15.46
1976	10.7±1.3	-2.2	12.55
1977	0.8±0.1	-12.1	27.48
1978	0.45±.04	-12.45	92.66
1979	13.1±1.7	0.2	155.3
1980	2.3±.03	-10.6	154.7
1981	13±1.5	0.1	140.5
1982	44.8±3.9	31.9	116.3
1983	40.3±3.5	27.4	66.64
1984	0	-12.9	45.85
1985	14.65±1.3	1.75	17.94
1986	11.8±1.4	-1.1	13.4
1987	0	-12.9	29.23
1988	0	-12.9	100
1989	0	-12.9	157.8
1990	8.9±.09	-4	142.3
1991	2.3±0.07	-10.6	145.8
1992	5±0.04	-7.9	94.48
1993	2.25±.02	-10.65	54.73
1994	0.05±.003	-12.85	29.87
1995	0.15±.02	-12.75	17.5
1996	27.8±2.5	14.9	8.63
1997	77.4±6.8	64.5	21.48
1998	23.15±1.9	10.25	64.21
1999	44.9±3.9	32	93.18
2000	0.6±0.04	-12.3	119.5
2001	24.25±2.3	11.35	34.37
2002	0	-12.9	14.33
2003	2.95±1.9	-9.95	3.45
2004	52.05±4.6	39.15	3.33
2005	0	-12.9	3.04
2006	1.3±.01	-11.6	19.56
2007	0	-12.9	55.21
2008	0.55±.04	-12.35	63.45
2009	12.55±1.2	-0.35	103.7
2010	40±3.8	27.1	74.9
2011	0	-12.9	58.95
2012	0.15±0.01	-12.75	31.72

This table categorized post monsoon season (Oct & Nov) was examined and data computed between SSN and rainfall is tabulated. The 3rd column contains the average rainfall of 12.9 mm obtain for the year 1952-2012 over Jaipur city. The corresponding graph is shown in figure 5.5.

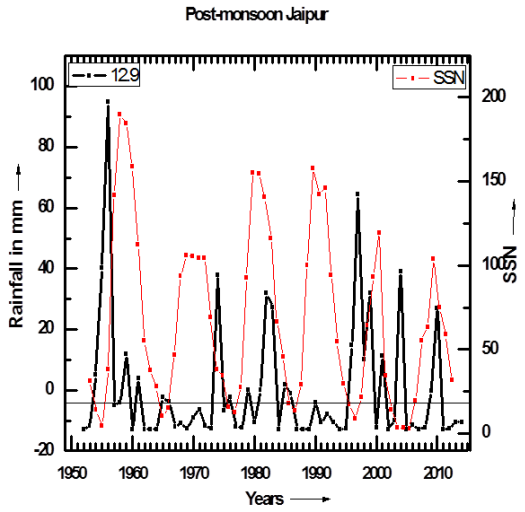

Figure: 5.5: plot of rainfall, ssn as a function of year 1952-2012 post monsoon wise (Oct & Nov).

This figure represents the post-monsoon season which was not well defined frequency of occurrence in maximum rainfall over the period of 60 years in Jaipur city.

Table-5.4: Data computed between SSN and Rainfall in Winter Season (Dec, Jan & Feb).

Year	Mean Rainfall(mm)	Avg Rainfall	SSN
1952	14.55±1.3	7.87593	31.41
1953	8.8±1.1	2.13	13.85
1954	8±.6	1.33	4.41
1955	6.9±0.4	0.23	37.95
1956	4.46±0.2	2.20333	141.71
1957	20.67±2.4	13.9967	189.86
1958	1.53±0.09	5.13667	184.59
1959	0.67±.05	6.00333	158.75
1960	0.63±.02	6.03667	112.28

1961	13.83±1.1	7.16333	55.15
1962	0.6±.03	-6.07	37.6
1963	2.93±	3.73667	27.89
1964	0	-6.67	10.2
1965	15.7±1.2	9.03	15.07
1966	4.97±0.3	1.70333	46.88
1967	0	-6.67	93.67
1968	15.3±1.1	8.63	105.89
1969	4.27±.35	2.40333	105.56
1970	25.8±1.9	19.13	104.69
1971	1.63±0.02	5.03667	104.69
1972	4.73±0.04	1.93667	68.93
1973	6.43±.46	0.23667	38.15
1974	2.13±.07	4.53667	34.41
1975	5.03±.08	1.63667	15.46
1976	10±1.1	3.33	12.55
1977	7.93±.9	1.26333	27.48
1978	7.23±.8	0.56333	92.66
1979	19.9±1.5	13.23	155.28
1980	1.87±.02	4.80333	154.65
1981	9.57±0.08	2.89667	140.45
1982	6.73±0.49	0.06333	116.3
1983	2.87±.27	3.80333	66.64
1984	0.27±.18	6.40333	45.85
1985	0.13±0.01	6.53667	17.94
1986	7.47±1.2	0.79667	13.4
1987	11.23±1.4	4.56333	29.23
1988	6.17±.89	0.50333	100
1989	9.03±.95	2.36333	157.8
1990	17.73±1.1	11.06	142.3
1991	0.87±.07	5.80333	145.8
1992	4.07±.46	2.60333	94.48
1993	13.33±1.5	6.66333	54.73
1994	9.3±1.1	2.63	29.87
1995	12.17±2.3	5.49667	17.5
1996	6.47±.68	0.20333	8.63
1997	0	-6.67	21.48
1998	8.13±.09	1.46333	64.21
1999	0	-6.67	93.18
2000	1.63±.18	5.03667	119.5
2001	0.27±.24	6.40333	34.37
2002	7.5±.65	0.83	14.33
2003	18.63±1.2	11.9633	3.45
2004	5.13±.43	1.53667	3.33
2005	0.35±.04	-6.32	3.04
2006	0	-6.67	19.56
2007	8.2±0.08	1.53	55.21
2008	0.4±0.03	-6.27	63.45
2009	0.13±0.02	6.53667	103.7
2010	4.87±.35	1.80333	74.9
2011	12.1±1.3	5.43	58.95
2012	0	-6.67	31.72

