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Semiannual Variation of Geomagnetic Field at Southern and Northern Hemisphere

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Abstract**-- This paper represents the seasonal variation of geomagnetic field at Southern (MAITRI) and Northern (TROMSO) Hemisphere. The Indian Antarctic Station MAITRI is located at geomagnetic Lat. (66.03^0, 53.21^0) where as TROMSO is at geomagnetic Lat. (66.69^0, 102.79^0). We have studied the behaviour of geomagnetic field with respect to geomagnetic storms at both the stations. It was observed that at Southern Hemisphere there is more variation in winter as compared to the summer season, where as in Northern Hemisphere the variations are more in summer as compared to winter. As in the Northern hemisphere the magnetospheric plasma is strongly turbulized in summer and in Southern hemisphere the magnetospheric plasma is strongly turbulized in winter.**

Keywords**-- geomagnetic storms, SSC, magnetospheric plasma turbulization.**

I. INTRODUCTION

The geomagnetic field intensity responds to a Sudden Impulses (SI) simultaneously all over the world**.** Generally, an SI event is caused by a sudden increase in the dynamic pressure of the solar wind near the Earth's orbit. At the time of SI, there is often an interplanetary shock wave in the solar wind, whose disturbed state is frequently associated with a coronal mass ejection [1]. The magnetic disturbance associated with the SI propagates to the surface of the earth and is recorded as sharp changes in the ground magnetograms. It was found by [2] [3] that the ground level magnetic field increase is proportional to the square root of the dynamic pressure ($nPa^{1/2}$) with a coefficient that ranges from $13nT/nPa^{1/2}$ to 34 $nT/nPa^{1/2}$. Evidently, the Storm Sudden Commencement (SSC) onset marks the time of a dynamic increase in the interaction of the solar wind with the magnetosphere, with a resulting strong penetration of solar wind momentum and energy into the Earth's environment. It is usually considered that SSC occurrence times are random because they depend on the solar wind state only**.**

A paper by [4] states that the steady southward IMF is also important in the formation of magnetic storm, while fluctuations in the solar wind electric fields are responsible for initiating magnetospheric substorms. During magnetic storms, auroral electrojet shifts equatorward. Hence the AE indices based on subauroral observatories are more relevant for the magnetic storm studies. The southward field is probably the more important because of its far greater variability [5]**.** Solar wind ram pressure is also important in ring current energization**.** Availability of satellite measurements of various interplanetary plasma and magnetic field parameters associated with the development of geomagnetic storms has provided a unique platform for investigating the interplanetary causes of geomagnetic storms [6][7]**.** Nevertheless, a variety of storm mechanisms have been reported by various researcher that due to the complexity involved in each storm event. This complexity could be due to varying nature of the storm sources such as simple coronal mass ejections (CMEs), magnetic cloud structures, multiple occurrences of CMEs, high-speed solar wind streams, etc. The magnetosphere responds differently to different interplanetary causes, thus leading to the alteration of the energy budget involved in each storm. Under these circumstances it is necessary to perform detailed qualitative and quantitative study of the storm time energetics of large number of storms.

Earlier studies of the interplanetary causes of intense geomagnetic storms (Dst < -100 nT) for the peak year of the maximum phase of solar cycle 21 and found that about half of the storms were associated with magnetic clouds and half with sheath field regions. CME are large explosions of material from the sun, which are often associated with solar prominences or flares.

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They travel into interplanetary medium and if directed towards the earth, can reach the earth in 3-5 days. Therefore to understand solar- terrestrial relationship and address the important question of weather geoeffectiveness can be studied. The strong correlation between magnetic storms indicates a cause effect intense substorms and the main phase relationship. The scenario of a sequence of sub storm injections leading to a magnetic storm is attractive from physical considerations and has observational support [8]**.** The high latitude dayside magnetosphere is predominantly controlled by transient phenomena. Various types of transient responses of the magnetosphere work as generators to produce pairs of field-aligned currents. In contrast to sudden commencements (SCs) that is produced by abrupt enhancements of solar wind dynamic pressure [9].

The disturbance storm time (Dst) index is a measure of geomagnetic activity, and has been commonly used to assess the strength of geomagnetic storms [4]**.** The condition that leads to the development of the ring current is due to the successive occurrence of many substorms, which are measured by the AE index**.** At the same time, some believe that a fluctuating interplanetary magnetic field (IMF), even with smaller southward amplitude, could result in enhanced AE but not in larger deviation of Dst index.

