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Impact of Cosmic Rays in the Earth's Atmospheric

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Abstract
In the present study, we used monthly data from the Grouped Solar Flare Index (GSF) and cosmic ray intensity (CRI) during solar cycles 22 to 24 in our correlative study. There is a strong and positive association between these solar indices. We have employed sunspot numbers and clustered solar flares as trustworthy solar metrics. "The running cross-correlation" approach has been used in a comprehensive correlative analysis. Using statistical and correlative research, we find a strong negative association between solar activity and cosmic rays. Our findings corroborate the previous observations made for solar cycles 18 to 20. When the most suitable solar activity index (GSF) is applied, the impacts are shown to be noticeably different in the four solar cycles 22 to 24, which calls for more short-term research. Furthermore, compared to other solar activity indicators, Earth's temperature is observed to follow decade changes in galactic cosmic ray flux and solar cycle duration more closely. The primary conclusion is that Earth's atmospheric conditions are influenced by the heliosphere's average state.

Keywords: Cosmic Ray Intensity, Solar Activity and Geomagnetic Activity.

1. Introduction

Sunspot counts are typically employed to estimate solar activity because they are a dependable and accessible solar parameter. Regretfully, there isn't a singular solar activity measurement that may be employed as a solar parameter in research on cosmic rays. Since sunspot regions are the source of Grouped Solar Flare, sunspot counts have been utilised as an active and trustworthy metric. Heliospheric modulation affects the energy and spectrum of galactic cosmic rays in the energy range of few hundred MeV to few GeV over the 11-year solar activity cycle due to variations in solar output. The established relationship between the fluctuation in cosmic ray strength and the sunspot number for the 11/22 year is inverse. However, in general but generally, it is seen that the maximum / minimum of sunspot numbers does not coincide with minimum/maximum of cosmic ray intensity. Popielawska [1] and others [2-3] have reported a detailed study, examining sunspot numbers and cosmic ray intensity data to demonstrate the relationship between the sunspot cycle and cosmic rays. A novel statistical method called "running cross correlation" has been applied recently to investigate the relationship between sunspot number (SSN) and CRI. This work aims to investigate the relationship between CRI and solar activity, as measured by SSN and GSF, using statistical techniques throughout the 1974–2003 timeframe (solar cycles 22, 23 and 24).
When the activity period shifts from the lowest to the maximum, the flow of cosmic ray particles with energy between 0.1 and 15 GeV falls by more than two times, while the low energy cosmic ray particles

(energy < 15 GeV) undergo an 11-year modulation. This energy range, which contains more than 60% of the total energy of cosmic ray particles, is where around 95% of cosmic ray particles are found [3, 4-6]. Since all of the energy is utilised to excite and ionise air atoms, the effect of cosmic rays ought should be most pronounced when activity is at its lowest. 23) [7, 8].

One of the main causes of the Little Ice Age may have been the low solar magnetic activity during the Maunder minimum and prior eras [4,9]. The lack of a strong magnetic field zone on the Sun's surface during the Maunder minimum may have changed the solar wind's trajectory, altering the properties of cosmic rays that strike the Earth's atmosphere. Low GCR flux is associated with a warmer temperature, whereas high GCR flux is associated with a cooler climate, according to research by Kirkby [4].

Ultra-fine particles created by cosmic ray ionisation in the troposphere and stratosphere have the potential to serve as cloud condensation nuclei [10–13]. By dispersing solar radiation in a forward direction and so effectively lowering the solar constant, the aerosol layers also significantly affect the thermal balance of the Earth's atmosphere [14].

2. Methodology

Various statistical and data science methods are applied to analyse the outcomes. For both short- and long-term investigations of cosmic ray modulation, a variety of graphs, charts, plots, and correlations have been taken into consideration. Regression analysis will be used. An analysis of the connection between a collection of independent factors and a dependent variable is called regression research. As a descriptive data analysis method, regression analysis may be applied without assuming anything about the underlying processes that produce the data. Data source: National Geophysical Data Centre (http: PoS(ICRC2023)1312 http://www.ngdc.noaa.gov/stp/SOLAR/ftpsunspotnumber.html), www.geomag.bgs.ac.uk/daaservice/dat. These datasets ought to depict distinct 11-year cycles at a temporal resolution that is ideal for solar cycle forecasting. Since 1868, such data has been accessible through geomagnetic indices. Using eastern naked eye records and aurora observations, attempts have been made to recreate the age and even the amplitude of the solar maximum during the past 2000 years [15, 16]. But there are currently too many unknowns in these reconstructions to utilise them as a foundation for forecasting.

