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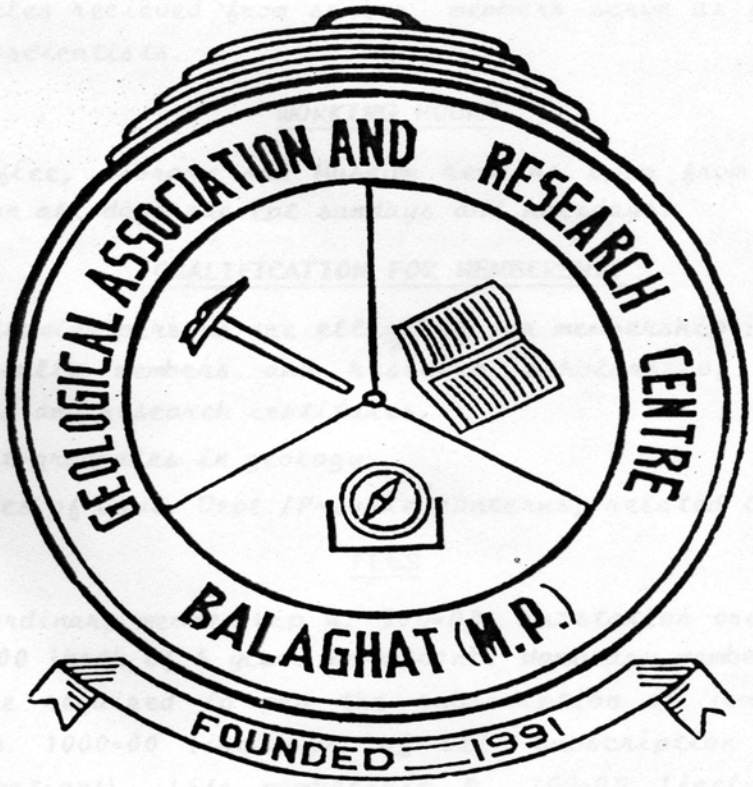

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SCALING OF K-INDICES THROUGH A COMPUTER ROUTINE

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ABSTRACT

Three Hourly geomagnetic indices (K-indices) are derived employing the digitally acquired high time resolution data at Alibag. These indices which are derived through a computer routine are argued to be least subjective. They are compared with the conventionally scaled indices from analogue magnetograms. It is concluded that this routine can safely be adopted in future as it is less subjective in the approach.

INTRODUCTION

Three hourly Geomagnetic activity index, known as K-Index derived from the continuous recording of field variations at permanent observatory is very useful not only for deriving the planetary index but also in correlative studies of the other geophysical phenomenon regionally. A comprehensive treaties on the measurements, their standardization and limitations has been given by Mayaud (1967). The guidelines listed there are very handy towards perfection of visual scaling of the indices. However, there is a subjectivity in estimating the general quiet day trend, over which the range of disturbances has to be estimated for deriving the index. Many of the key observatories in the world have changed over to digital recordings of geomagnetic field components at finer time resolutions (one minute or less) and thus facilitated computer processing of the indices with minimum subjectivity. There are few studies dedicated to the scaling of K-Indices towards optimizing the technique to bring it closer to the objectivity of the procedure (Jankowski et al. 1988; Hattingh, Nagtegaal & Loubser, 1988; Hattingh, Loubser & Nagtegaal 1989; Nowozynsky, Ernst & Jankowski, 1990).

Recently, IAGA in their publication No. 32 has announced the capability of four algorithms for computer estimation of K-Indices which appears to be very comprehensive and effective.

K-Indices are being scaled, employing analogue (photographic) recordings of the gemomagnetic field at Alibag since the year 1945. These are being used extensively by the researchers since then. The derivation of Indices are done by means of a grid specially prepared for this purpose and the trained analysts can seldom go wrong in the tabulations. Based on the suggestions of Von Wijk and Nagtegall (1977) in eliminating the subjectivity of estimating the quiet day trend and ease scaling using

digital computers for speedy computations, Rangarajan & Murty (IAGA News, 1980) listed out a FORTRAN program for deriving the indices. This procedure is suitable for magnetograms obtained from photographic recordings.

As a step towards International collaboration, Indian Institute of Geomagnetism entered into a new era by installing and networking a special set of magnetographs which provide stable digital geomagnetic field values at one minute resolution at Alibag. This project known as 'INTERMAGNET', started at Alibag (geographic Lat. 18 38' N & geographic Long. 72° 52' E) in July 1993. In this communication, after briefly describing the INTERMAGNET system. The procedure to derive the K-indices employing the digtal one minute values by a suitable computer program is given. The indices that are derived compared for over ten months with those handscaled from the analogue recordings for their consistency.

INTERMAGNET SYSTEM

This system records X,Y,Z (N-S,E-W & Vertical respectively) components of the Earty's magnetic field using fluxgate sensors and the total field F by PPM (Proton Precession magnetometer) at a resolution of 0.1 nT. Sampling intervals for X, Y, Z components are one second whereas for F it is five seconds. Supporting Software computes one minute means from one second and five seconds data. This minute data are stored in binary form in its master memory. About thirteen days continuous data can be accommodated in the master memory at a time.

