**International Journal of Scientific Research in Physics and Applied Sciences** **Research Paper**

Vol.7, Issue.5, pp.11-15, October (2019) **E-ISSN:** 2348-3423

# Comparative Study of Odd and Even Solar Cycles

**Sarver Ahmad khan[1*], Niyaz Ahmad[2], Shabir Ahamd[3], C. M. tiwari[4], A. K. Saxena[5], A. P. Mishra[6], G. N. Singh[7], K .L. Jaiswal[8]**

[1,2,3,4,5,6]Department of physics, A P S University Rewa 486003(M.P), India
[7]Sudarshan College, Lalgawan, Rewa, India
[8]Department of physics, Govt. Model Science College Rewa, India

**Corresponding Author: sarverahmadkhan@gmail.com*

**Available online at: www.isroset.org**

Received: 11/Oct/2019, Accepted: 20/Oct/2019, Online: 31/Oct/2019

***Abstract-*** Several solar activity phenomena occurring on the surface of the Sun, such as Sunspot number (SSN), Solar flare index (SFI), Solar flux (SF) etc. known as Solar activity. The Solar phenomena produced during 11- year cycle variation which is known as 11- year solar activity cycle. The Sunspot number (SSN), Solar flare index (SFI), grouped Solar flares (GSF) and Solar flux (SF) for the Solar cycle 21 to 24 have been analyzed. We have found that Sunspot number (SSN) and Solar flux (SF) are highly correlated in solar cycle 21 as compared to solar cycle 23. We have found that Sunspot number (SSN) and Solar flux are highly correlated in solar cycle 22 and are not highly correlated with solar cycle 24. Also we have found that Sunspot number (SSN) and (GSF) are highly correlated in Solar cycle 21 as compared to Solar cycle 22 and Solar cycle 23 and Solar flux (SF) are highly correlated in Solar cycle 21 as compared to Solar cycle 22 and Solar cycle 23. The maximum value of Sunspot number for Solar cycle 22 is greater than the maximum value of Sunspot number for Solar cycle 21, Solar cycle 23 and Solar cycle 24 and the maximum value of Grouped solar flare for Solar cycle 21 is greater than the maximum value of Solar flare for Solar cycle 22 and Solar cycle 23. The maximum value of solar flux for solar cycle 22 is greater than the maximum value of solar flux for solar cycle 21, 23 and 24.

***Keywords***: - Sunspot number (SSN), Solar cycle (SC), Solar Flux (SF), Solar flare index (SFI) and Grouped Solar Flare (GSF).

## I. INRODUCTION

When observing the sun with appropriate filtration, the most immediately visible features are usually its sunspots which are well-defined surface areas that appear darker than their surroundings because of lower temperatures. Sunspots are regions of intense magnetic activity, where convection is inhabited by strong magnetic fields, reducing energy transport from the hot interior to the surface. The magnetic field causes strong heating in the corona, forming active regions that are the source of intense solar flares and coronal mass ejections. The largest sunspots can be ten and thousands of kilometers across.

The number of sunspots visible on the sun is not constant, but various over an 11-year cycle known as the solar cycle. At a typical solar minimum, few sunspots are visible, and occasionally none at all can be seen. Those they do appear at high solar latitude. As the sunspot cycle progresses, the number of sunspots increases and they move closer to the equator of the sun, a phenomena given by the Sporer's law. Sunspots usually exist as pairs with opposite magnetic polarity. The magnetic polarity of the leading sunspots alternates every solar cycle, so that it will be a north magnetic pole in one solar cycle and a south magnetic pole in the next solar cycle.

The solar cycle has a great influence on space whether, and is a significant influence on the earth's climate since luminosity has a direct relationship with magnetic activity. Solar activity minima tend to be correlated with colder temperatures and longer from average solar cycles tend to be correlated with hotter temperatures.

In the 17$^{th}$ century, the solar cycle appeared to have stopped entirely for several decades; few sunspots were observed during this period. During the 17$^{th}$century era called as the Maunder minimum or little ice age. Europe experienced unusually cold temperatures.

The solar cycle was discovered in 1843 by Samuel Heinrich Schwable, who after 17 years of observation, notice a periodic variation in the average number of sunspots seen from year to year on the solar disk.

