Geomagnetic storm-time variations in the South Atlantic Anomaly Region

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Abstract

Geomagnetic variations in the horizontal components *H* (North-South) and *D* (East-West) during the large geomagnetic storm of 7 to 10 November 2004 are studied from the data collected at the stations São Martinho da Serra – SMS (29.43° S, 53.82° W and 33° dip) and Vassouras (22.40°S, 43.65° W and 33° dip). We have observed amplitude differences in the *H* variations and in the *D* variations between the two stations. The ring currents seem to undergo quick changes between the two stations situated in the South Atlantic Anomaly-SAMA region. The local time difference between the two stations is only 40 minutes.

Introduction

Active Region 696 was the dominant feature on the Sun during the period of November 7-10, 2004 which produced solar flares and CME events. Two X class flares were observed, a ~X2 on Nov 7 and ~X3 on November 10.

Two separate CME passages occurred generated by the sunspot activity during November 7-10, 2004. The first CME passage caused the storm on November 7-8 and the second CME passage caused the storm on Nov 9-10 period.

We present here the geomagnetic variations during Nov 7-10, 2004 observed at two stations, viz. São Martinho da Serra – SMS (29.43° S, 53.82° W, -19.0 geomagnetic latitude and 33° dip) and Vassouras – VSS (22°.40 S, 43°.65 W, -16.7 geomagnetic latitude and 33° dip), both situated in the South Atlantic Magnetic Anomaly - SAMA region at nearly the same magnetic latitude.

The geomagnetic variations in *H*, *D*, and *Z* components are recorded at both the stations SMS and VSS by identical low noise ring-core fluxgate magnetometers at a sampling rate of 2 seconds. The time keeping is done by GPS signals.

Data and results

The geomagnetic data acquired at a sampling rate of 2 seconds are converted in data files of one minute average. Thus it has 1440 points per day and 5760 points for the 96 hour record for the four days of the storm studied here.

In the Figure 1 we have plotted geomagnetic variations in *H* and *D* components observed at São Martinho da Serra – SMS (29.43° S, 53.82° W, -19.0 geomagnetic latitude and 33° dip) and Vassouras – VSS (22°.40 S, 43°.65 W, -16.7 geomagnetic latitude and 33° dip) for the storm period of 7 to 10 November, 2004. The plot starts at the zero hour UT of 7 November. Both the stations are situated in the South Atlantic Anomaly - SAMA region at nearly the same magnetic latitude and longitudinally separated by 10 degrees. The upper half of the Figure 1 shows the plots of *H* component, upper trace for São Martinho da Serra (SMSTORM.DAT) and the lower trace for Vassouras (VSSTORM.DAT). The lower half of the plot is for the component *D* in a similar fashion as was done for *H* component. This facilitates the comparison of the storm variations. Great similarity between the two traces gives confidence that the recorded data is of good quality.

We wish to compare the geomagnetic variation at both stations during the period of storm, Nov 7-10, 2004 to see the differences in the storm time variations at the above mentioned two stations. In the Figure 2 we have plotted the difference in *H* [(SMS(*H*)-VSS(*H*)] and *D* [SMS(*D*)-VSS(*D*)] components observed at the stations SMS and VSS. As the base values of *H* are different at both the stations we have subtracted the first value of *H* and *D* time series of the four days. Hence all the variations above zero meant that those values were larger at the station SMS compared to the station VSS and in the case of negative values the opposite is true. We can note that the differences in *H* and *D* variations at the two stations are noteworthy. It could mean that the ring currents undergo good amount of changes in the region of SAMA.

We thought to calculate total horizontal field *H*, ($H = \sqrt{(X^{**}2 + Y^{**}2)}$), from the data plotted in Figure 1 as the declination undergoes change of over 10 degrees between SMS and VSS, approximately 10 degrees West at SMS and over 20 degrees west at VSS. In the Figure 3 are plotted *H* variations at SMS and VSS in the upper half of the figure and in the lower half are plotted the differences in *H* variations between the two stations. As the storm time variations remain almost the same means that we are operating both the magnetometers in the respective magnetic meridians of both the stations.

In the Figure 4 we have plotted the same storm time variations at both the stations after the trend removal that is filtering out variations of periods above 120 minutes. The results are unchanged confirming that storm time changes between the two stations SMS and VSS are real.

Discussion

Geomagnetic storms are a spectacular manifestation of space weather changes. The physical processes and its causes are in discussion since Chapman and Bartels (1940) till recent days Gonzalez et al. (1994). Nagata and Fukushima (1971) have discussed in detail average storm time variation *Dst* and *Ds* disturbance local time variation or disturbance longitudinal inequality. In the present analysis the differences in *H* variations and *D* variations between SMS and VSS are seen very clearly. The longitudinal separation between the stations SMS and VSS is only 10 degrees in longitude or about 40 minutes in local time. It is surprising that between the two stations close by the *Ds* component is so large. At the present we do not have a good explanation but this difference is certainly due to the presence of South Atlantic Magnetic Anomaly and the large difference in declination between the two stations. The question to be answered is that can the ring current under go so much change in in such a short distance?