A PC is interfaced to master memory unit to retrieve data on floppy disk for any chosen interval. The binary files can be converted into ASCII with the help of another special Software.

SCALING K-INDICES

The ASCII files of a month's field values in the horizontal component (H) forms the basic data for deriving 8 sets of 3 hourly (UT hours) indices per day.

In this procedure five quiet days are selected in each month by computing the range of H on each of the UT days in a month. The ranges are arranged in ascending order and the lowest range days (five days) are selected as the quietest days of the month the mean of these fieve days at each of the minutes are treated as mean quiet day for that particular month.

A FORTRAN program is coded closely following Rangarajan & Murty (1980), to derive K-Index at each of the three hourly intervals (180

minutes values.) A search for the lowest value of the field is made in the interval and the corresponding minute values of the three hourly quiet day field is shifted to match the lowest value. Deviation ot the field at the interval with those on quiet day are worked out at each of the minutes in 3-hour interval and the range is estimated from the deviations. From this range, the semi-logarithimc index (K) is fixed using the standard table (Table 1) adopted at Alibag. This procedure is repeated on all the 8 intervals of the day and for all the days of the month.

TABLE - 1

STANDARD RANGES USED FOR K-INDEX AT ALIBAG.

K-INDEX	RANGE IN nT (H)
0	0 - less than 3 nT
1	3 - less than 6 nT
2	6 - less than 12 nT
3	12 - less than 24 nT
4	24 - less than 40 nT
5	40 - less than 70 nT
6	70 - less than 120 nT
7	120 - less than 200 nT
8	200 - less than 300 nT
9	300 nT and above

COMPARISON OF THE INDICES

Comparion of indices that are derived from one minute digital values and those obtained from analogue recordings (hand scaling) for the period July-1993 to May-1994 (both months inclusive) are made. In all, there are 2366 indices that are available for comparison. The difference between K derived from digital recordings and K estimated by hand scaling is '0' in 1303 cases and the difference aret 1 in 923 cases. However, there is an higher bias towards digitally derived K-Index showing higher values of 1 (in 815 cases K difference is +1 when compared to 108 cases of K difference-1). These differences are given in Table 2 and shown as histogram in figure 1.

TABLE - 2

Difference (DIFF) between the two K-Indices.

DIFF	>3	+3	+2	+1	0	-1	-2	-3
No. of cases	4	12	122	815	1303	108	2	0

DIFF = K from digital minute data from INTERMAGNET - K from hand scaling of magnetograms.

Out of the total 923 differences within ± 1, 389 differences are when the index K has values from 0 to 2 while larger number (534) are noticed when K is 3,4,5,6. Though large number of differences are noticed for K = 3,4,5 & 6, 384 intervals are found to be either very close to the upper limit of the previous range or lower limit of the next range in Table 1, leaving out substantial differences in only 148 intervals.

DETAILS OF 384 INTERVALS WITH K DIFFERENCE = ± 1 BUT VERY CLOSE TO PREVIOUS OR NEXT K RANGES IS AS SHOWN

No. of intervals with range difference 0 to less than 1 nT = 131

No. of intervals with range difference 1 to less than 2 nT = 78

No. of intervals with range difference 2 to less than 3 nT = 68

No. of intervals with range difference 3 to less than 4 nT = 58

No. of intervals with range difference 4 to less than 5 nT = 32

No. of intervals with range difference 5 to less than 6 nT = 17

Total 124 intervals are showing ± 2 difference. Out of these 26 intervals are showing ± 2 differnce, when K=2 by digital data & K=0 by hand scaling. As upper limit of range for K=0 and lower limit of range for K=2 are differing only by 6 nT, i.e. 3.5 mm of analogue recording trace, these intervals can also be considered as close matching. 25 intervals are showing ± 2 difference, when K=3 by digital data and K=1 by hand scaling, but again upper limit for K=1 is very close to lower limit for K=3, As such they can be considered the same with allowance for subjectivity.

The matching/mismatching of the indices are shown as histogram in Figure 2.

THE REASON FOR THESE DIFFERENCES MAY BE AS UNDER

1. While deriving K-Indices manually from analogue recordings, it is quite possible that the trend assumed for some intervals may not be perfect.

2. During disturbed days, actual quiet day curve (trend) is not taken into account properly for manual computation whereas while computing K by the method due to automatic processing mean quiet day is considered with least subjectivity.

3. Thickness of analogue recording may also play an important role at the boundaries of the K ranges.

4. Sometimes when a day is magnetically quiet but is abnormal or is characterized by a large scale amplitude differing significantly from the Solar quiet day vaiation, the corresponding K-Indices will be over estimated. This is likely to affect one or two intervals only. (Rangarajan & Murty, 1980).

