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Study of solar parameter and interplanetary medium with geomagnetic parameter on the solar cycle 24

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Abstract
We have studied the trend of solar interplanetary with geomagnetic indices during solar cycle 24 move upward phase of recent cycle. The sunspot number (Rz), interplanetary magnetic field and geomagnetic indices indicate a trend during solar cycle 24. In the solar cycle 24, the sunspot numbers (Rz), IMF and geomagnetic indices represent the periodic nature, with a low peak. We found a positive correlation among sunspots numbers (Rz), IMF and geomagnetic indices. This means that during this period there is a large difference between the maximum and minimum. Solar cycle 24 had a smaller magnitude of the cosmic ray decrease in the present cycle. Through continuous wavelet transform, we found that IMF, sunspot number, and indices all have the highest variability from beginning of cycle to end of cycle. We suggest that these unique condition of solar interplanetary with geomagnetic indices have originated from solar activity
Keywords: - Sunspot Numbers, Interplanetary magnetic field (IMF), geomagnetic indices.

1. Introduction

The Sun's gases are constantly flows, which masses, elasticities and rotations the magnetic fields. This motion creates a lot of activity on the Sun's surface, called solar activity. Sometimes the Sun's surface is very active. The solar activity shows periodically variation from days to thousands of years (Adikari Binod. et al,2019). Sunspot are dark magnetic field areas create in the interior of the sun. They are continuously examined on the solar surface. Sunspot is most reliable parameter for correlation cosmic ray decreases, interplanetary medium and geomagnetic indices also. Study of cosmic rays and their propagation in the effect of the large-scale structure of the interplanetary medium. Its correlation of the cosmic ray intensity variation through Neutron monitor intensity with variation of sunspot number, geomagnetic indices, interplanetary magnetic field (B), near the Earth for the period solar cycle24 (D.Lingri, et al.2016,Badruddinn kumar,A.,2015, Shrivastava,P., 2005).
It has been proposed that the sunspot number provide a proxy for the long-term changes in the interplanetary magnetic field (Shirish K. Persai et al,2013). According to Usoking (2005) the variation in cosmic ray intensity exhibits a strong sensitivity to sunspot numbers during a period of low solar activity and relative invariance at a time of higher solar activity. Pankaj K. Shrivastava et al. (1996) reported that various solar controlled disturbances in interplanetary medium represent by solar flare, coronal holes, solar wind stream produced significant decrease in cosmic ray intensity as well as enhancement in geomagnetic field.

2. Data Source & Methodology

we take the daily data pressure corrected (counts of neutrons) of cosmic ray intensity from Oulu neutron monitor (NM) have been used, where the short-term change from the data has been removed by the method of trend correction. The days of cosmic ray decreases have also been removed from the analysis to avoid their influence in cosmic ray variation. Interplanetary magnetic field and geomagnetic indices data have been taken from the omni web dataset (https://omniweb.gsfc.nasa.gov)

3. Results and Analysis

In the table shows are solar activity, solar interplanetary and geomagnetic indices are found the year wise during solar cycle 24**.** Following the previous studies, the sunspot numbers (*R*z), interplanetary magnetic field and geomagnetic indices indicate inclination of such parameters. In this duration the sunspots numbers (*R*z), IMF (B_z) and geomagnetic indices showing the periodically (Shrivastava, P.2005). We found a positive correlation among sunspots numbers (R_z), IMF (B_z) and geomagnetic indices & all analysis showing in graphs.

Table: Different parameters year wise are SSN, IMF, Dst, Ap and FDS

Year	SSN	IMF	Dst	Ap	FDS
2008	4.15	4.18	-30	4.2	1.84
2009	4.75	3.88	0	0	0
2010	24.9	4.7	-48	16.45	2.2
2011	80.75	5.24	-48	5.91	2.85
2012	84.39	5.8	-52	13.52	2.98
2013	93.7	5.17	-52.63	11.94	2.46
2014	113.6	6.09	-33.94	13.88	2.39
2015	69.78	6.67	-6.55	19.7	2.54
2016	39.82	6.02	-53.88	7.33	1.83
2017	21.81	5.24	-48.7	10.6	2.31
2018	7	4.65	-59	14.66	1.66
2019	3.58	4.5	-53	20.5	1.55