The above table proves that, the winter season comprising the month Dec, Jan & Feb witnessed very less rainfall within the average of 6.67mm observed from the year 1952-2012 over Jaipur city. The data computed for SSN and rainfall and the corresponding graph is plotted in the figure-5.6.

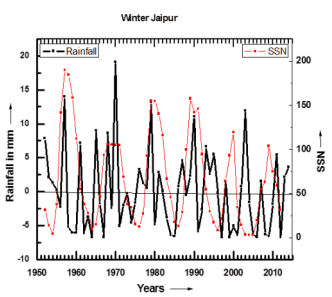

Figure: 5.6: Plot of rainfall, SSN as a function of year 1952-2012 Winter wise (Dec, Jan & Feb).

Here the plot of rainfall is clearly indicated the maximum rainfall more than average during 1950-2012 over Jaipur city.

Conclusion & Discussion

During the previous analysis in chapter 3 & 4 we come to know that, the average rainfall has been increased with the observed maximum & minimum number of sunspots in a solar cycle. (K. M. Hiremath 1995)

On the other hand analyzing the data in Jaipur city it was found that, the average rainfall is relatively low during Pre-Monsoon, Post-Monsoon and winter. Hence, graphs don't justify any correlation between rainfall and sunspot number.

But in the monsoon season, if we compared the rainfall data with the Sun spot data we can see the good correlation between them.

For the better analysis of monsoon rainfall data of 60 years with Sunspot Number we divided the whole year (1952-2012) into three parts .One from 1950- 1975, 1975 –1995 and 1995 - 2012. In the first part 1950 - 1975 there is two solar cycle of 11 years i.e. one solar cycle from 1952 – 1963 and second solar cycle from 1963 – 1974. In the first solar cycle there is two peak of maximum rainfall in the year 1956 and 1959 and in the solar minima there is also two peak of maximum rainfall in the year 1961 and 1964. In the second solar cycle there is one peak in the year 1971 on solar maxima and another peak of maximum rainfall in the year 1973and 1975 on solar minima.

In the second half of the graph from 1975 to 1995 there are two solar cycles one is from 1975 to 1986 and another from 1986 to 1997.In the first solar cycle there is one peak of maximum rainfall in the year 1981 on solar maxima and one peak of maximum rainfall in 1984 on solar minima.

In the last portion of the graph contained 1995 to 2012 which consist of two solar cycle 1995 to 2006 and 2006 to 2012. In this period there is one peak of maximum rainfall in 1996 on solar minima and here is an exception that there is no maximum rainfall in solar maxima. And again there is a maximum rainfall in 2004 on solar minima.

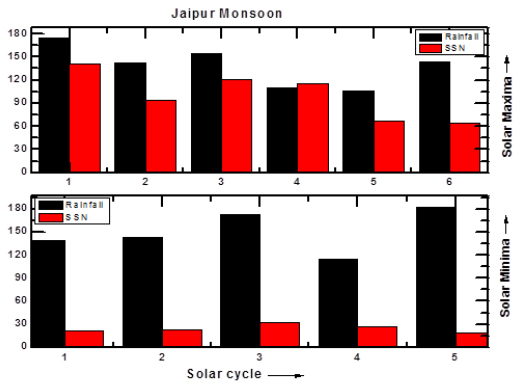

Figure-5.7: Histograms represents for rainfall versus SSN for Jaipur City (Monsoon wise).

In order to understand the systematic trend of rain and its attribution with SSN is clearer manner, the histograms of average SSN and rain is plotted in two parts of figure 5.7. Here we found clear trends of maximum rainfall during maximum and minimum of SSN.

The results are quiet encouraging in the context of extra terrestrial influence on rain because it existed not only in the last century but since the birth of the earth. There is no doubt about the anthropogenic influence (global warming, pollutions, green house

effect, La nina and El Nino etc.) on the rain but still I am observing variations in rainfall with draught and flood. This clearly indicates the role of solar activities and galactic cosmic radiations on the rainfall. This may produce charged secondary cosmic radiation in atmosphere, which are prone to act like centers for the cloud formation and nucleation for essential precipitation. This justifies the correlation and attribution of rainfall with the extra terrestrial influences.

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