3. Results and Discussion

Talk The pressure-corrected monthly cosmic-ray values are derived from the 1950–2003 Kiel neutron monitor data. The sunspot number mean values are derived from solar geophysical data. The fundamental cause of the change in cosmic ray strength is the outward correlation of solar outputs, which are often linked to sunspots. Sunspots, on the other hand, are features of the solar surface and have no direct relationship to the interplanetary parameters, which are constantly changing. Grouped solar flares are regularly produced by assigning duration and significance weights [17, 18].

To quantify the daily flare activity scale and t the flare length (in minutes), the group of index solar flare index was originally created in 1952 by adding Q = it. This connection should provide (about) the entire energy that the flare emits. Sunspot counts are often utilised as a long-term, reliable indicator of solar activity. The CRI data have been normalised for this study.

To track the solar cycle's link between sunspot number and cosmic ray (22–24). It has been determined what the correlation coefficient is between these two parameters' monthly mean values. One neutron monitor, Kiel, a mid-latitude site, has had its monthly mean cosmic ray data adjusted for pressure

measured. Over the past four to five decades, it has been noted that there is often an inverse relationship between solar activity and the long-term cosmic ray intensity [19-23]. Moreover, it has been noted that the precise month of solar activity maximum and minimum does not match the maximum and lowest of cosmic ray activity. Even though the correlative analysis in the earlier research was carried out over a far longer period of time [24-26]. Thus, over the years 1950–2003, the long-term fluctuation of GSF with CRI for the Kiel neutron monitor is displayed. Figure 1 makes the overall inverse link between GSF and CRI very evident. Furthermore, it is seen that the degree of anti-correlation varies qualitatively with time. We have carried out "running cross-correlation analysis between these two parameters" in order to quantitatively monitor the change in the correlation coefficient between GSF and CRI for Kiel.).
Oulu (0.81 GV), Moscow (2.41 GV) and Beijing (9 GV) limit stiffness. 56GV).