Since cycle 21 started in June 1976 and lasted 10 years and 3 months. Solar cycle 22 started in September 1986 and lasted 9 years and 8 months. Solar cycle 23 started in May 1996 and lasted 12 years and 6 months. Solar cycle 24 started in December 2008 and still continues.

## II. METHODOLOGY

In this paper, we have studied the variations of solar activity {Sunspot number (SSN), Solar flare index (SFI), Grouped solar flares (GSF), Solar flux (F10.7 index)}.The correlation coefficients have been calculated between Sunspot number (SSN) with Solar flux, Solar flare index, Grouped solar flares. The solar activity (SSN) parameter is available for monthly and yearly average data on http://solarscience.msfc.nasa.gov,(ftp;//ftp.ngdc.noaa.gov/STP/SOLAR_DATA/….html).
Solar Flux is available on https://omniweb.gsfc.nasa.gov. Solar flare index and Grouped solar flares on www.ngdc.noaa.gov.

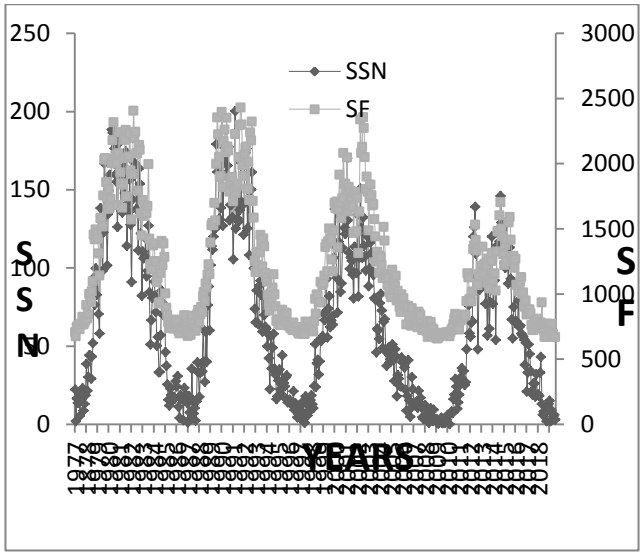
## III. RESULTS

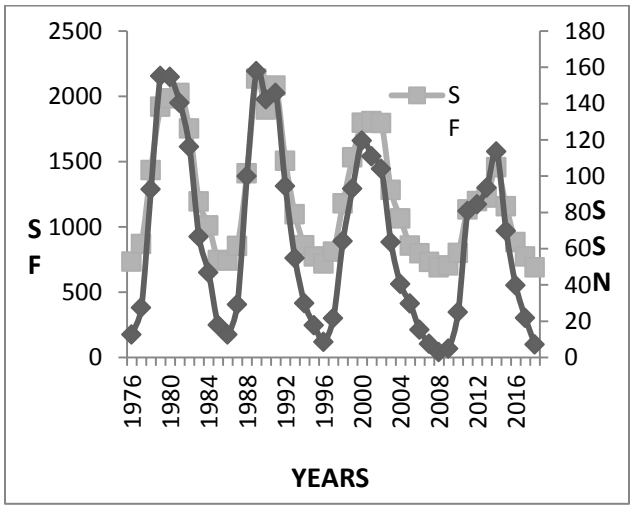
Comparative study of solar activity indices are expressed in the form of periodic variation of many observed quantities, e.g.; grouped solar flare vs. sunspot number, solar flux vs. sunspot number, solar flux vs. grouped solar flare etc. It has become common practice to study the various parameters of solar output in relation to sunspot number. The sunspot number is the photosperic index of solar activity. Similarly the occurrences of flares are highly correlated with sunspot cycle. Solar flares naturally occur more than often during the high solar activity (Maximum sunspot number).

