ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 8.4
IJAR 2023; 9(5): 230-233
www.allresearchjournal.com
Received: 04-03-2023
Accepted: 06-04-2023

Rahul Kumar Patle
Research Scholar Physics, Department of Physics, APS University, Rewa, Madhya Pradesh, India

Dr. AK Saxena
Professor, Department of Physics, APS University, Rewa, Madhya Pradesh, India

Dr. Laxmi Tripathi
Department of Physics, Govt. Model Science College, Rewa, Madhya Pradesh, India

Dr. CM Tiwari
Department of Physics, APS University, Rewa, Madhya Pradesh, India

Corresponding Author:
Rahul Kumar Patle
Research Scholar Physics, Department of Physics, APS University, Rewa, Madhya Pradesh, India

Study of variability of cosmic ray in descending phase of solar cycle 24

Rahul Kumar Patle, Dr. AK Saxena, Dr. Laxmi Tripathi and Dr. CM Tiwari

Abstract
In this paper, we examine the current solar cycle 24 and compare it to the previous solar cycle. A series of 24 solar currents from late 2006 to 2020 show a solar minimum similar to the Dalton minimum. In estimating the solar dynamo, the number of suns is often used as solar activity, which affects climate change. According to the observation, the solar minimum from the 23rd to the 24th solar activity from 2007 to 2009 is the longest in at least 100 years. It looks like the sun will enter the next solar eclipse. Our goal is to find the truth about the behavior of the sun during the current 24 solar seasons.

Keywords: Sunspot numbers (SSN), solar cycle (SC), Dalton minimum (DM), gleissberg minimum (GM)

Introduction
The sunspot number (SSN) is used as an important factor in understanding the behavior of solar activity occurring in the sun's photosphere. It has very high magnetic fields of up to a thousand gauss and is cooler than its surroundings, so it is like a dark spot in the sun's photosphere. The sun number is usually calculated using Wolff's diurnal number or Zurich's Rz number and states:

$R_z = k\,(10g + s)$

Where: S is the number of individual spots, G is the number of sunspot groups, and K is a factor that varies with location and instrumentation [1].

Fluctuations in space weather depend on the variability of the Sun, mostly expressed in sunspot numbers (SSN). Sunspot cycles appear in the photosphere of the Sun's disk with an average cycle period of 11.2 years, during which time the polarity of the sunspot magnetic field changes to the opposite sign in the northern hemisphere than in the southern hemisphere. The polarities of previous spots shift from one cycle to the next as the solar field reverses polarities over a period of ~22 years (Hale cycle)[3]. It is great to study the behavior of the solar activity of solar cycle 24 with respect to the period of solar minima, such as the Maunder minimum (1645-1715), Dalton minimum (1790-1830), and Gleissberg minimum (1889-1923) in which observed minimum solar activity [2, 4].

Solar cycle 24 begins after a deep solar minimum during the 2007-2008 Solar Cycle 23 descent and the 2008-2009 Solar cycle 24 ascension. In fact, hardly any sunlight was observed between 2008 and 2009, making this a very unusual event at a time when the sun was at least a hundred years old. 24. The cycle's peak activity and unusual patterns will be discussed with reference to solar cycle [5]. Solar radiation activity continues to decrease from 20 to 23 of the solar cycle [6].

It has been observed that the solar activity cycle is an important factor for study of hemispheric atmospheric conditions which mainly depends on the sun spot numbers, its area and magnetic property appears in the photosphere of the Sun. It is therefore important for long-term space-weather predictions to understand the rate of formation of different types of sunspots during a solar cycle and the possible consequences for the long term behavior of geomagnetic activity in an ascending and descending phase of the solar cycle [7, 8, 9, 10].

For the present study we have selected the solar activity parameter SSN from 1700 to 2015. It is observed that from descending and ascending period of solar cycle 23 and 24, such as 2007 to 2008 and 2008 to 2009, there were almost no sunspots observed for 265 days and

262 days respectively, this unusual solar activity occurs after almost a century and seems to progress like a period of Dalton minimum [11, 12, 13].