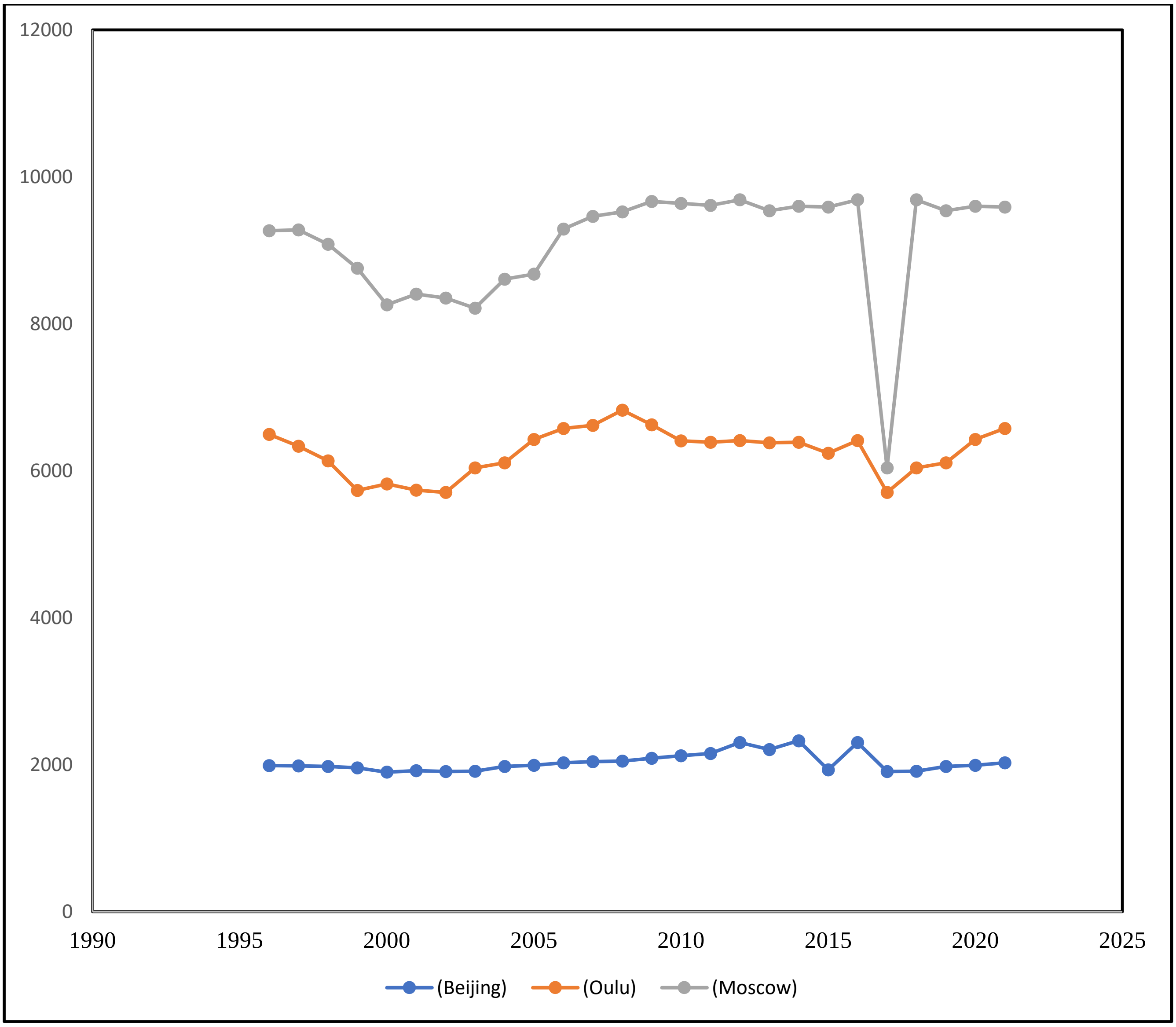

Fig 1: - Neutron monitor stations Beijing, Oulu &Moscow from years 1996 to 2021.

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Fig 2: Yearly values of cosmic rays' intensity for Oulu stations along withGeomagnetic Solar index (Ap), Vector magnetic field (V*B) & sunspot number (Rz) for years 1996-2021.

