ORIGINAL RESEARCH PAPER

Physics

CORRELATIVE STUDY OF INTERPLANETARY MAGNETIC FIELD (IMF) WITH SOLAR INDICES DURING PERIOD 2008-2020

KEY WORDS: Interplanetary Magnetic field (IMF) (B), Sun-spot Number (Rz), Solar Wind Velocity (V), Ap-Index and Disturbance Strom Time (Dst).

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ABSTRACT

Burnberg & Deter (1954) have observed spatial anisotropy & attributed it to the existence of the extra cosmic ray particles arriving from asymptotic direction 1800 hours' local time. Long term variations of cosmic ray intensity are related to 11 year-period of solar activity related by sunspot number & the 22 year period of solar magnetic polarity cycle. Bush (1954) demonstrated for the first time sunspot cycle & cosmic rays intensity variation were anti correlated, Parker (1965) provided the theoretical explanation for this modulation. Nagashima & Morishita (1974) used sunspot number to study the long term variation of cosmic rays intensity Bowe & Hutton (1982) used solar flare number as representative of solar activity. Akassfu et al. (1985) have made a detailed study of long term variation by considering a number of parameter representing the solar activity index. The importance of propagation of disturbance to interplanetary medium associated with solar flare & sunspot number was shown by Hotton (1980) Donald et al (1982), Burlaga et al (1983). The relationship between solar wind parameters & geomagnetic disturbance has been investigated by many authors in past. Statistical studies of the correlation between the index & interplanetary magnetic field are reviewed by Hinshberg & Colburn (1969) & Snyder et al (1963). The nature of long term modulation is expected to depend upon the polarity of the solar poloidal magnetic field in addition to the sunspot numbers & other parameters of solar activity.

INTRODUCTION

The interplanetary magnetic field (IMF) is a part of the Sun's magnetic field that is carried into interplanetary space by the solar wind. The interplanetary magnetic field lines are said to be "frozen in" to the solar wind plasma. Because of the Sun's rotation, the IMF, like the solar wind, travels outward in a spiral pattern that is often compared to the pattern of water sprayed from a rotating lawn sprinkler. The IMF originates in regions on the Sun where the magnetic field is open i.e. where field lines emerging from one region do not return to a conjugate region but extend virtually indefinitely into space. The solar wind is a stream of energetic charged particles basically electrons and protons. Solar wind is flowing outward from the Sun through the solar system more than 900 km/s speed at a temperature of 1 million degrees (Celsius). A geomagnetic storm is defined by changes in the Dst (disturbance – storm time) index. The Dst index estimates the globally averaged change of the horizontal component of the Earth's magnetic field at the magnetic equator based on measurements from a few magnetometer stations. Dst is computed once per hour and reported in near-real-time. During quiet times, Dst is between +20 and -20 nano- Tesla (nT). The Ap index is averaged planetary A-index based on data from a set of specific Kp stations. The A-index provides a daily average level for geomagnetic activity. Because of the non-linear relationship of the K-scale to magnetometer fluctuations.

OBERVATIONAL ANALYSIS

In present analysis we observed interplanetary magnetic field, sun-spot number, Ap-index, Dst data due to omini website. Yearly average data observed from 2012-2020 which are given below:

YEAR	Interplanetary Magnetic Field	Solar wind Velocity	Sun- spot no.	Dst	Ap-index
2008	4.2	450	4	-8	7
2009	3.9	364	5	-3	4
2010	4.7	403	25	-9	6
2011	5.3	420	81	-11	7
2012	5.7	408	85	-12	9
2013	5.2	397	94	-10	8
2014	6.1	398	113	-11	8
2015	6.7	437	70	-14	12
2016	6.1	446	40	-10	10
2017	5.2	455	22	-9	10
2018	4.7	412	7	-6	7
2019	4.5	398	4	-5	6
2020	4.3	377	3	-3	5

RESULTS AND CONCLUSIONS

In present study, we initially determined solar Parameters during years 2008-2020, have been associated with different parameters such as sunspot numbers (Rz), interplanetary magnetic field (B), Solar wind velocity, Ap-index, Dst parameter. Solar terrestrial relationship also provides an important factor to explain the aspects of the variation of cosmic rays.

A correlative analysis has been done between interplanetary magnetic field (B), Sun-spot number, Solar wind velocity, Ap-index and Dst parameter. Yearly mean values of all parameters have been taken in correlative analysis. Direct correlation between solar wind velocity (V) & interplanetary magnetic field (B), interplanetary magnetic field and Sun-spot number, interplanetary magnetic field and Ap-index are reconfirmed for the recent periods but anti correlation between interplanetary magnetic field and Dst are reconfirmed for the resent period. For correlative analysis, we have used the period of 2008-2020.

Using the yearly mean values of interplanetary magnetic field, Sun-spot number, Solar wind velocity, Ap-index and Dst parameter, the correlation coefficient have been derived for the period 2008-2020. Coefficient of correlation is found to be positive & high for the most of the period. We have drawn cross plot for the yearly values of interplanetary magnetic field and Solar wind velocity, Sun-spot number, Ap-index in fig 1.1 (a, b), fig 1.2 (a, b), fig 1.3 (a, b) & fig 1.4 (a, b). These plots reveal similar shape of curve for each solar cycle our results indicate positive correlation in this correlative analysis, except cross plot between interplanetary magnetic field and Dst our result indicate negative correlation in this correlative study. The correlation coefficient between interplanetary magnetic field and Solar wind velocity, Sun-spot number, Ap-index and Dst is given in table 2.