Data and method of analysis

In this work, we have taken the solar indices data of monthly mean and smoothed monthly mean count of sunspot numbers (SSN) during the period of 1750 to 2015, and yearly mean sunspot numbers (SSN) during the period of 1700 to 2020 from the website of NOAA which is available in the public domain for a long period of time and it is publishing "Solar Geophysical Data" every month from NOAA [14], Boulder Colarado, USA.

In this paper we have selected the solar activity parameter sunspot numbers (yearly mean, monthly mean and smoothed monthly mean of SSN) during the period of Dalton minimum (1790-1830), Gleissberg minimum (1889-1923), and period of solar cycle 20 to present solar cycle 24. We have compared the long term behavior of sunspot cycle during the period of Dalton minima and present solar cycle 24. The data available for the cycle 24 from 2006 to till now shows a strange behavior in respect to solar activity during minima and maxima of solar cycle. The maximum sunspots have been counted up to 146.1 only till now, and it seems that the present cycle now going to follow decline phase.

We have plotted line –graph by taking the Year as (common) axis and SSN as Value axis for the period of Dalton Minimum, Gleissberg Minimum, and present solar cycle 24. We have plotted separate graph for comparing the behavior of solar cycle 24, by taking yearly mean (from 1700-2020) and smoothed monthly values (from 1750-2020) of sunspot numbers. The facts of solar activity during the periods of solar minima of various solar cycles are shown in the Table-1.

Table 1: Maximum monthly mean Sunspot numbers (SSN) observed during the period of various solar cycles

Period of minimum Solar activity	Solar Cycle	Monthly mean SSN /Year
Dalton minimum (1790-1830)	SC-5	62.3 (Oct. 1804)
	SC-6	96.2 (March 1817)
	SC-7	106.3 (April 1830)
Gleissberg minimum (1889-1923)	SC-12	129.2 (Aug. 1893)
	SC-13	108.2 (Feb. 1907)
	SC-14	154.5 (Aug. 1917)
Present Solar Cycle (2006-2020)	SC-24	139.1 (Nov. 2011) 146.1 (Feb. 2014)

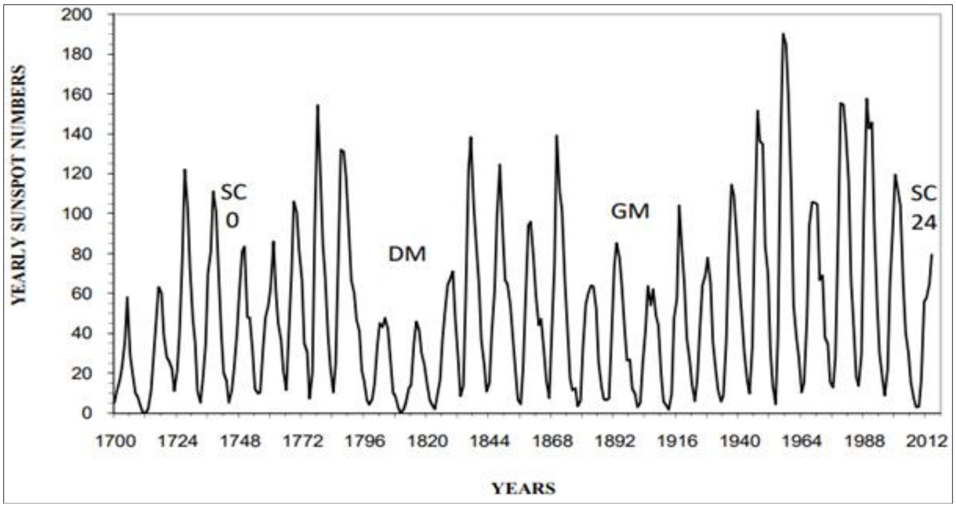

Fig 1: Shows the yearly mean value of sunspot numbers from 1700 to 2020, indicating the period of Dalton minimum and Gleissberg minimum.

