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STATISTICAL RELATION OF GEOMAGNETIC ACTIVITY PARAMETERS WITH SOLAR ACTIVITY PARAMETERS

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Abstract
We studied the relation between yearly average geomagnetic activity parameters Ap,Kp and aa index observed during the period of solar cycle 22 and 23 (1986-2006) with various solar activity (SA) parameters, e.g. sunspot numbers (SSN), grouped solar flares (GSF) and solar flare index (SFI),.It is seen that yearly average of geomagnetic activity parameters Ap, Kp and aa is well correlated with yearly mean of sunspot numbers, grouped solar flares and solar flare index .We have determined positive correlation with correlation coefficient 0.59 between yearly mean of sun spot numbers and yearly average of Ap index,0.64 between yearly mean of solar flare index and yearly average of Ap index, 0.5 7 between yearly total number of grouped solar flares and yearly average of Ap index. From the analysis of solar activity parameters and Kp index We have obtained positive correlation with correlation coefficient 0.61 between yearly mean of sun spot numbers and yearly average of Kp index, 0.66 between yearly mean of solar flare index and yearly average of Kp index, 0.61 between yearly total number of grouped solar flares and yearly average of Kp index. From the study of solar activity parameters and geomagnetic activity aa index, positive correlation with correlation coefficient 0.55 has been found between yearly mean of sun spot numbers and yearly average of aa index 0.58 between yearly mean of solar flare index and yearly average of aa index, 0.51 between yearly total number of grouped solar flares and yearly average of aa index.
Keywords: *Sunspot numbers, solar flare index, grouped solar flares, geomagnetic activity indices.*

Introduction

The geomagnetic field is influenced by several solar and interplanetary phenomena like sunspots, solar flares, coronal mass ejections (CMEs), interplanetary shocks, and disturbances in solar wind plasma. Coronal mass ejections and solar flares derive solar wind disturbances and these disturbances cause geomagnetic field variations at the earth. Observations of the geomagnetic field allow separation of these variations into two main categories (1) short term variations and (2) long term variations. These variations are connected with transient solar activity, transient and recurrent magnetic activity. The Kp,Ap,aa geomagnetic index are used for analyzing long-term trends in the global geomagnetic activity and in its correlation with solar activity (Feynman, 1982; Legrand and Simon, 1989; Mursula et al., 2004; Lukianova et al., 2009). It has an 11-year variation similar to that of solar activity, as described by the Zurich relative sunspot number (Rz). In the twentieth century, there has been a significant increase in the aa index, the reason for which, however, is unknown (Feynman and Crooker, 1978; Clilverd et al., 1998; Demetrescu and Dobrica, 2008; Lukianova et al., 2009). Studying the correlation between the aa and Rz series is useful for understanding the long-term evolution of solar activity (Legrand and Simon, 1989; Russell and Mulligan, 1995; Prestes et al., 2006; Cameron and Sch¨ussler, 2007). Borello-Filisetti et al. (1992) examined the secular variations in the correlation between aa and Rz in terms of ascending (A) and descending (D) phases of the solar cycle and pointed out that the linear correlation coefficient (r) during the Dphase tends to decrease. They also suggested by visual inspection two periodicities of 5-cycle in A-phase, which they insist on later (Mussino et al., 1994), and 8-cycle in D-phase. Kishcha et al. (1999) examined the long-term variations in the 23-year running correlation and suggested that the decreasing trend of the correlation is caused by the upward linear trend of the time delay of aa to Rz accompanied by a quasi-periodicity of 40–50 years. Echer et al. (2004) suspected that the long-term decrease in the correlation has a monotonic nature or it is part of a long solar activity periodicity. Du et al., (2009), Du and Wang, (2011) studied the geomagnetic precursor prediction method and found that its predictive power shows a weakening trend and a cyclical behavior of about 44 years. Therefore, studying the variations in the correlation between aa and Rz is useful for understanding the solar dynamo theory, in which the level of geomagnetic activity in the declining phase of a solar cycle is related to the magnitude of the maximum solar activity in the ensuing cycle (Schatten et al., 1978). In this paper we have analyzed geomagnetic activity Kp,Ap,aa index with solar activity parameters sunspot numbers, solar flare index and grouped solar flares to get possible relationship between these parameters.

Experimental Data

In this study geomagnetic activity parameters Ap,Kp,aa index has been analyzed with solar activity parameters yearly mean of sunspot numbers, yearly mean of solar flare index and yearly counts of grouped solar flares during the period of 1986-2006. To determine the yearly average of Ap,Kp,aa index monthly and yearly data of Ap,Kp,aa index has been used and these data has been taken from Omni web data (http;//omniweb.gsfc.nasa.gov/form/dxi.html) . The data of solar activity parameters sun spot numbers, solar flare index and grouped solar flares are taken from STP solar data (http://www.ngdc.noaa.gov/stp/solar/solardat aservices.html).