II. Data Analysis

The duration of 2003 – 2004 comes under period of the solar minimum and solar minimum is featured mainly by the absence of explosive solar phenomenon like major solar flares, CMEs, solar proton events and consequent geomagnetic storms. But still during declining phase of 23 solar cycle we found 42 geomagnetic storms, out of which we are showing only 6 severe geomagnetic storms whose Dst index is < -100 and Kp index greater than 5. The Dst and Kp index are taken from World Data Centre. The geomagnetic field data are taken from Indian Antarctic Station "Maitri" and Tromso Geophysical Observatory.

The sudden storm commencement list was taken from http://www.ngdc.noaa.gov/stp/SOLAR/ftpssc.html. We take also the quite days data from World Data Centre. In the present study we compare the geomagnetic data seasonally. The variation is compared from the average of ten quietest days of that month in which the severe geomagnetic storm is observed.

Table1

S.N.	**Geomagnetic Storms**	**SSC Time UTC**	**Dst Index nT**	**Kp**
1.	18 June 2003	10:00	-141	7-
2.	29 October 2003	02:06	-353	9-
3.	24 July 2004	08:15	-148	6-
4.	26 July 2004	22:49	-197	7+
5.	7 November 2004	10:52	-373	8
6.	9 November 2004	09:31	-289	9-

III. Results

Southern Hemisphere:

Winter Season:

In southern hemisphere there is more variation in winter as compared to the summer. We have divided the year in summer and winter season only. We took October to March as winter and April to September as summer season. This variation is the difference of the average of ten quietest days and disturbed condition of that month.

18 June 2003:

The SSC time of this event is 10:00 UTC shown in Table 1 with value -141 nT . In event of 18 June of 2003 at Maitri the X and Z components decrease upto a value of ~1686 nT and ~947 nT , whereas the Y component gives a dip with SSC then increases upto a value of 907 nT.

At station Tromso the X and Y component of earth's magnetic field increases with a value of ~20000 nT and ~7000 nT whereas the Z component shows decrement then increases with main phase as shown in figure 1.

29 October 2003:

In this case the SSC time is 02:06 UTC with Dst value of -353 nT. The geomagnetic response at southern and northern hemisphere is shown in figure 2. At Maitri the X and Z components decrease with values ~3500 nT and ~1500 nT and Y component increases with value of ~2500 nT. At northern hemisphere the X and Y component increases with a very small value and Z fluctuates only.

24th -26th July 2004:

Figure 3 shows that during this event the Dst index for 24th July is -148 nT and -197 nT at 08:15 and 22:49 UTC respectively. With SSC the geomagnetic field components X and Y at Maitri decreases upto a value of 1510 nT and 1500 nT respectively whereas the Z component fluctuates with decrement in starting and increases then upto a value of 400 nT. At northern hemisphere TRM, all the components X, Y and Z increases with a very small value and same trend is followed for 26 July 2004 as shown in Figure 4.

7 Nov 2004:

The Nov. 6th explosion hurled a coronal mass ejection towards the Earth and the Nov. As kp index and Dst indices are shown in table 1 and in figure 5. At Southern hemisphere MTR Y and Z components of geomagnetic field increase with value ~ 1150 nT and 1200 nT respectively where as the X component decreases ~ 1800 nT. At station TRO the X component increases upto 22000 nT on 8th Nov and X components variation. Y component also increases upto 22000 nT and Z component shows the variation of 2500 nT.

9 Nov 2004:

Figure 6 shows that on 9 Nov 2004 the Dst index is -289 nT at 09:31 UTC. With respect to the geomagnetic storm at Southern hemisphere the X and Z components decreases ~ 1490 nT and ~700 nT on 9th Nov 2004 and Y component increases ~ 1200 nT on the same day. At northern hemisphere all the components increases with very small value.

IV. Conclusion And Discussion

At MAITRI the variation in the month of June 2003 is less than the month of October 2003 and during 2004 there is more variation in November (winter) as compared to the month of July (summer). At TROMSO the Northern Hemisphere we have observed more variation in the month of June 2003 as compared to October. During 2004 we have observed more variation in the month of November. Hence at Northern Hemisphere there is more variation in summer as compared to winter. From the analysis of the data it is clear that at Southern Hemisphere there are more variations in winter as compared to the summer season, where as in Northern Hemisphere the variations are more in summer as compared to winter. As in the Northern hemisphere the magnetospheric plasma is strongly turbulized in summer and in Southern hemisphere the magentospheric plasma is turbulized strongly in winter. As magentospheric plasma turbulization depends upon the power index (α) and the tendency of α variations in both the hemisphere is identical, but in equinox the value of both the hemisphere is less than the winter and summer season.