### 3.1. CORRELATION BETWEEN MONYHLY & YEARLY VALUES OF SOLAR FLUX AND SUNSPOT NUMBER.

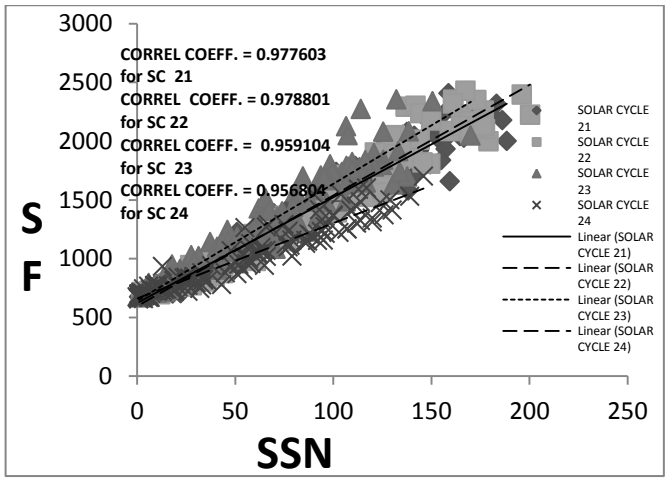
From the Figures we have compared the monthly & yearly average value of solar flux with the value of sunspot number for solar cycle 21, 22, 13 and 24 respectively. It is evident that the two indices (solar flux and sunspot number) show the strong correlation.

- It is clear that the value of solar flux first increases from Aug-1976 to Nov-1979 becomes the maximum in Nov-1979 and then decreases from Nov-1979 to June 1986 for solar cycle 21. The sunspot number first increases from July-1976 to Sep-1979 becomes maximum in Sep-1979 and then decreases from Sep-1979 to June-1986, become minimum in june-1986 for solar cycle 21.
- It is clear that the value of solar flux again starts increases from june-1986 to Feb-1991 becomes the maximum in Feb-1991 and then starts decreasing from Feb.-1991 to Mar-1996 for solar cycle 22. The sunspot number starts increasing from Oct.-1986 to Aug.-1990 becomes the maximum in Aug.-1990 and then starts decreasing from Aug.-1990 to Feb.-1996 become the minimum in Feb.-1996 for solar cycle 22.
- It is clear that the value of solar flux again increases from June-1996 to Dec.-2001 becomes maximum in Dec.-2001 and then starts decreasing from Dec.-2001 to July-2008, become minimum in July-2008 for solar cycle 23. The sunspot number starts increasing from Oct.-1996 to July-2000 becomes the maximum in July-2000 and then starts decreasing from July-2000 to Aug.-2008 for solar cycle 23.
- It is clear that the value of solar flux increases from Aug. -2009 to Nov.- 2011 becomes maximum in Nov.-2011 and then starts decreasing from Nov.-2011 up to 2018 for solar cycle 24. The sunspot number starts increasing from April-2009 to Nov.-2011 and attains maximum value of 96.7 in Nov. 2011 and then starts decreasing from Nov.-2011 for solar cycle 24.

