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Selection of Ten Geomagnetially Quietest Days Using Kp Index.

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Abstract: *The global* Kp *index is obtained as the mean value of the disturbance levels in the two horizontal field components, observed at 13 selected, subauroral stations. The name* Kp *originates from "*p*lanetarische* K*ennziffer" (planetary index). The quietest days of each month are deduced from the Kp indices on the basis of three criteria for each day:the sum of the eight Kp values, the sum of squares of the eight Kp values and the maximum of the eight Kp values. According to each of these criteria, a relative order number is assigned to each day of the month, the three order numbers are averaged and the days with the lowest and the highest mean order numbers are selected as the ten quietest and the five most disturbed days respectively. The selected ten quietest days are seen to be consonance with the international quiet days.*
Keywords; *Geomagnetially, Quietest, Subauroral, Stations and Index.*

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I. Introduction

Kp is a 3-hour index that aims at describing the global level of "all irregular disturbances of the geomagnetic field caused by solar particle radiation within the 3-hour interval concerned" [1]. It was introduced by Julius Bartels in 1938 and adopted by IAGA in 1951. It is obtained as the mean value of the disturbance levels in the two horizontal field components, observed at 13 selected, subauroral stations. For each of these observatories, the disturbance level at that site is determined by measuring the range a (i.e. the difference between the highest and lowest values) during three-hourly time intervals (in UT) for the most disturbed horizontal magnetic field component, after removing of the regular daily variation. The Kp index is assigned to successive 3-hour UT intervals (0-3 hr, 3-6 hr, ... , 21-24 hr UT) giving eight values per UT day and ranges in 28 steps from 0 (quiet) to 9 (disturbed) with intermediate values denoted by -, o, or +, resulting in 0o, 0+, 1-,1o, 1+, 2-, 2o, 2+, ..., 8-, 8o, 8+, 9-, and 9o. [2], [3], [4]. The Kp index is not linearly related to the geomagnetic disturbances measured in the unit of nT. Instead, the Ap index is introduced as it is roughly proportional to the geomagnetic disturbances. One Ap unit corresponds to ~2 nT of geomagnetic variations. The Ap index is derived directly from the Kp index. [5],

II. Method Of Analysis

The quietest days of each month are deduced from the *Kp* indices on the basis of three criteria for each day:the sum of the eight *Kp* values, the sum of squares of the eight *Kp* values and the maximum of the eight *Kp* values.

The Kp index assigned to successive 3-hour UT intervals are denoted bykp_1, kp_2,…, kp8 giving eight values per UT day.

The first criteria is $\Sigma Kp = kp_1 + kp_2 + \dots + kp_8$

Where ΣKp is the sum of 8 Kps of the day.

The Second criteria is $\Sigma(Kp^2) = kp_1^2 + kp_2^2 + \dots + kp_8^2$

The third criteria is Kp Max = Max (kp_1, kp_2, … kp_8)

According to each of these criteria, a relative order number is assigned to each day of the month. The relative number assigned to each day of the month based on the first criteria is denoted by A_d where d represents the day of the month i.e. $A_d = A_1, A_2, A_3, \dots, A_n$ where n is the number of days in the month as the case may be. For the second criteria, the relative number assigned to each day of the month is B_d and C_d respectively, d also represents the day of the month.

For each month, the mean order M_d is the average of the three order numbers A_d, B_d and C_d. For the first day of the month, $M_1 = (A_1 + B_1 + C_1)/3$, for the second day of the month, $M_2 = (A_2 + B_2 + C_2)/3$, it continues in this order until the last day of the month. The days with the lowest mean order numbers M_d are selected as the ten quietest days of the month. The same procedure is repeated for all the months of the year.

It should be noted that these selection criteria gave only a relative indication of the character of the selected days with respect to the other days of the same month [6]. As the general disturbance level may be quite

different for different years and also for different months of the same year, the selected quietest days of a month may sometimes be rather disturbed or vice versa.

In order to indicate such a situation, selected days which do not satisfy certain absolute criteria are marked as follows: A selected quiet day is considered "not really quiet" and is marked by the letter **A** if *Ap* > 6, **B** if Ap = 6, **K** if *Ap* ≤ 6 and either one *Kp* value > 3 or two *Kp* values > 2+. On the other hand, a selected quiet day is considered "very quiet' and marked **q** if all Kp = 0 or marked **p** if all Kp < 1- or at most two Kp is 1-.