Relation between Solar indices	Correlation coefficient (r)
B and V	0.4445
B and Rz	0.7632
B and Ap-index	0.8732
B and Dst index	-0.8608

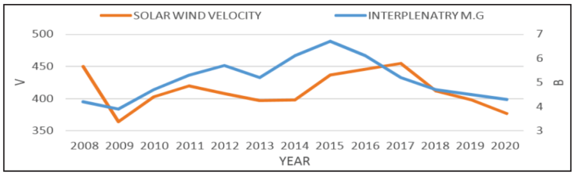

Fig. 1.1 (a): Line cross plot between interplanetary magnetic field and solar wind velocity for year 2008-2020.

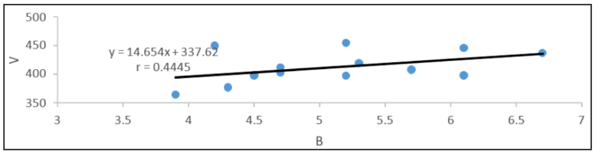

Fig. 1.1 (b): Correlative cross plot between interplanetary magnetic field and solar wind velocity for year 2008-2020.

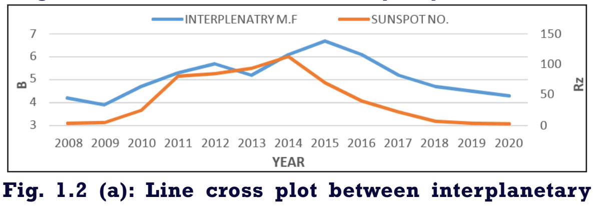

Fig. 1.2 (a): Line cross plot between interplanetary magnetic field and sun-spot for year 2008- 2020.

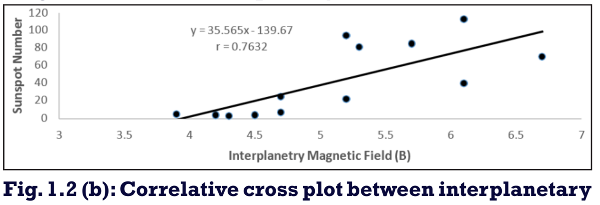

Fig. 1.2 (b): Correlative cross plot between interplanetary magnetic field and sun-spot for year 2008-2020.

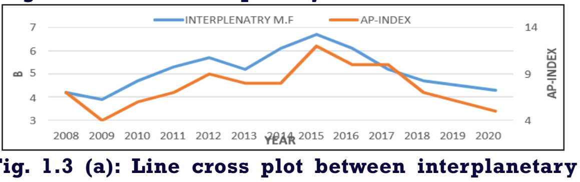

Fig. 1.3 (a): Line cross plot between interplanetary magnetic field and Ap-index for year 2008- 2020.

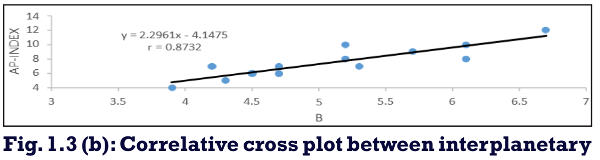

Fig. 1.3 (b): Correlative cross plot between interplanetary magnetic field and Ap-index for year 2008-2020.

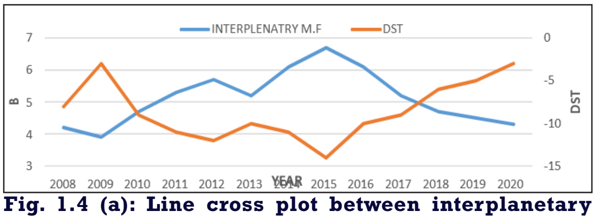

Fig. 1.4 (a): Line cross plot between interplanetary magnetic field and Dst-index for year 2008- 2020.

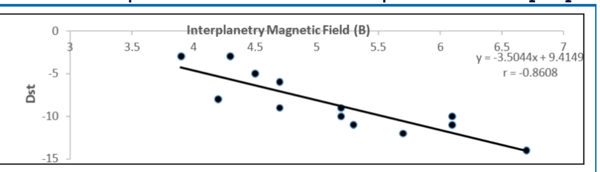

Fig. 1.4 (b): Correlative cross plot between interplanetary magnetic field and Dst-index for year 2008-2020.

REFERENCES:

1. Parker, E.N.; "The passage of energetic changed particles through interplanetary space", Planet Space Sci, 13, 9 (1965).
2. Nagashima, K., and Morishita, I.; Proc. 16th ICRC, 3, 325 (1979).
3. Hatton, C.J., "Solar flares cosmic ray intensity", Solar physics 66, 159 (1980).
4. Burlaga L.F.; "Magnetic cloud in physics of the inner Hemisphere" Vol.2, 1-22 (1991).
5. Snyder, C.W., Neugehauer, M. & Rao, U.R.; "The solar wind velocity & its correlation with solar & geomagnetic activity", J. Geophys, Res, 68, 6361 (1963).