Acknowledgements

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References

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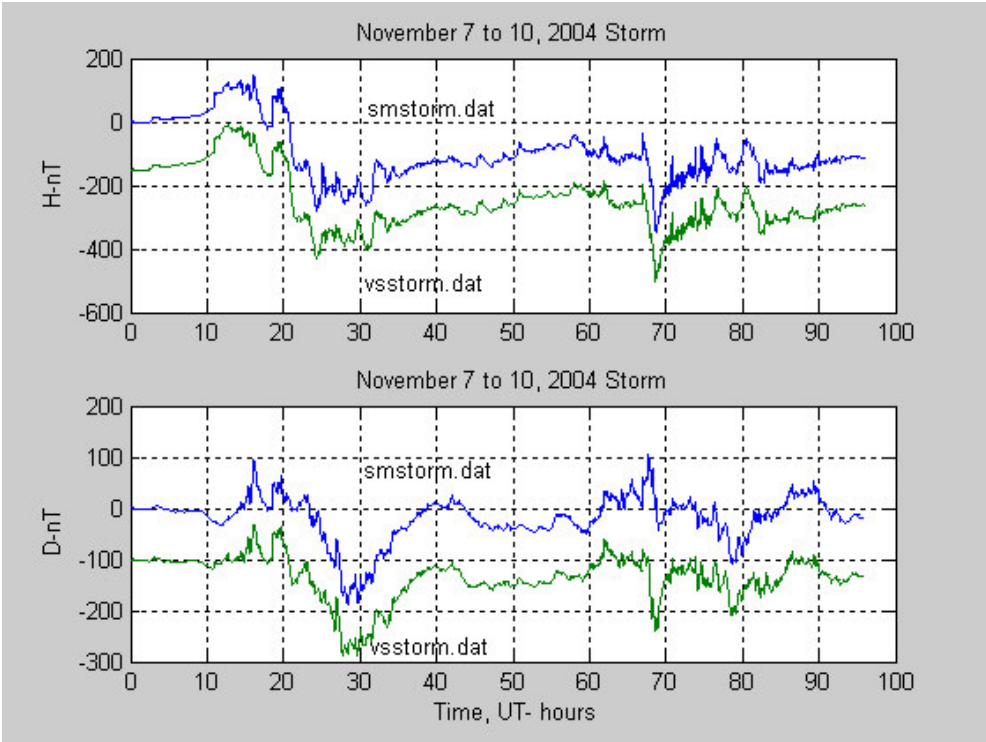

Figure 1 – Geomagnetic variations in *H* and *D* components at stations SMS and VSS during the storm period of November 7-10, 2004.