III. RESULTS AND DISCUSSION

The ten quietest days for the years 2006-2009 selected using the kp index is shown in Tables (1-4)It can be seen from the tables that the five quietest days have less or none of the marks A and B which indicates "not really quiet" and more of the marks q and p which indicates "very quiet", during these days, the kp maximum is very low. In 2006 and 2007, most of the five quietest days have a maximum Kp value less than or equal to 1+. Maximum kp value for the ten quietest days in the same year is in the order of 2+. In 2008, the maximum Kp value of the five quietest days was up to 2, the value reduces as it approaches the end of theyear. The ten quietest days of 2008 have Kpvalue up to 3-, the value however reduces as the year proceeds. In 2009, it is observed that most of the five quietest days have a Kp maximum less than or equal to 1 while most of the ten quietest days have a Kp maximum not more than 1+.

Table 1: Selected quietest days for 2006

Year	Month	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
2006	JANARY	9	10	30	4	29	31	11	B13	B14	B12
2006	FEBRUARY	14	9	B13	A 25	B18	B5	B27	B2	A8	A 1
2006	MARCH	5	13	2	4	3	B17	A 14	A30	B 12	A23
2006	APRIL	q30	p12	p1	3	2	29	7	B 19	A26	27
2006	MAY	16	1	27	29	9	15	26	A3	B25	B2
2006	JUNE	26	4	21	23	13	5	24	19	12	B20
2006	JULY	p21	p2	18	19	8	20	3	17	16	23
2006	AUGUST	25	13	4	16	14	6	26	15	5	A24
2006	SEPTEMBER	p15	22	9	21	B16	28	A27	8	A20	A29
2006	OCTOBER	10	19	26	6	11	17	5	B23	B18	A 4
2006	NOVEMBER	q7	p8	p20	21	18	13	6	A19	A5	A14
2006	DECEMBER	p4	31	27	2	29	30	28	B3	A5	A1

Table 2: Selected quietest days for 2007

Year	Month	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
2007	JANARY	q13	7	24	B25	26	B22	8	A23	A9	A14
2007	FEBRUARY	q21	20	4	B22	B11	A24	B23	B19	B25	B3
2007	MARCH	q20	21	3	19	9	29	22	18	A31	A4
2007	APRIL	q16	p13	21	A8	20	5	B6	A7	B24	A11
2007	MAY	q6	5	2	12	13	11	4	14	16	30
2007	JUNE	6	5	12	7	11	25	26	20	A30	A27
2007	JULY	p9	25	19	18	24	2	22	23	17	16
2007	AUGUST	p24	p4	23	5	13	20	B18	9	B22	B14
2007	SEPTEMBER	9	13	10	11	12	16	A17	B19	A26	A15
2007	OCTOBER	p8	p11	p17	p9	10	7	13	16	B15	24
2007	NOVEMBER	p7	p6	3	11	2	5	30	B18	B12	A29
2007	DECEMBER	p3	p4	8	25	7	26	2	29	15	16

Table 3: Selected quietest days for 2008

Year	Month	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
2008	JANARY	3	2	22	B30	B4	B1	B11	A27	A28	A10
2008	FEBRUARY	25	24	B22	B26	A5	A9	A6	A17	A23	A21
2008	MARCH	7	6	B24	B4	A25	B31	B22	A17	A3	A21
2008	APRIL	p2	14	3	B20	A11	A1	A21	A15	A19	A29
2008	MAY	p17	14	15	9	B18	12	26	B11	B13	B27
2008	JUNE	13	10	5	22	12	11	B9	21	B4	B23
2008	JULY	19	8	7	9	2	25	31	3	29	20
2008	AUGUST	p25	26	2	24	30	5	29	28	23	4
2008	SEPTEMBER	p13	p12	29	B21	24	11	23	2	B28	1
2008	OCTOBER	p9	p18	25	24	27	17	7	8	14	B10
2008	NOVEMBER	p22	p21	p14	p3	p18	p13	p5	19	4	6
2008	DECEMBER	q1	q2	p9	p29	p14	18	30	20	21	28