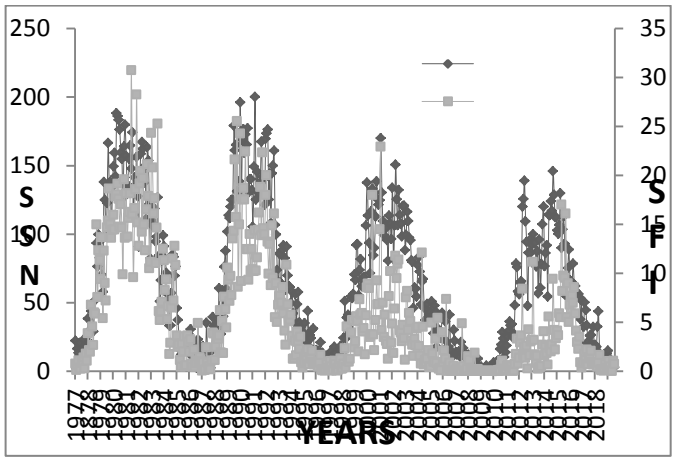


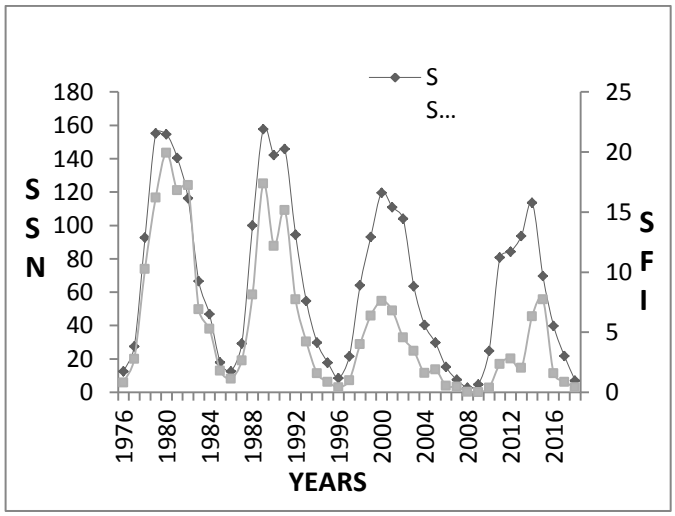



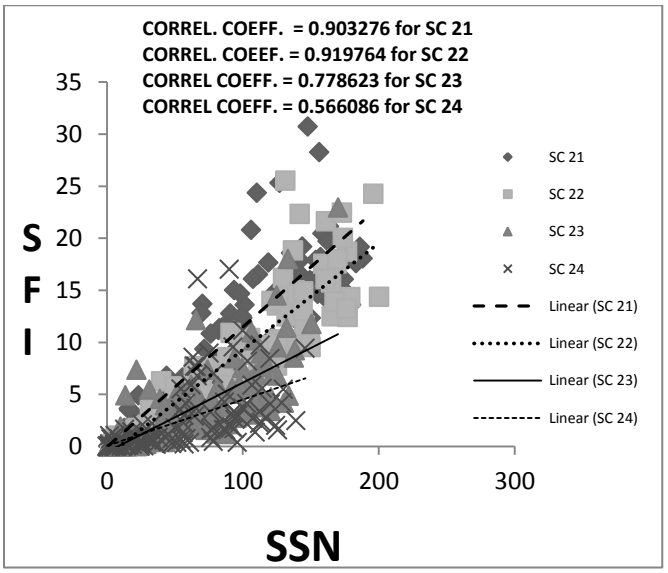

 




The correlation coefficients for these indices are 0.977603, 0.978801, 0.959104 and 0.956804 for solar cycle 21, 22, 23 and 24 respectively.




The correlation coefficients for these indices are 0.903276, 0.919764, 0.778623 and 0.566086 for solar cycle 21, 22, 23 and 24 respectively.

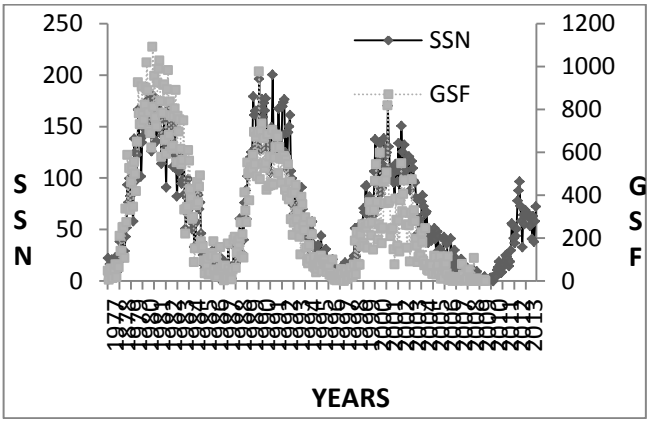
### 3.2 CORRELATION BETWEEN MONTHLY & YEARLY VALUES OF GROUPED SOLAR FLARE AND SUNSPOT NUMBER

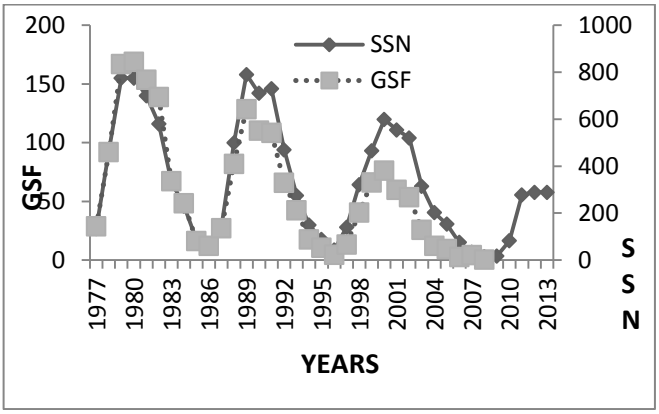
From the Figures we have compared the monthly & yearly average value of grouped solar flare with monthly average value of sunspot number for solar cycle 21, 22 and 23 respectively. It is clear from the figure that the two indices (grouped solar flare and sunspot) show the strong correlation.