Table- Solar and geomagnetic Activity Parameters

Years	Yearly Sunspot numbers	Yearly mean Solar flare index	Yearly Total GSF	Yearly Avrage of Kp	Yearly Average of Ap	Yearly Average of aaindex
1986	13.4	1.13	730	21.62	12.52	20.9
1987	29.4	2.66	1627	20.73	11.01	19
1988	100.2	8.14	4816	21.86	12.78	22.5
1989	157.6	17.39	7711	27.71	19.52	31
1990	142.6	12.2	6610	25.94	16.31	26.6
1991	145.7	15.16	6495	30.19	23.49	34.2
1992	94.3	7.74	3952	25.81	16.53	27.3
1993	54.6	4.23	2541	23.77	15.11	25.5
1994	29.9	1.58	1066	27.04	18.18	29.4
1995	17.5	0.86	639	21.63	12.7	22
1996	8.6	0.42	280	18.95	9.37	18.6
1997	21.5	1.01	790	16.32	8.46	16.1
1998	64.3	4	2423	20.17	12.06	21
1999	93.3	6.39	3963	21.87	12.58	22.2

2000	119.6	4.64	4474	23.55	15.09	25.4
2001	111	6.8	3597	20.95	12.99	22.4
2002	104	4.56	3223	22.56	13.16	22.7
2003	63.7	3.46	1552	28.61	21.82	37.1
2004	40.4	1.6	728	21.74	13.43	23.1
2005	29.8	1.91	571	21.14	13.54	23.2
2006	15.2	0.54	159	16.12	8.54	16.2

Data Analysis and Results

In this study, we have performed correlative analysis between yearly average of geomagnetic activity Kp, Ap and aa index with yearly mean of solar activity parameters sunspot numbers for the period of 1986-2006. We have plotted a liner graph between yearly averages of Ap.Kp. aa index and yearly mean of sunspot number and the resulting figure is shown in .Figure 1 .From the figures it is observed that the geomagnetic activity parameters Kp,Ap.aa index are positively correlated with yearly mean of sun spot numbers .We have determined positive correlation with correlation coefficient 0.59 between yearly mean of sun spot numbers and yearly average of Ap index, 0.61 between yearly mean of sun spot numbers and yearly average of Kp index and 0.55 has been found between yearly mean of sun spot numbers and yearly average of aa index

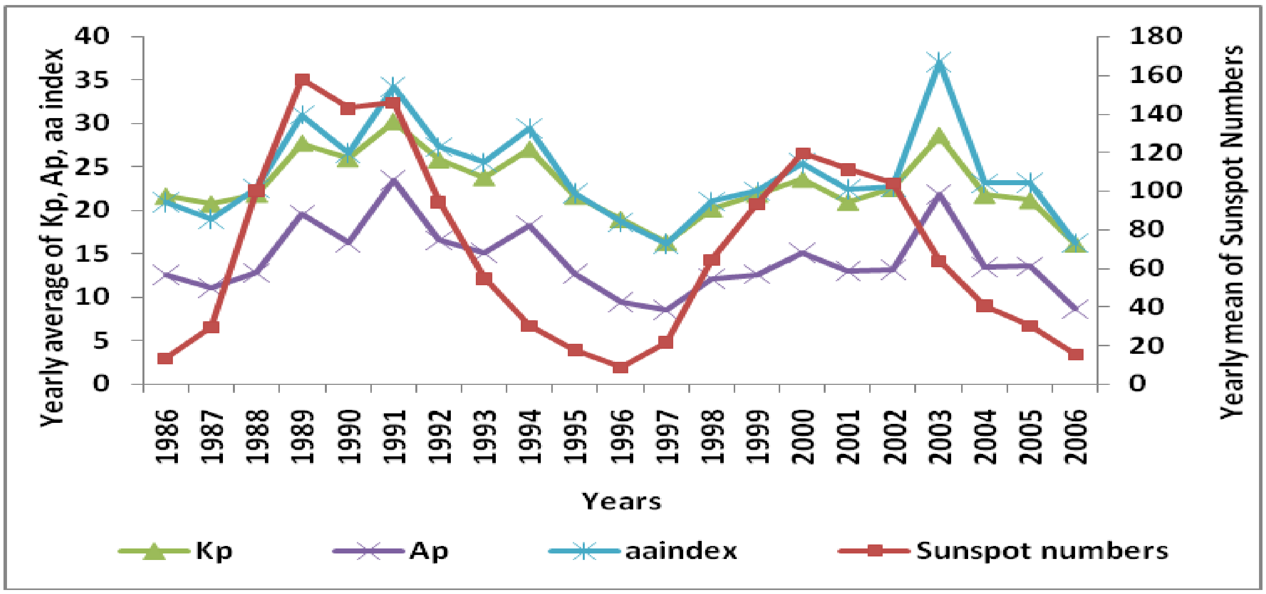

Figure 1-Shows line graph between yearly mean of sun spot nuber and yearly average of geomagnetic activity parameter Ap.Kp.aa index .