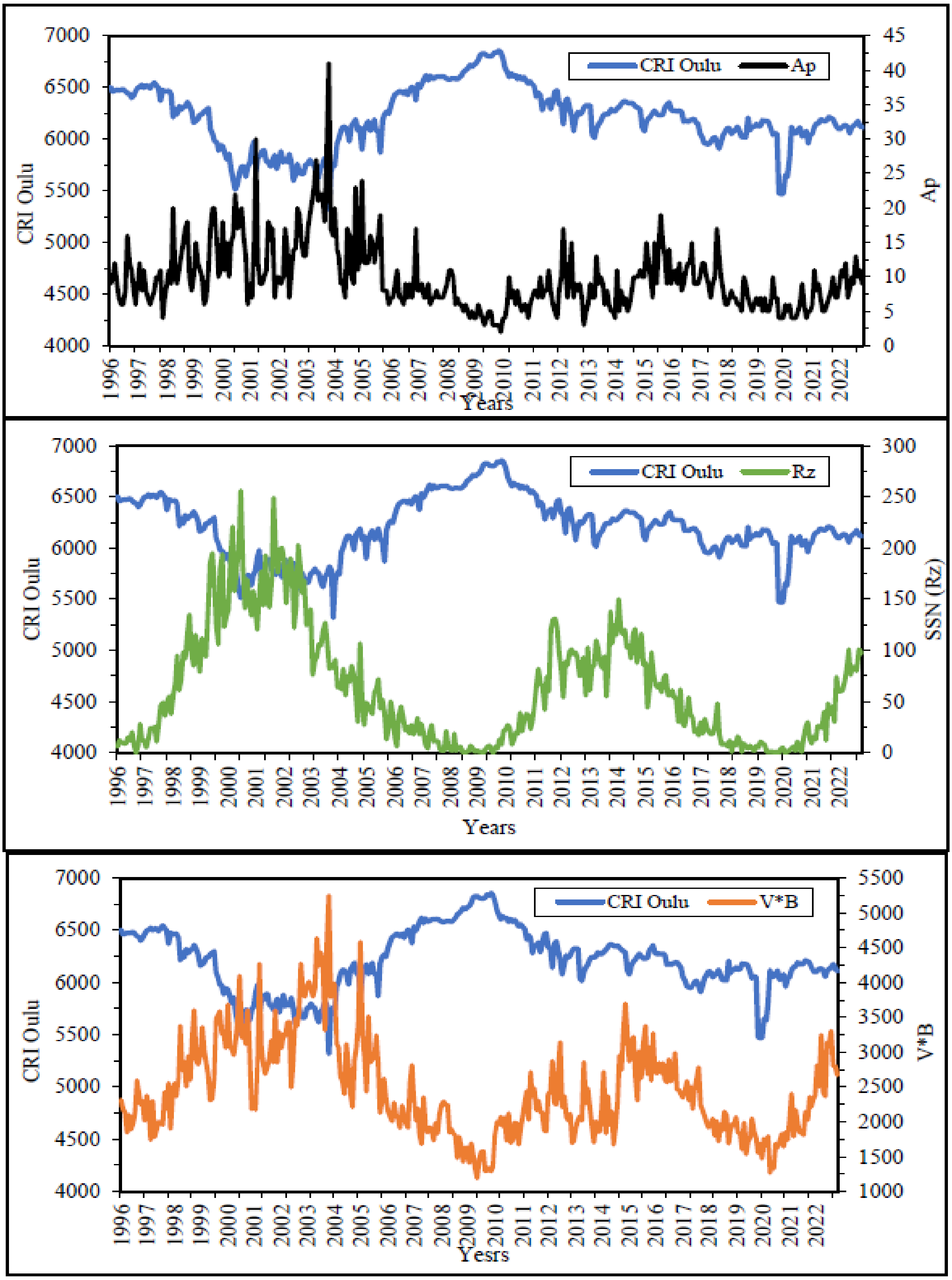

Fig 2: Yearly values of cosmic rays' intensity for Oulu stations along withGeomagnetic Solar index (Ap), Vector magnetic field (V*B) & sunspot number (Rz) for years 1996-2021.

suggests that the energy and long-lived significant solar flares (appropriately included into the GSF preparation) are far more potent. We discover that in solar cycle 22, GSF is often lower.

Conclusions

This study leads to the conclusion that GSF is a superior index to select for any extended research on variations in cosmic rays. Furthermore, it is noted that by utilising the data on a daily basis, the observed difference in the cross-correlation function for the solar cycles 22, 23 and 24 using GSF can be further investigated on a short-term basis for the entire period of 1967–2001. This is especially true given that the depth of modulation is larger in solar cycle 23 than in solar cycle 22, despite the fact that GSF is exhibiting a reverse tendency.

During periods of high solar activity, the Sun emits more matter and electromagnetic fields, which increases the difficulty of Galactic cosmic rays reaching Earth. When solar activity is strong, cosmic ray intensity is lower. Right now, there is a high cosmic ray intensity and little solar activity. The number of sunspots will rise soon, and the strength of cosmic rays will begin to fall.

References

1. Popielawska B, Planet & Space Sci (UK). 40, 811 (1992).
2. P.K. Shrivastava, Proceedings of 25th Int. Conf. on Cosic Ray, Durban (1997), 2, 65.
3. M. Singh et al., Proc. Natl. Acad. Sci. India A, Phys Sci (India), 68, 111 (1998).
4. K Mursala and T Ulich Geophys. Res. Lett. 25 1837 (1998)
5. J Lean, A Skumanich and O White Geophys. Res. Lett. 19 1591 (1992)
6. A R Choudhuri, P Chatterjee and J Jiang Phys. Rev. Lett. 98
7. R Kane Solar Phys. 205 383 (2002)
8. S Dubey and A P Mishra Indian J. Radio Space Phys. 29 51 (2000)
9. S Singh, D Shrivastava, S Lahauriya and A Mishra Nat. Sci.4 349 (2012)
10. R Ehrlich J. Atmos. Sol. Terr. Phys. 69 759 (2007)
11. Sham Singh, Mahender Pal, Pawan Kumar, Amita Rani, Namrata Thakur, Kalpana Singh and A. P. Mishra The Relationship between Cosmic Ray Intensity, Sunspot Cycle with Geomagnetic Activity PoS(ICRC2023)1312, University of Tokyo, Japan
12. Sham Singh Cosmic-Ray Modulation in relation to Solar and Heliospheric Parameters PoS(ICRC2023)1310, University of Tokyo, Japan
13. S Dubey and A Mishra Earth Moon and Planets (Netherlands) 84 23 (2000)
14. J Feynman and X Y Rev. Geophys. 24 650 (1986)
15. E Chernosky J. Geophys. Res. 71 965 (1966)
16. S Singh, D Shrivastava and A P Mishra Indian J. Sci. Res. 3 121 (2012)
17. J L Wang, W G Zong, G M Le, H J Zhao, Y Q Tang and Y Zhang Res. Astron. Astrophys. 9 133 (2009)
18. T Atac and A Ozguc Sol. Phys. 180 397 (1998)
19. M Lee and L Fisk Astrophys. J. 248 836 (1981)
20. R Kane Ann. Geophys. 25 2087 (2007)
21. S Singh and A P Mishra Indian J. Phys. 89 1227 (2015)
22. L Burlaga, F McDonald, M Goldstein and A Lazarus J. Geophys. Res. 90 12027 (1985)
23. B Popielawska Planet Space Sci. 40 811 (1992)
24. G Brown and W Williams Planet Space Sci. 17 455 (1969)

25. S Narang, M Gupta and A S Gaur Res. J. Phys. Sci. 4 5 (2016)
26. J Kirkby, Surv Geophys, 28, 333-375 (2007)
27. J Lean, A Skumanich and O White, Geophys. Res. Lett. 19, 3195 (1992)