Table 4: Selected quietest days for 2009

Year	Month	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
2009	JANARY	p12	23	p22	11	24	28	7	18	B25	17
2009	FEBRUARY	p8	p2	17	p10	19	13	26	A6	B9	21
2009	MARCH	p2	p7	9	p18	6	23	29	B31	A 1	B20
2009	APRIL	p4	23	2	30	14	3	7	28	26	29
2009	MAY	p12	p27	p25	17	5	15	26	13	1	19
2009	JUNE	p12	1	17	9	22	2	19	11	8	6
2009	JULY	p17	p19	18	2	26	16	29	27	4	12
2009	AUGUST	p16	15	24	29	17	14	25	18	28	4
2009	SEPTEMBER	p23	p29	24	19	25	12	9	8	7	5
2009	OCTOBER	p14	p20	p10	p17	p3	p18	2	12	6	7
2009	NOVEMBER	q6	p23	p29	p3	p5	p30	p4	p11	p16	p10
2009	DECEMBER	q1	q3	q4	q11	q30	p9	p29	p31	p8	p2

With these, 2008 can be said to be less quiet than the rest of the years under study while 2009 can be seen to be the quietest years. This can also be seen in the table. In the year 2009, there are less of the marks 'A and B' indicating "not really quiet" and more of the marks 'q and p' indicating "very quiet". The selected quietest days was seen to be in consonance with the international quietest days. None of the years have a day marked **K** which should come if $Ap \leq 6$ and either one *Kp* value > 3 or two *Kp* values > 2+. This indicates that the years 2006-2009 can be generally said to be geomagnetically quiet days. This is in line with the deep solar minimum of 2006-2009 noted by NASA. The solar minimum is characterized by a period of decreased solar activity with few, if any, sunspots. The accompanying decrease in solar radiation makes it the safest time for astronauts to carry out space missions. During 2008–09, NASA scientists noted that the Sun is undergoing a "deep solar minimum," stating that there were no sunspots observed on 266 of [2008's] 366 days (73%). Prompted by these numbers, some observers suggested that the solar cycle had hit bottom in 2008. Sunspot counts for 2009 dropped even lower [7]. As of September 14, 2009 there were no sunspots on 206 of the year's 257 days (80%). This confirms our inference that 2009 is the quietest of the four years. The selected ten quietest days are also seen to be consonance with the international quiet days.

IV. Conclusion

The ten quietest days for the years 2006-2009 have been selected using the kp index. It can be seen from the tables that the five quietest days have less or none of the marks A and B which indicates "not really quiet" and more of the marks q and p which indicates "very quiet", during these days, the kp maximum is very low. The ear 2008 can be said to be less quiet than the rest of the years under study while 2009 can be seen to be the quietest year.

References

[1]. Bartels, J. (1949) The standardized index, Ks, and the planetary index, Kp, IATME Bulletin 12b, 97.
[2]. Bartels J, and J. Veldkamp (1954) International data on magnetic disturbances, first quarter, 1954. J. Geophys. Res., 59, 3, 423-427.
[3]. Mayaud,P.N., Derivation, meaning and use of geomagnetic indices, Geophys. Monogr., 22, AGU,Washington,1980.

[4]. Menvielle, M., T. Iyemori, A. Marchaudon, and M. Nosé. (2011). Geomagnetic indices, in Geomagnetic Observations and Models, IAGA Special Sopron Book Series, Vol. 5, edited by M. Mandea and M. Korte, pp. 183-228, Springer, doi:10.1007/978-90-481-9858-0_8.
[5]. Mayaud,P.N., Derivation, meaning and use of geomagnetic indices, Geophys. Monogr., 22, AGU,Washington,1980
[6]. "NASA/Marshall Solar Physics". nasa.gov." NASA Science - Deep Solar Minimum ". *nasa.gov*
[7]. Siebert, M. & Meyer, J. (1996). Geomagnetic Activity Indices, in The Upper Atmosphere, ed. by W. Dieminger, G.K. Hartman, R. Leitinger (Springer, Berlin Heidelberg New York,), pp. 887–911

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