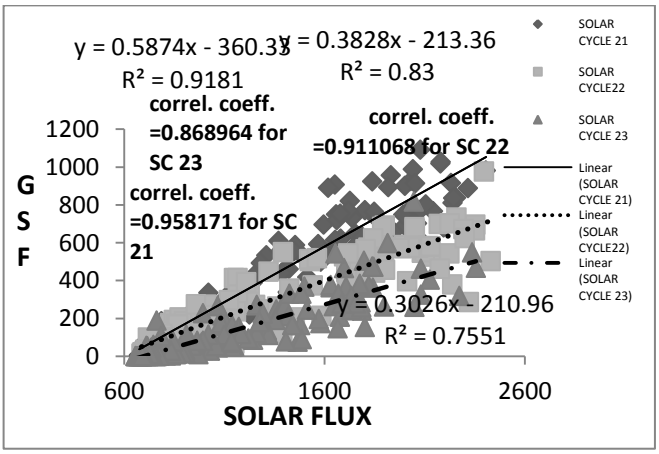
- It is clear that the value of grouped solar flare first increases from July -1976 to Nov-1980 becomes the maximum in Nov-1980 and then starts decreasing from Nov-80 to June- 1986, becomes the minimum in june-1986 for solar cycle 21. The value of sunspot number first increases from july-1976 to Sep-1979, becomes maximum in Sep-1979 and then starts decreases from Sep.-1979 to June -1986, becomes minimum in June 1986 for solar cycle 21.
- It is clear that the value of grouped solar flare again starts increasing from Feb-1987 to June- 1989 becomes maximum in june-1989 and then starts decreasing from june-1989 to Feb-1996, becomes minimum in Feb-1996 for solar cycle 22. The sunspot number starts increasing from Oct-1986 to Aug-1990 becomes maximum in Aug-1990 and then starts decreasing from Aug- 1990 to Feb-1996, becomes minimum in Feb -1996, for solar cycle 22.
- It is clear that the value of grouped solar flare again starts increasing from November-1996 to July-2000 becomes the maximum in July- 2000 and then starts decreasing from July-2000 to Feb-2006 becomes minimum in Feb-2006 for solar cycle 23. The sunspot

number starts increasing from October -1996 to July -2000 become maximum in July- 2000 and then starts decreasing from July -2000 to August- 2008 for solar cycle 23.




The correlation coefficients for these indices are 0.958171, 0.911068, and 0.868964 for solar cycle 21, 22, and 23 respectively.

## IV. CONCLUSIONS

Based on the observational result of various solar activities, such as sunspot number, grouped solar flare, and solar flux discussed in the previous chapter the following conclusions are drawn:

1. The maximum value of sunspot number for solar cycle 22 is greater than the maximum value of sunspot number for solar cycle 21, 23, & 24
2. The maximum value of grouped solar flare for solar cycle 21 is greater than the maximum value of solar flare for solar cycle 22 and 23.
3. The maximum value of solar flux for solar cycle 22 is greater than the maximum value of solar flux for solar cycle 21, 23, and 24 which shows that solar cycle 22 was more active in comparisons to that of solar cycle 21, 23, & 24.
4. The study shows high correlation between solar flux and sunspot number. The correlation coefficient decreases slightly from solar cycle 21 to solar cycle 24.
5. The study shows the high correlation between grouped solar flare and sunspot number. The correlation coefficient decreases slightly from solar cycle 21 to solar cycle 23.
6. The study shows the high correlation between solar flux and grouped solar flare .The correlation coefficient decrease slightly from solar cycle 21 to solar cycle 23.
7. The period of solar cycle 21, 22 and 23 are 10.3 years, 9.7 years and 12.6 years respectively i.e. period of solar cycle 22 is less than the cycle 21, 23. & the solar cycle 24 is the active cycle, scientists predicts that it will complete in 2016.
8. It is clear that the duration of increasing phase (minimum to maximum) of sunspot is shorter than its decreasing phase (maximum to minimum) the duration of increasing phase of sunspot for solar cycle 21, 22, 23&24 are 39 months, 47 months, 46 months and 32 months respectively, i.e. the duration of increasing phase of sunspots is greater in case of solar cycle 22 in comparisons to solar cycle 21, 23 &24.
9. The duration of ascending phase( minimum to maximum) of solar flux is shorter than its descending phase( maximum to minimum) .The duration of ascending phase of solar flux for solar cycle 21,22,23 &24 are 40 months ,37 months ,67 months, and 28 months respectively .i.e. the duration of ascending phase of solar flux is greater in case of solar cycle 23 in comparisons to solar cycle 21, 22, & 24.
10. The increasing phase (minimum to maximum) of grouped solar flare is short than its descending phases (max. to min.). The duration of ascending phase of grouped solar flare for solar cycle 21, 22, & 23 are 53 months 29 months and 45 months respectively .i.e. the duration of ascending phase of grouped solar flare is