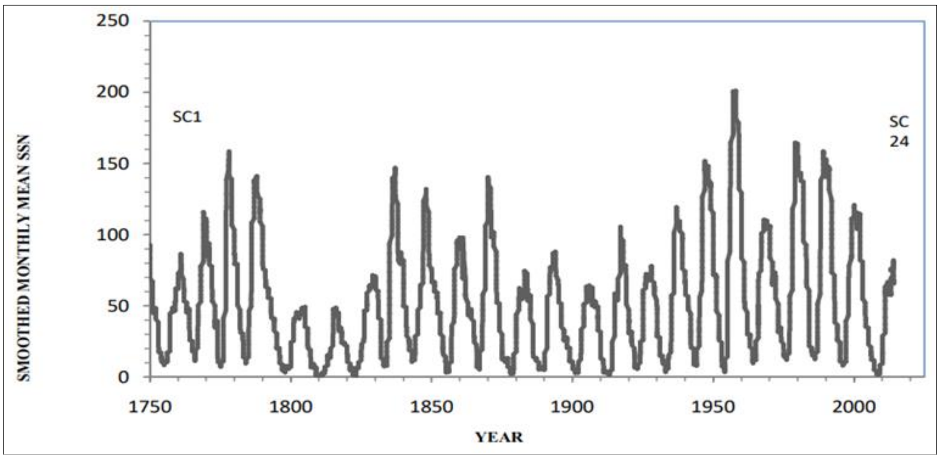

Fig 2: Shows the smoothed monthly mean sunspot numbers from 1750 to 2020

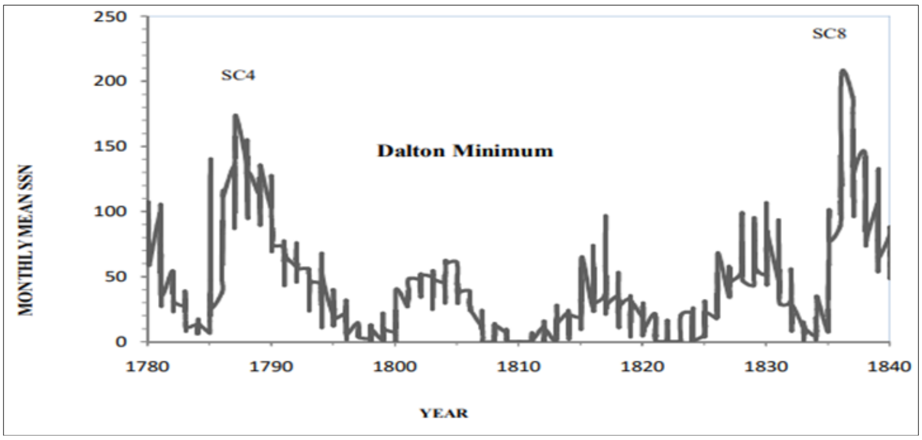

Fig 3: Shows the monthly mean count of sunspot numbers for the period of Dalton minimum from 1790 to 1830 observed minimum solar activity for solar cycle 5, 6 and solar cycle 7