REFERENCES

[1] Lindsay, G. M., Luhmann, J. G., Russell, C. T., and Gaziz, P. R.: On the sources of interplanetary shocks at 0.72 AU, J. Geophys. Res., 99, 11–17, 1994.

[2] Russell, C. T., Ginskey, M., and Petrinec, S.M.: Sudden impulses at low-latitude stations: Steady state response for northward interplanetary magnetic field, J. Geophys. Res., 99, 253–261, 1994a.

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[3] Russell, C. T., Ginskey, M., and Petrinec, S. M.: Sudden impulses at low-latitude stations: Steady state response for southward interplanetary magnetic field, J. Geophys. Res., 99, 13 403–13 408, 1994b.

[4] Kamide, Yokoyama,: Interplanetary and magnetospheric electric fields during geomagnetic storms: what is more important, steady-static fields or fluctuating fields?, J. Atmos. Sol-Terr. Phys., 63, 413, 2001.

[5] Tsurutani, B.T., the interplanetary causes of magnetic storms, substorms and geomagnetic quite in space storms, space weather hazards, edited by Daglis, I. A., 103, Kluwer Academic Press, Norwell, 2001.

[6] Huttunen, K.E.J., H.E.J. Koskinen and R.S. Schwenn, Variability of magnetospheric storms driven by different solar wind perturbations, to appear in J. Geophys. Res., 2002.

[7] Turner, N. E., D. N. Baker, T. I. Pulkkinen, J. L. Raeder, J. F. Fennell, and V. K. Jordanova (2001), Energy content in the stormtime ring current, J. Geophys. Res., 106, 19,149–19,156, doi:10.1029/2000JA003025.

[8] Gonzalez, W.D., J.A. Joselyn, Y. Kamide, H.W. Kroehl, G.Rostoker, B.T. Tsurutani and V.M. Vasyliunas, What is a geomagnetic storm?, J. Geophys. Res., 99, 5771, 1994.

[9] Araki, T., A physical model of the geomagnetic sudden commencement, in the Solar Wind Sources of Magnetospheric Ultra-Low-Frequency Waves edited by M. J. Engebretson, K. Takahashi, and M. Scholer, 183, 1994.

Figure and Table Caption:

In the present paper there are six figures and one table:

In every figure there are three parts one is Dst index in nT, second is Geomagnetic field components variation in nT of Maitri: Southern hemisphere and last is Geomagnetic Field variation at Tromso : Northern Hemisphere .

Figure 1 is of 18 June 2003
Figure 2 is 29 October 2003
Figure 3 is 24 July 2004
Figure 4 is 26 July 2004
Figure 5 is 7 November 2004
Figure 6 is 9 November 2004