In this study, we have performed correlative analysis between yearly average of geomagnetic activity Kp, Ap and aa index with yearly mean of solar activity parameter solar flare index for the period of 1986-2006. We have plotted a liner graph between yearly averages of Ap.Kp. aa index and yearly mean of sunspot number and the resulting Figure is shown in .Figure 2 .From the figures it is observed that the geomagnetic activity parameters Kp,Ap.aa index are positively correlated with yearly mean of solar flare index . We have determined positive correlation with correlation coefficient 0.64 between yearly mean of solar flare index and yearly average of Ap index, 0.66 between yearly mean of solar flare index and yearly average of Kp index, 0.58 between yearly mean of solar flare index and yearly average of aa index,

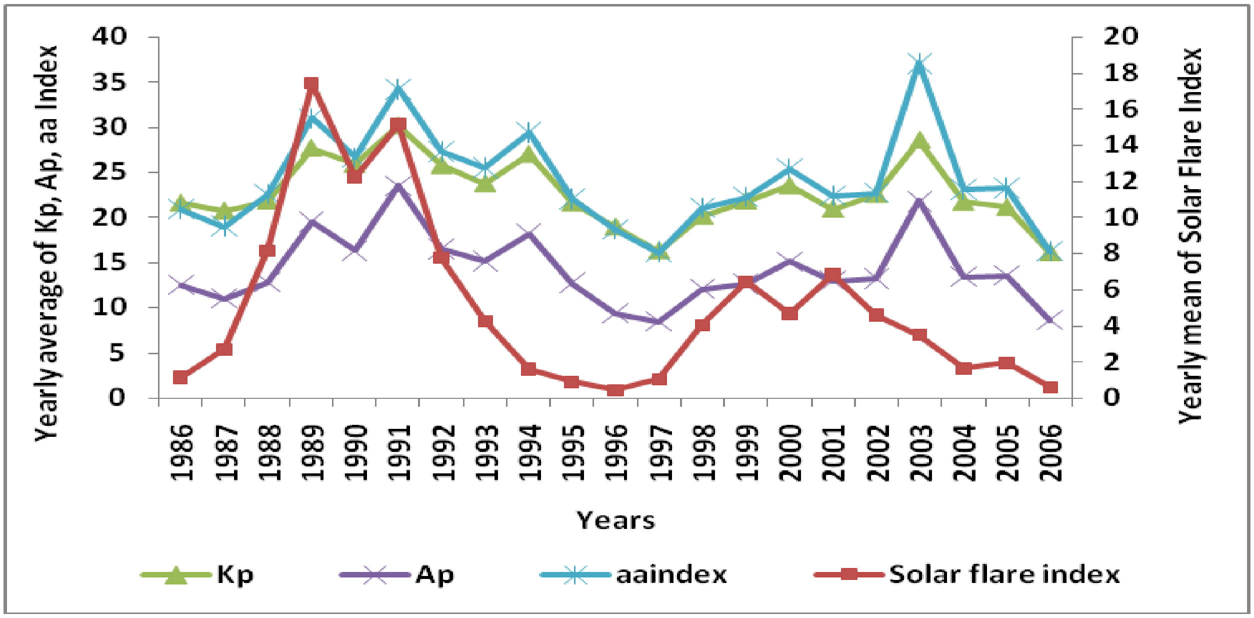

Figure 2-Shows line graph between yearly mean of solar flare index and yearly average of geomagnetic activity parameter Ap.Kp.aa index .

In this study, we have performed correlative analysis between yearly average of geomagnetic activity Kp, Ap and aa index with yearly total of grouped solar flare for the period of 1986-2006. We have plotted a liner graph between yearly averages of Ap.Kp. aa index and grouped solar flares and the resulting figure is shown in .Figure 3 .From the figures it is observed that the geomagnetic activity parameters Kp,Ap.aa index are positively correlated with grouped solar flare .We have determined positive correlation with correlation coefficient 0.5 7 between yearly total number of grouped solar flares and yearly average of Ap index. 0.61 between yearly total number of grouped solar flares and yearly average of Kp index. 0.51 between yearly total number of grouped solar flares and yearly average of aa index.