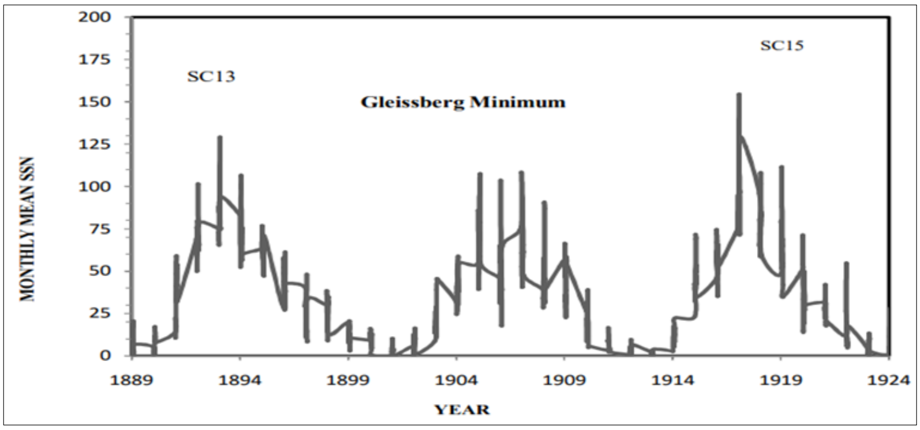

Fig 4: Shows the monthly mean sunspot numbers for the period of Gleissberg minimum from 1889 to 1923 as low solar activity cycle for solar cycle 13 to solar cycle 15

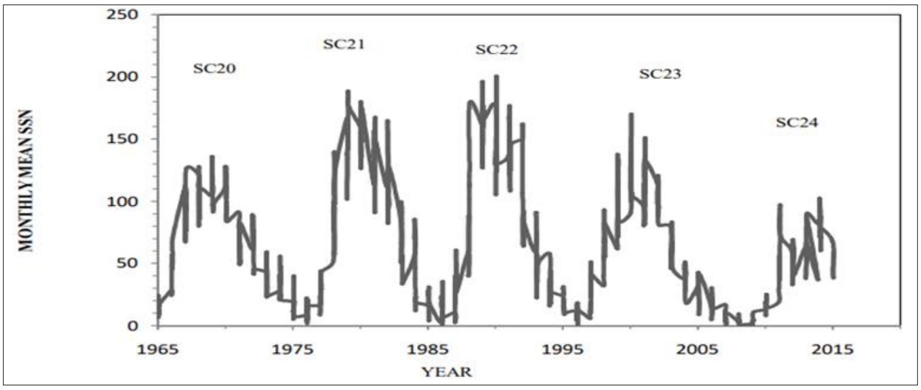

Fig 5: Shows the monthly mean count of sunspot numbers from the solar cycle 20 to solar cycle 24

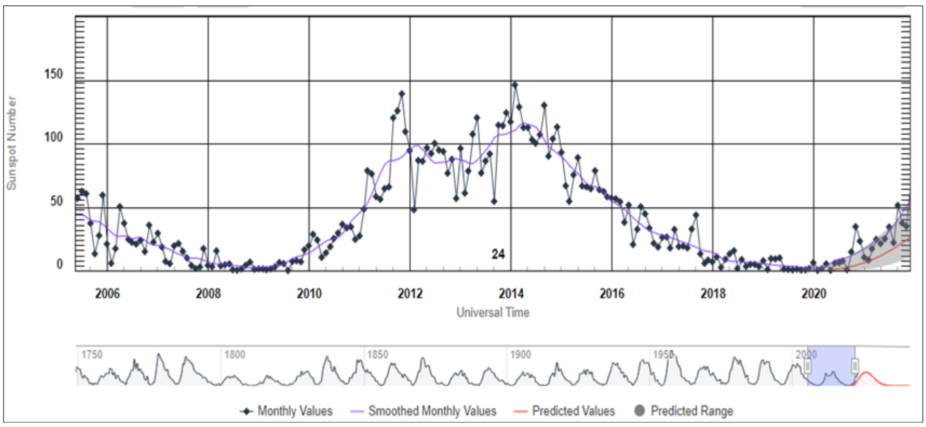

Fig 6: Shows the 1st and 2nd peak values as monthly count of sunspot numbers of solar cycle 24