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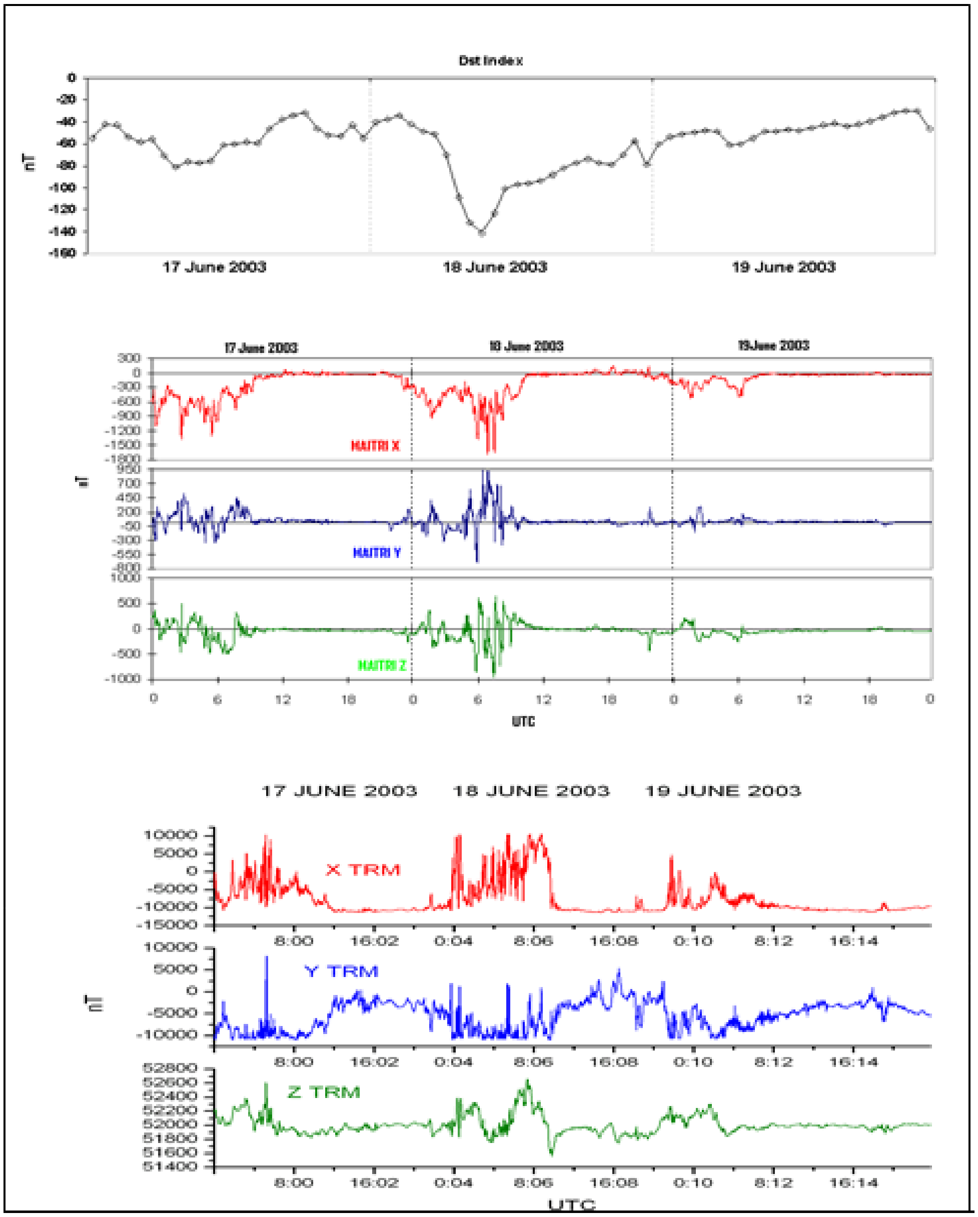