greater in case of solar cycle 21 in comparisons to solar cycle 22 & 23.

11. Solar cycle 24 has initially displayed much less activity than recent cycles.

## REFERENCES


[1]. Aryans, A.E. (1965). Solar system radio Asronomy, platinum N. Y.

[2]. Akaofu, S.I. and Chapmann, S. (1972). Solar terrestrial physics, Clarendon press. Oxford.

[3]. Badaruddin et al, 1985; planet space science 83,191.

[4]. Badaruddin et al, 1986; Ellison et al, 1999; scoot, D. 1991; J.Geo. phys.Rev. 75.6366.

[5]. Gopalswamy, (2004). Solar physics, Z., 14.610.

[6]. Gupta, M. (2005). Ph.D thesis, A.P.S.U, Rewa.

[7]. Gustav, sporer; J.Astrophysics, 207,799.

[8]. Hale, G.E. (1908). "On the probable existence of a magnetic field in sunspots". The astrophysical journal 28.315.

[9]. Hess, V.F. (1964). Solar physics, Z., 14, 611

[10]. Kane, R.P. solar physics P. 2002 J. 29,450-500.

[11]. Kour, S. (1998). M.phil Dessretation, A.P.S.U, Rewa.

[12]. Krieger, A.S. and Timothy (1973). Solar physics, 9, 305.

[13]. Mishra, A.P. (1997). Ph.d thesis, A.P.S University, Rewa.

[14]. Mishra V.K., (2001) Ph.d. thesis. A.P.S.U. Rewa.

[15]. NASA (2007). "Ancient Sunlight". *Technology through Time* (50). Retrieved 2009-06-24

[16]. Patil, L.P. (2005).M.phil Dissertation, A.P.S.U, Rewa.

[17]. Prithvi Raj Singh, Shabir Ahmad, AC Pandey, A.K.Saxena, CM Tiwari, AP Mishra(2017)International Journal of Astronomy and Astrophysics.7(03)162.

[18]. Sham singh, Divya shrivastava, AP Mishra. (2012). Indian Journal of Scientific Research.3 (2)121.

[19]. Sham singh, Divya Shrivastava, Shri Ram Lahauriya, Adya Prasad Mishra (2012). Natural science.4 (6) 349.

[20]. Sham singh, AP Mishra. (2016) Journal of Pure Applied and Industrial Physics. 6(11) 190-198.

[21]. Sham singh, AC Pandey, Kalpana Singh, AP Mishra. (2017).) Journal of Pure Applied and Industrial Physics. 13(1)35-43.

[22]. Shrivastava, 2001, .astrophys Astro. Res.29.293-302.

[23]. S. singh, A. P. Mishra (2015). Indian Journal of Physics.

[24]. Shukla, U.K. 92008). M.Phil. Dessertation, A.P.S.U, Rewa.

[25]. Tiwari, D.P, Tiwari, C.M. Agerwal, S.P, and shrivastava, P.K. (2004) J. current science.5 (1) 133.

[26]. Tiwari, C.M., pandey, G.K., Mishra, M.G. 85 khare, N.; M.phil. Disseertation A.P.S.U; 1998.

[27]. V. K. Mishra, A. P. Mishra (2016) International Journal of science, Engineering and Technology Research. 5(2) 390-394.

[28]. V. K. Mishra, A. P. Mishra. (2018) Solar Physics. 293(10)141.