Result and Discussion

It is found that from the time series analysis of long term behavior of sunspots data set of about 265 years from the period of 1750 to 2020, the solar activity of present solar cycle 24 is progresses similar to the solar activity of the period of Dalton minima. In Table-1 maximum monthly mean sunspot numbers observed in minimum solar activity period is shows that the behavior of present solar cycle 24 is more close to the age of the Dalton minima. In Dalton minimum period the maximum sunspot numbers has been observed (96.2 in march 1817 and 106.3 April 1830) which is more close to the 1st and 2nd peek values observed (139.1 and 146.1) of present solar cycle (Figure - 6) as well as to Gleissberg minimum period. These findings of the low solar activity of solar cycle 24, which is in decline phase, passes more than half age of the period of 11 years cycle shows in fig.6, it is clearly apparent that the present solar cycle is minimum solar activity cycle and it is progresses to become a minimum solar activity cycle after a century. By comparison of solar activity behavior of the Dalton minimum (Figure-3). Gleissberg minimum (Figure-4) and present solar cycle (Figure - 5 and 6) is strongly validates our prediction. Figure-1 and 2, indicates that the present solar cycle 24 is continuously in declining phase and a very week solar activity cycle, which influences the space weather, outer atmospheric conditions of the Earth.

Conclusion

Conclusion for the current solar cycle 24 are based on an analysis of a 265-year historical record. Solar Cycle 24 appears to follow the Dalton minimum solar cycle. More than half of its 11-year cycle provides strong evidence that the solar system is weak and affecting the atmosphere. The long period of the current solar cycle from full cycle to present with low solar activity can give us a unique opportunity to understand solar changes.

References

1. Kilcik A, VB Yurchyshyn, A Ozguc, JP Rozelot. Solar Cycle24: Curious change in the relative numbers of Sunspot Group types, The Astrophysical Journal; c2014.
2. William Dean Pesnell. Predictions of Solar Cycle 24, Solar Phys. 2008;252:209-220.
3. Ahluwalia HS. Three-cycle quasi-periodicity in solar, geophysical, cosmic ray data and global climate change, Indian Journal of Radio and Space Physics. 2012;41:509-519.
4. Usoskin IG, K Mursula, GA Kovaltsov. Cyclic behavior of sunspot activity during the Maunder minimum, Astron. Astrophys. 2000;354:L33-L36.
5. Gupta Meera, SR Narang, VK Mishra, AP Mishra. Correlative Study of Solar Activity and Cosmic Ray Intensity Variations during Present Solar Cycle 24 in Comparison to Previous Solar Cycles, Int. Journal of Engg. Tech. Manag. And Appl. Sciences. 2014;2:104-115.
6. Gupta Meera, VK Mishra, AP Mishra. Solar activity parameters and their interrelationship: Continuous decrease in flare activity from solar cycles 20 to 23, J. Geophysics. Res; c2007. p. 112.
7. Yoshida A. Difference between even and odd numbered cycles in the predictability of solar activity and prediction of the amplitude of cycle 25, Ann. Geophys. 2014;32:1035-1042.
8. Boris Komitov, Vladimir Kaftan. The sunspot cycle no. 24 in relation to long term solar activity variation, Journal of Advanced Research. 2013;4:279-282.
9. Tlatov AG, VI Makarov. Indices of Solar Activity in minimum of Sunspot Cycles, ASP Conference Series; c2005. p. 346.
10. Miyahara, Hiroko, Yusuke Yokoyama, Yasuhiko T. Yamaguchi, Influence of the Schwabe/Hale solar cycles on climate change during the Maunder Minimum, Solar and Stellar Variability; Impact on Earth and Planets IAU Symposium; c2009. p. 264.
11. Svalgaard Leif, Edward W, Cliver Yohsuke Kamide. Sunspot Cycle 24: Smallest Cycle in 100 Years, ASP Conference Series; c2005. p. 346.
12. Watari S. Low solar activity around minimum of cycle 23 and expected amplitude of cycle 24, ASP Conference Series; c2012. p. 454.
13. Suyeon Oh, Bogyeong Kim. Variation of Solar interplanetary and Geomagnetic Parameters during Solar Cycles 21-24, Journal of Astronomy and Space Science. 2014;30:101-106.
14. NOAA. Space Weather Prediction Center, National Oceanic and Atmospheric Administration; c2023. https://www.swpc.noaa.gov/products/solar-cycle-progression.