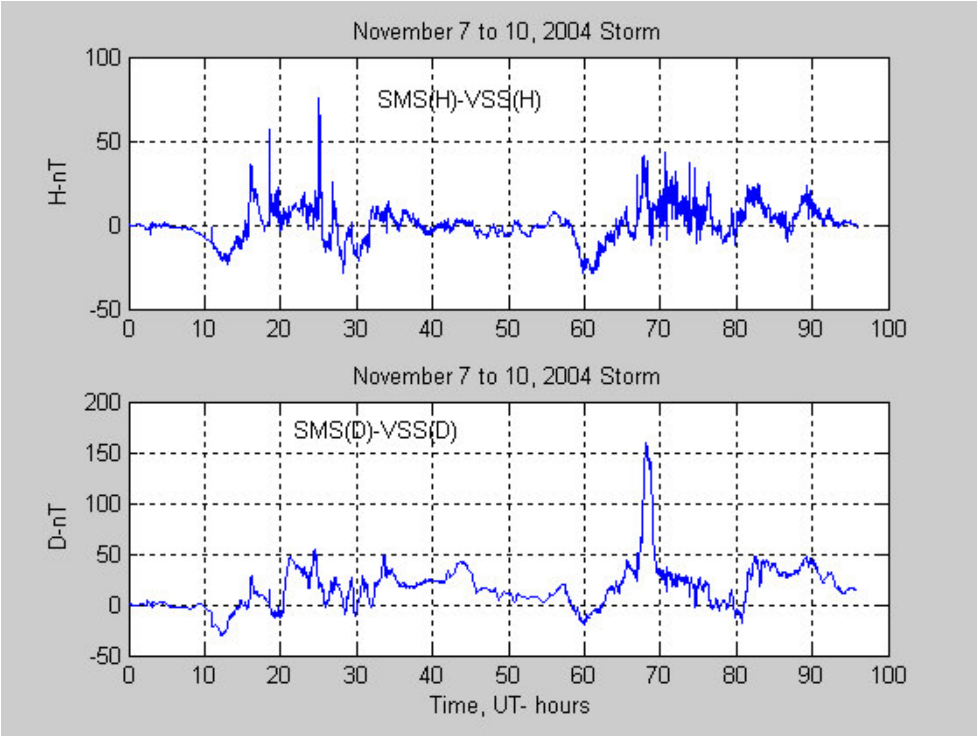

Figure 2 – Difference of geomagnetic variations between the stations SMS and VSS

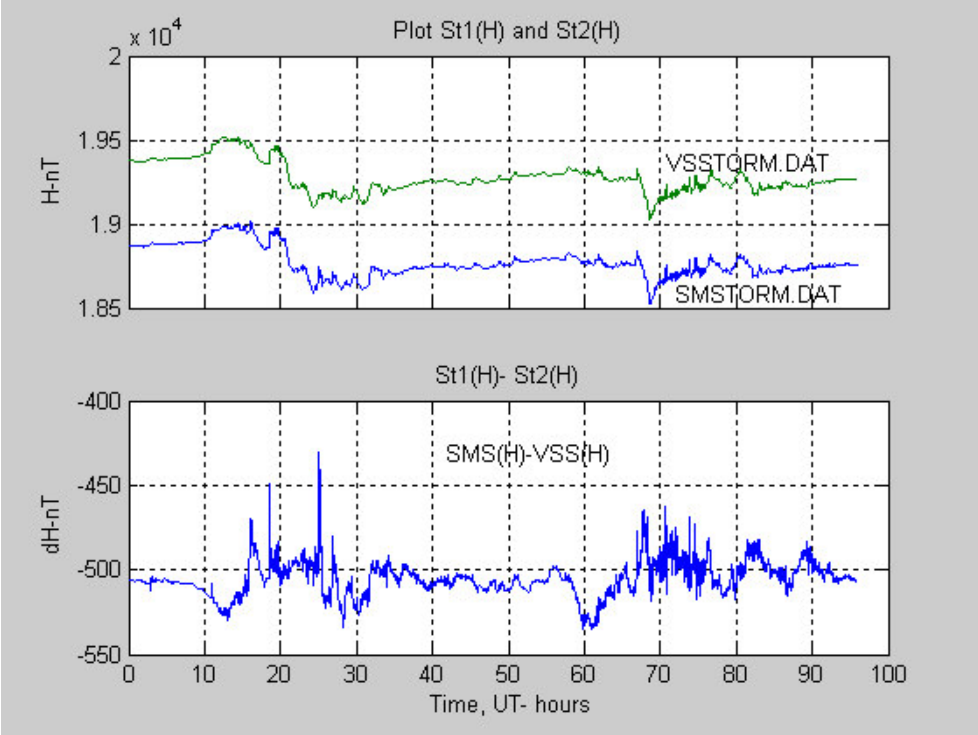

Figure 3 – Plot of H ($\sqrt{H^2 + D^2}$) versus time in hours after the zero hour UT of November, 2004.

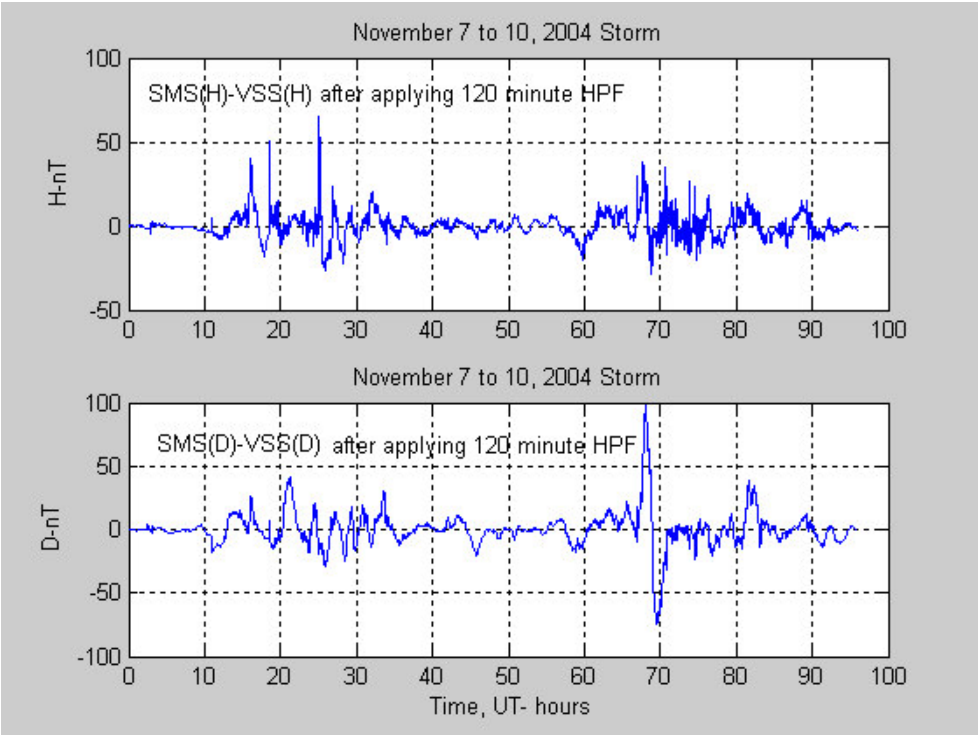

Figure 4 – The storm data of H, and D plotted after filtering out the data with periods over 120 minutes.