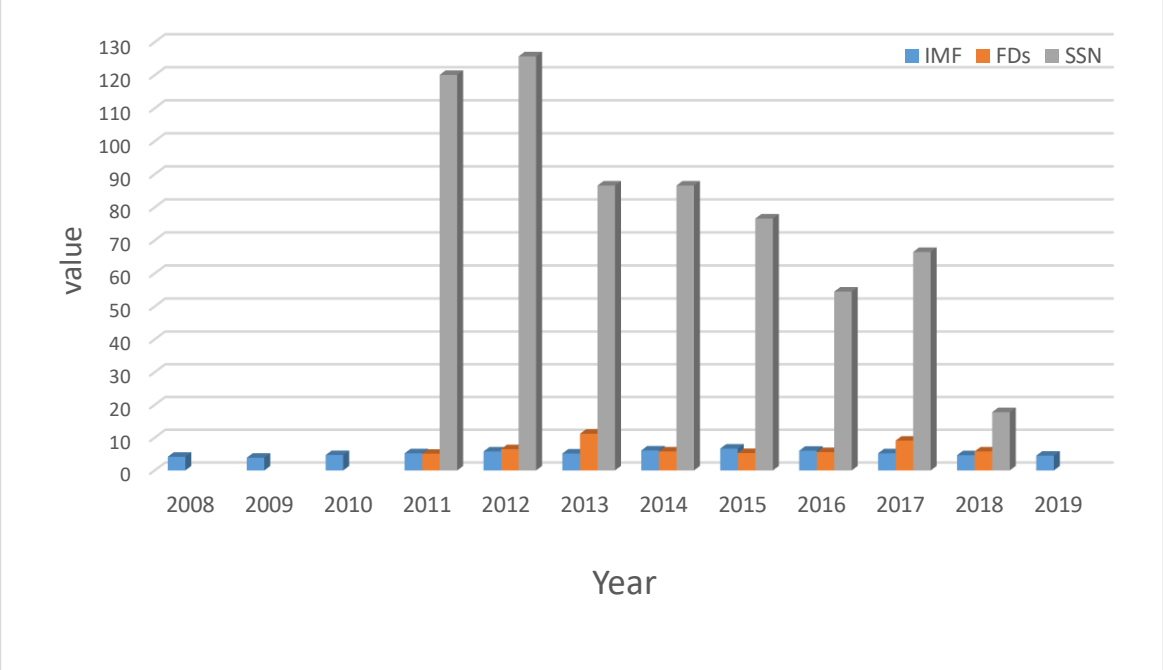

Figure-1 Show the trend of IMF, FDs and SSN during solar cycle 24.