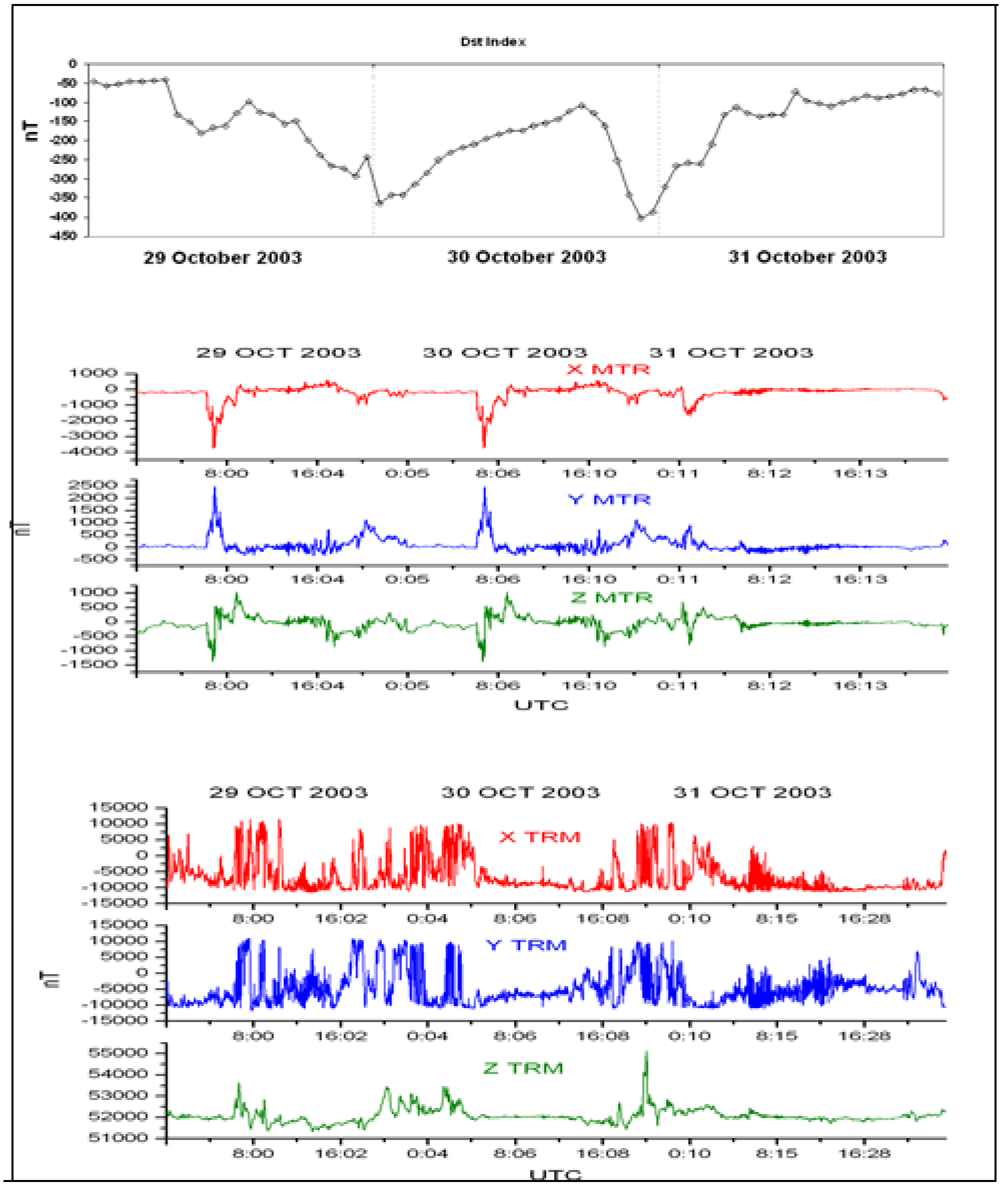
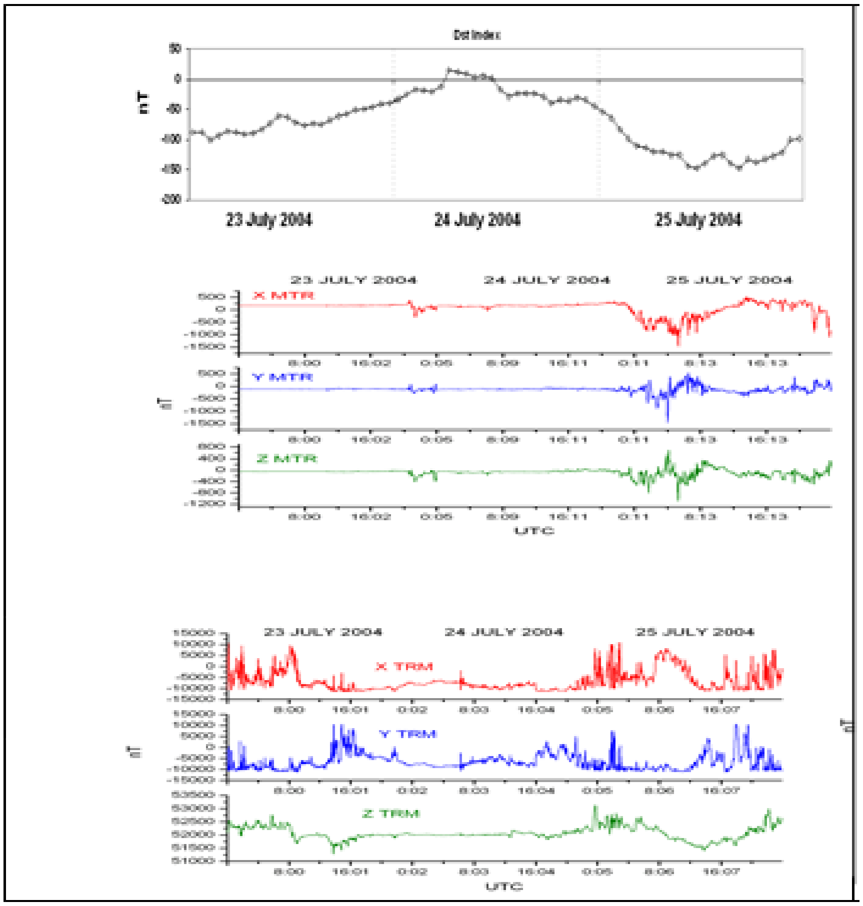