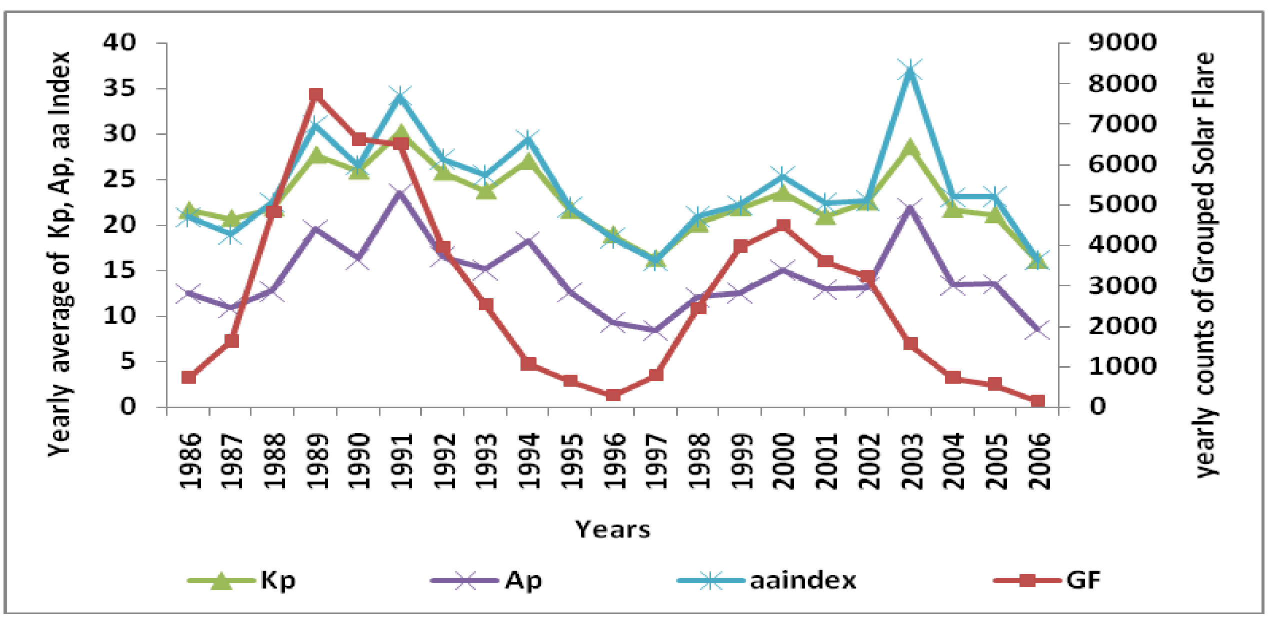

Figure 3-Shows line graph between yearly counts of grouped solar flare and yearly average of geomagnetic activity parameter Ap.Kp.aa index .

Main Results

It is observed that yearly average of geomagnetic activity parameter Ap, is well correlated with yearly mean of sunspot numbers, yearly counts of grouped solar flares and yearly mean of solar flare index.

Positive correlation with correlation coefficient 0.59 has been determined between yearly mean of sun spot numbers and yearly average of Ap index,

Positive correlation with correlation coefficient 0.64 has been obtained between yearly mean of solar flare index and yearly average of Ap index,

Positive correlation with correlation coefficient 0.5 7has been determined between yearly total number of grouped solar flares and yearly average of Ap index.

It is observed that yearly average of geomagnetic activity parameter Kp is well correlated with yearly mean of sunspot numbers, grouped solar flares and solar flare index.

Positive correlation with correlation coefficient 0.61 has been found between yearly mean of sun spot numbers and yearly average of Kp index,

Positive correlation with correlation coefficient 0.66 has been found between yearly mean of solar flare index and yearly average of Kp index,

Positive correlation with correlation coefficient 0.61 has been determined between yearly total number of grouped solar flares and yearly average of Kp index.

It is observed that yearly average of geomagnetic activity parameter aa is well correlated with yearly mean of sunspot numbers, grouped solar flares and solar flare index.

Positive correlation with correlation coefficient 0.55 has been found between yearly mean of sun spot numbers and yearly average of aa index,

Positive correlation with correlation coefficient 0.58 has been found between yearly mean of solar flare index and yearly average of aa index,

Positive correlation with correlation coefficient 0.51 has been determined between yearly total number of grouped solar flares and yearly average of aa index.

Conclusion

From our study of yearly average geomagnetic activity parameters Ap,Kp and aa index observed during the period of solar cycle 22 and 23 (1986-2006) with various solar activity (SA) parameters, e.g. sunspot numbers (SSN), grouped solar flares (GSF) and solar flare index (SFI).It is seen that yearly average of geomagnetic activity parameters Ap, Kp and aa is well correlated with yearly mean of sunspot numbers, yearly counts of grouped solar flares and yearly mean of solar flare index . Positive correlations has been found between yearly mean of solar activity parameters sunspot numbers, solar flare index and yearly counts of grouped solar flares and yearly average of geomagnetic activity parameters Ap,Kp. aa index. From these results it is concluded that yearly average variation in geomagnetic field depends on the yearly variations in solar activity parameters sunspot numbrs, solar flare index and grouped solar flares.

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