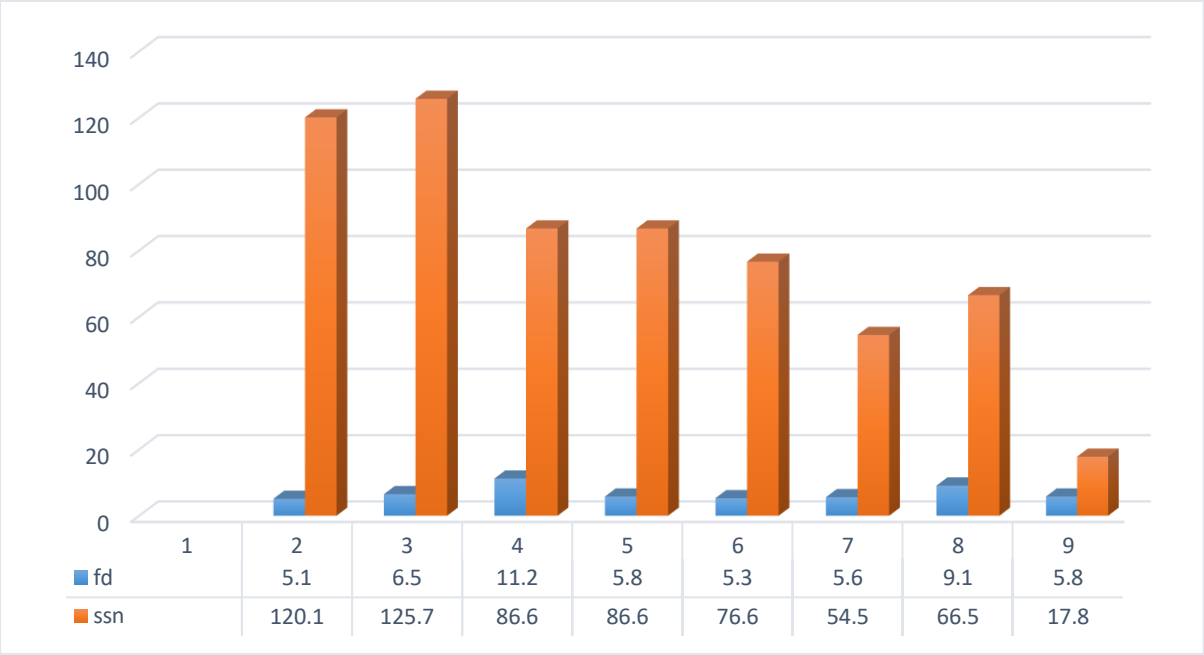

Figure-2 Show the trend of CR-FDs vs SSN during solar cycle 24.

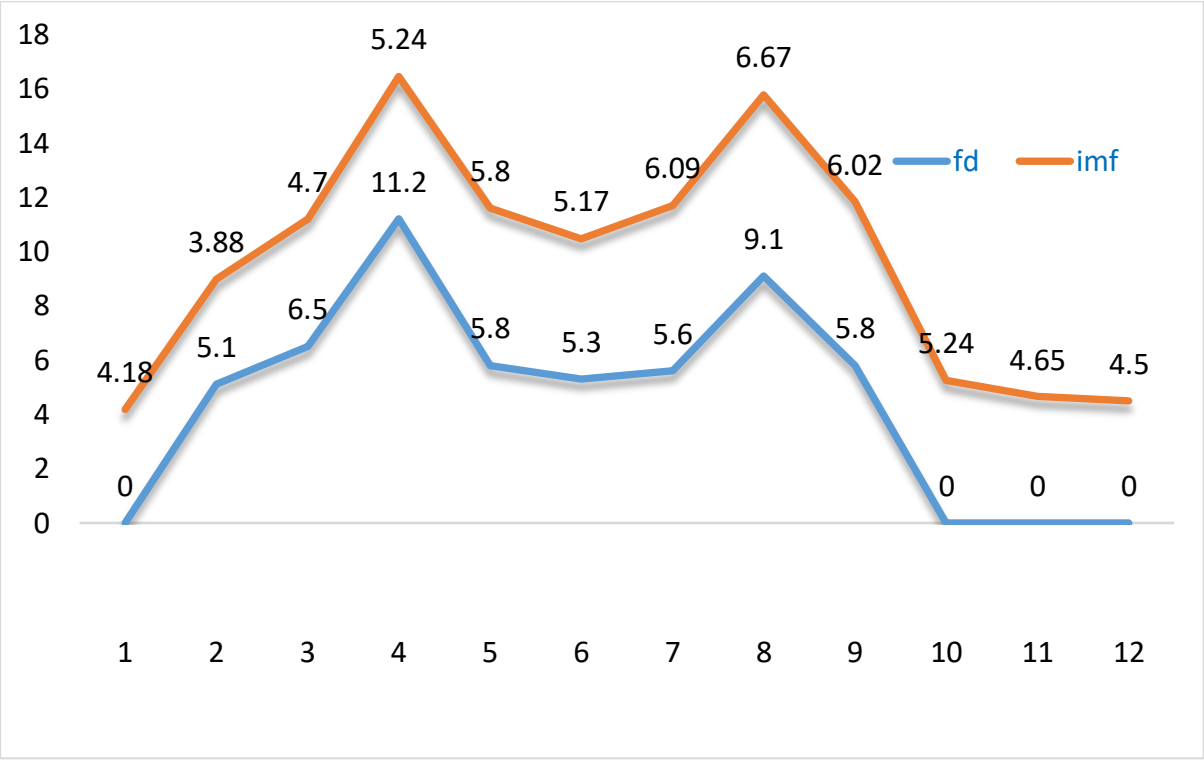

Figure-3 Time profile variation of CR-FDs vs IMF during solar cycle 24.
(Where in X - axis 1-12 shows the year respectively 2008 to 2019)