Dst Index
nT
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
29 October 2003
30 October 2003
31 October 2003
29 OCT 2003
30 OCT 2003
31 OCT 2003
X MTR
1000
0
-1000
-2000
-3000
-4000
8:00
16:04
0:05
8:06
16:10
0:11
8:12
16:13
Y MTR
2500
2000
1500
1000
500
0
-500
Z MTR
1000
500
0
-500
-1000
-1500
UTC
nT
29 OCT 2003
30 OCT 2003
31 OCT 2003
X TRM
15000
10000
5000
0
-5000
-10000
-15000
8:00
16:02
0:04
8:06
16:08
0:10
8:15
16:28
Y TRM
nT
Z TRM
55000
54000
53000
52000
51000
UTC



Dst index
nT
23 July 2004
24 July 2004
25 July 2004
23 JULY 2004
24 JULY 2004
25 JULY 2004
X MTR
Y MTR
Z MTR
nT
UTC
23 JULY 2004
24 JULY 2004
25 JULY 2004
X TRM
Y TRM
Z TRM
nT
UTC

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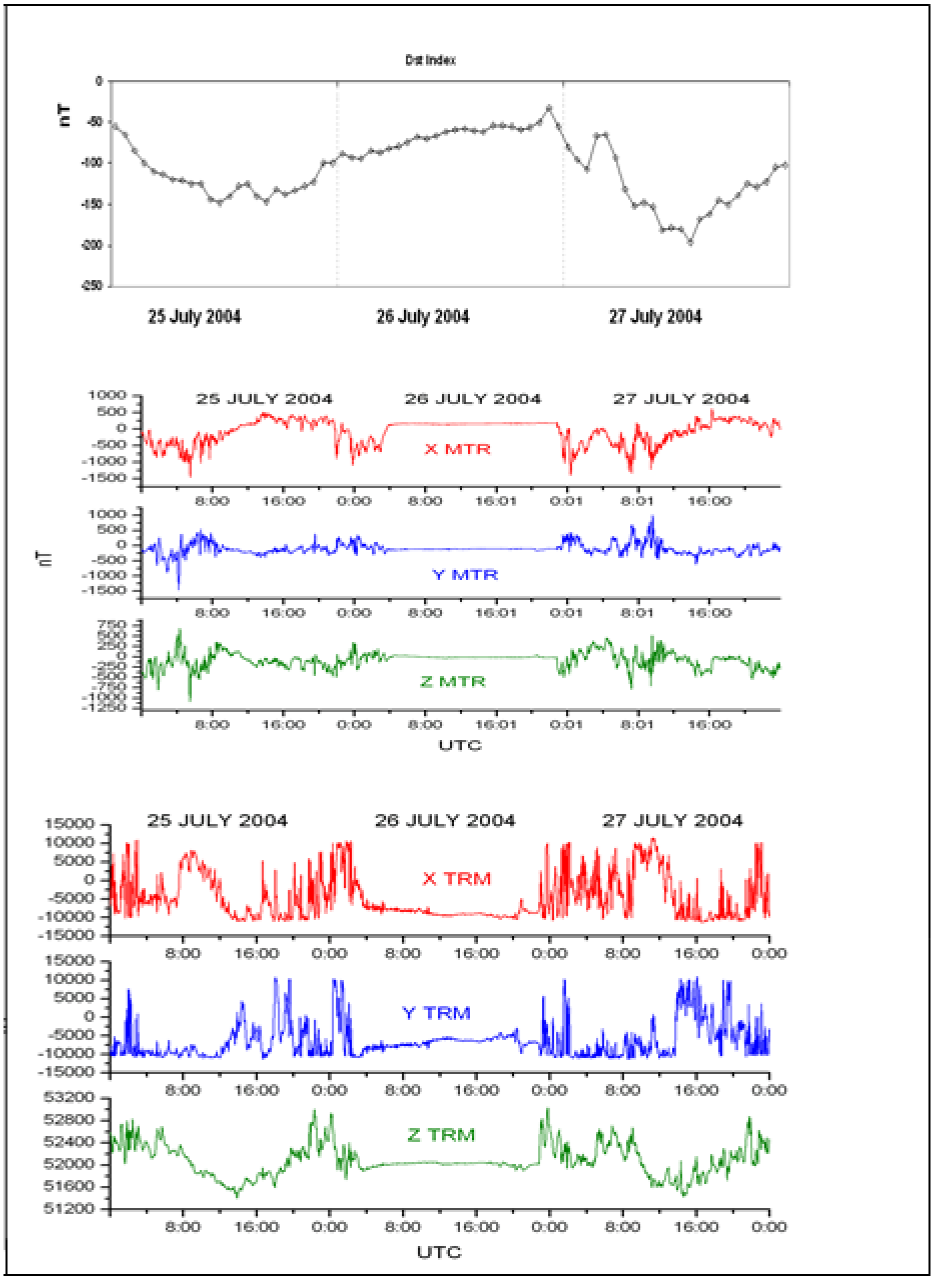