5. The abnormal quiet days cannot be classified as belonging to regular SR variation as defined by Mayaud (1967) and therefore the K-Indices for these intervals may represent a genuine irregular variations (Rangarajan and Murty, 1980).

SUMMARY

Comparison of K-indices computed by using analogue recording and those derived using INTERMAGNET digital minute values give the following results.

Total No. of intervals compared 2366
Total No. of intervals with difference 0 .....1303 ..... 55%

TOTAL NO. OF INTERVALS SHOWING CLOSE COMPARISON

1. ± 1 DIFF., when K=0,1,2, by digital.....391
2. ± 1 DIFF., when K=3,4,5,6 by digital.....384
3. ± 2 DIFF., but close.....51

TOTAL ..... 826...35%

No. of intervals showing significant differences 237...10%

In conclusion, it may be stated that employing finer resolution

digital field values from INTERMAGNET System, the geomagnetic 3 hourly activity index K, can be derived with ease and accuracy with negligible subjectivity (with 90 % closeness). Efforts are to follow the detailed procedures that have been appearing in the literature to derive k-Index in more and more refined way and the method detailed above would be used to correct/scale the K-indices from Alibag till that time on a routine basis.

ACKNOWLEDGMENT

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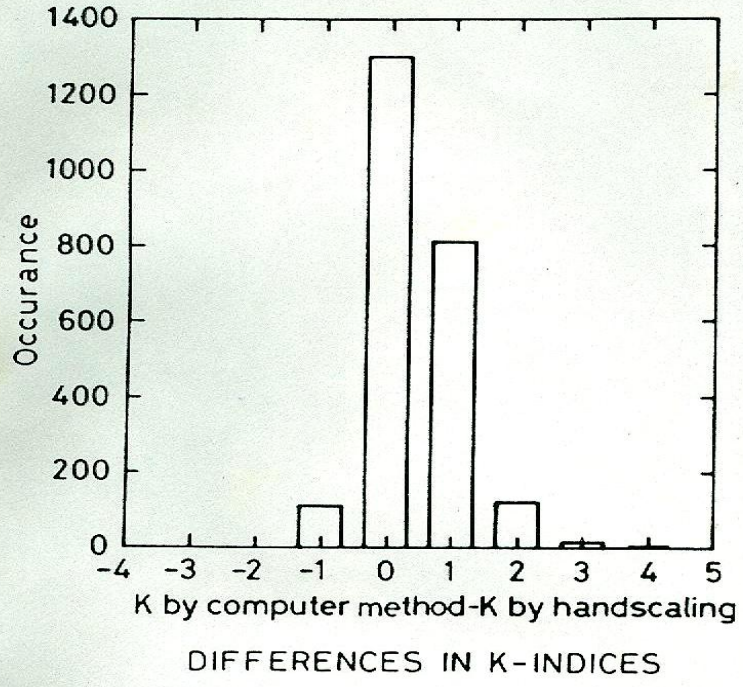

Fig.1 : Histogram plot of differences in the K-indices derived from computer routine and hand scaling .The difference upto ± 4 against the occurrence occasions are shown .

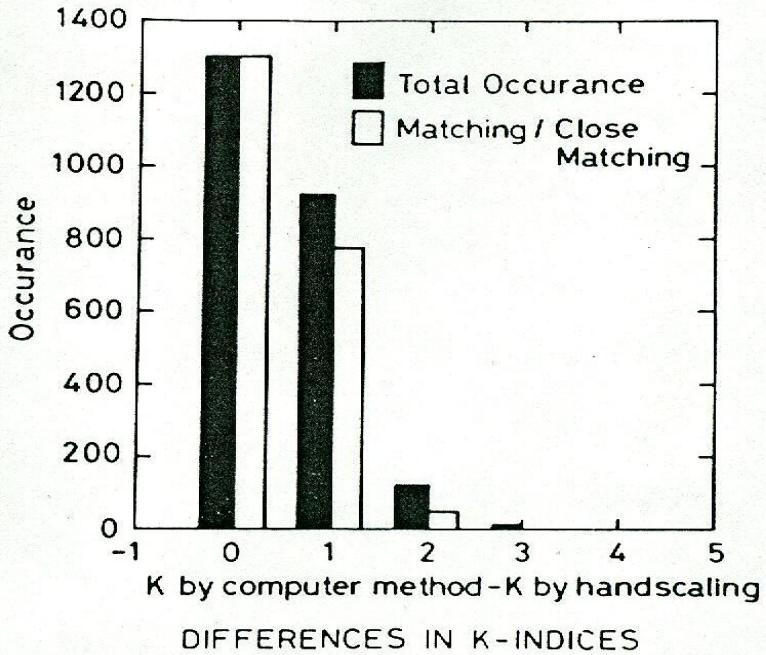

Fig.2 : Histogram showing the number of occasions of K-indices for ten months derived by hand scaling (solid hatched portion) and the occassions in which the same are matching or closely matching with those derived by computer calculations (hollow boxes).