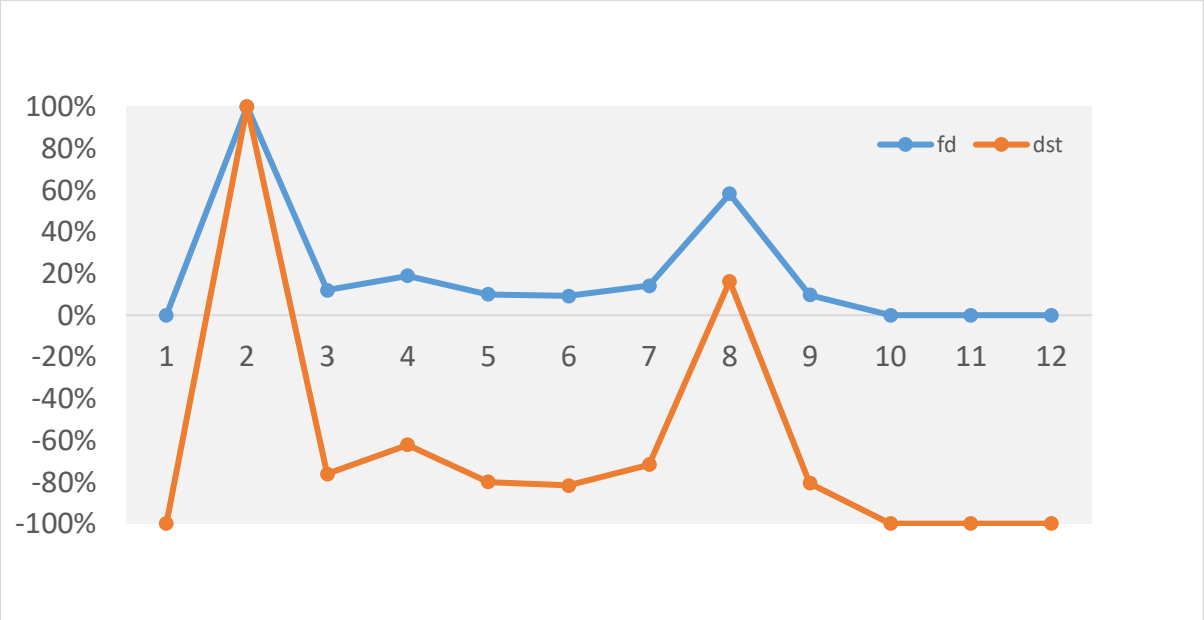

Figure-4 Time profile variation of CR-FDs vs dst during solar cycle 24.
(Where in X- axis 1-12 shows the year respectively 2008 to 2019)

Fig 1 shows the trend of IMF, FDs and SSN during solar cycle 24. We found that the maximum increase in SSN in 2012, IMF in 2015 and FDs in 2013, while maximum decrease in SSN in 2019, IMF in 2009 and FDs in 2009. We also found that from fig.2 CR-FDs show a different periodicity with SSN. From fig. 3 we found a positive trend between CR-FDs and IMF. These employs that when CR-FDs increases, IMF also increases and when CR-FDs decreases IMF also decreases. We also examined that both peak of CR-FDs and IMF coincide with each other. We also investigated from fig 4 that CR-FDs and dst show a same periodicity, when CR-FDs increases, dst also increases and when CR-FDs decreases, dst also decreases, both achieve their maxima and minima at same time of period.

4. Conclusion

Our observation on the basis of previous studies the trend of solar activity, solar interplanetary and geomagnetic indices during solar cycle 24 following as-

1. The sunspot numbers (*Rz*), interplanetary magnetic field and geomagnetic indices indicate positive trend during solar cycle 24.
2. In the solar cycle 24, the sunspots numbers (*Rz*), IMF (Bz) and geomagnetic indices represent the periodic nature.
3. We found that CR-FDs is highly IMF and dst effective.
4. We investigate that CR-FDs, IMF and dst achieve their maxima and minima at same period.
5. Solar cycle 24 had a smaller magnitude of the cosmic ray decreases in the present cycles.
6. We found that IMF, sunspot number, indices all have the highest spectral variability from beginning of cycle to cycle.

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Conflict of Interest

The authors potentially declares that no conflict in this manuscript.

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