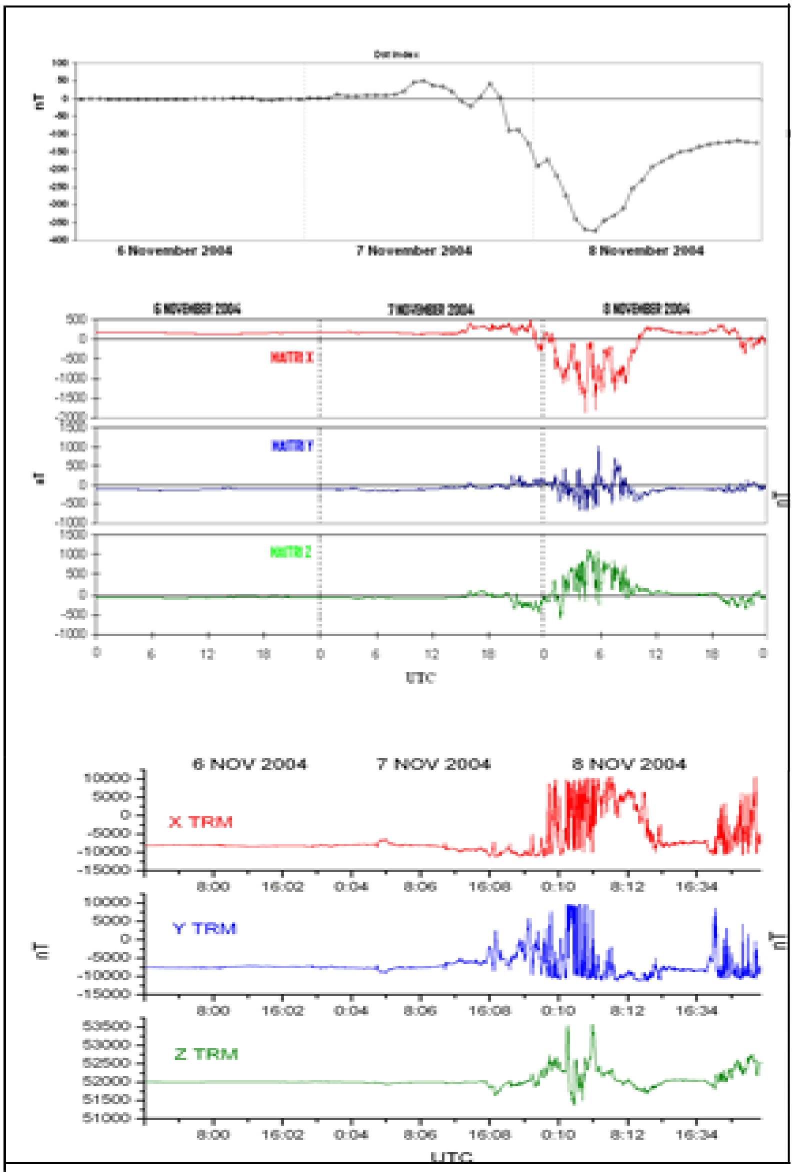
nT
6 November 2004
7 November 2004
8 November 2004
UTC
6 NOV 2004
7 NOV 2004
8 NOV 2004
X TRM
Y TRM
Z TRM
nT
8:00
16:02
0:04
8:06
16:08
0:10
8:12
16:34
UTC

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