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SOUTH ATLANTIC MAGNETIC ANOMALY RELATIONSHIP BETWEEN THE SOLAR ACTIVITY AND GEOMAGNETIC VARIATIONS

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Abstract

Comparative studies are performed between the solar wind parameters measured by ACE satellite and geomagnetic variations data recorded in the Southern Space Observatory - OES/CRS/CCR/INPE– MCT, in São Martinho da Serra, (29.4°S, 53.8°W, 480m a.s.l), RS, Brazil, situated near the SAMA's center, which shows the lowest intensity of the geomagnetic field, and at the Vassouras Geomagnetic Observatory, RJ (22.40° S, 43.65° W), located on the SAMA edge region. The geomagnetic field three orthogonal components data, (H, D and Z) were measured with "fluxgate" magnetometers, with a 0.5Hz acquisition rate. The solar plasma speed and density data were obtained from the ACE satellite, located at the Lagrangian point L1, ($1.5x10^6$ km away from Earth). Comparisons between the intensity variation of the geomagnetic field and solar wind parameters for the different phases of the solar cycle are made. It is possible to identify fast changes in the geomagnetic field which are correlated with the solar activity, stronger or wicker, and its effects in the local Ionosphere, mostly around midday. Due to the low intensity of the geomagnetic field at SAMA's region, the periods of higher solar activity are related to an Atmosphere significant increasing in the flow of electrically charged particles. The physical and chemical phenomena associated to this increased particles flow may produce damages in satellites that orbit this region and inducing electric currents in the Earth's surface causing damages in the electric power distribution systems.

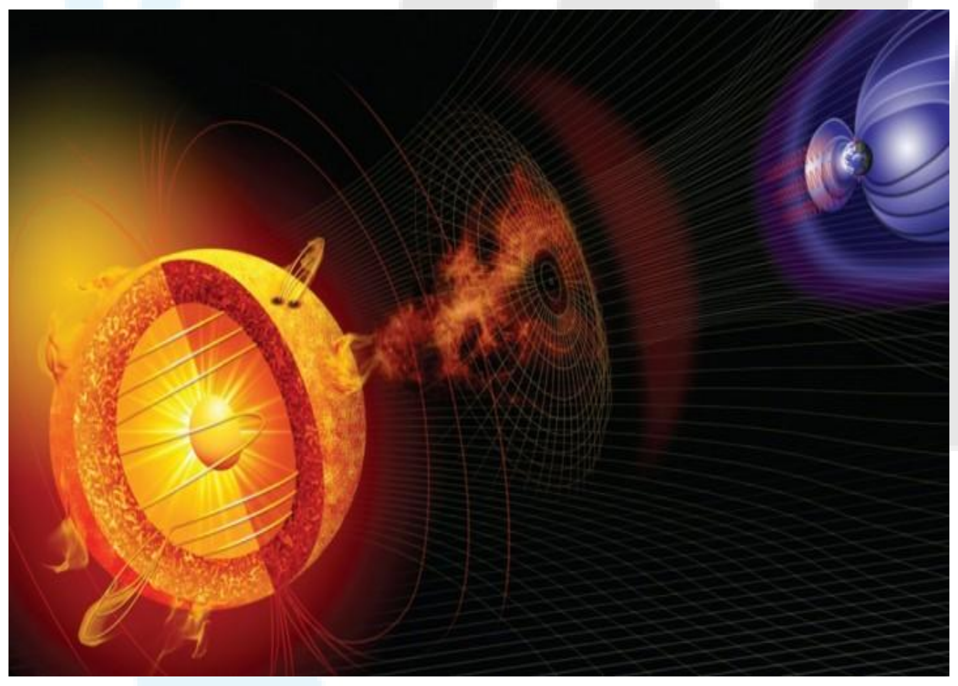

Figure 1 - Earth-Sun Interactions, Earth's magnetosphere.
Source : **NASA.**

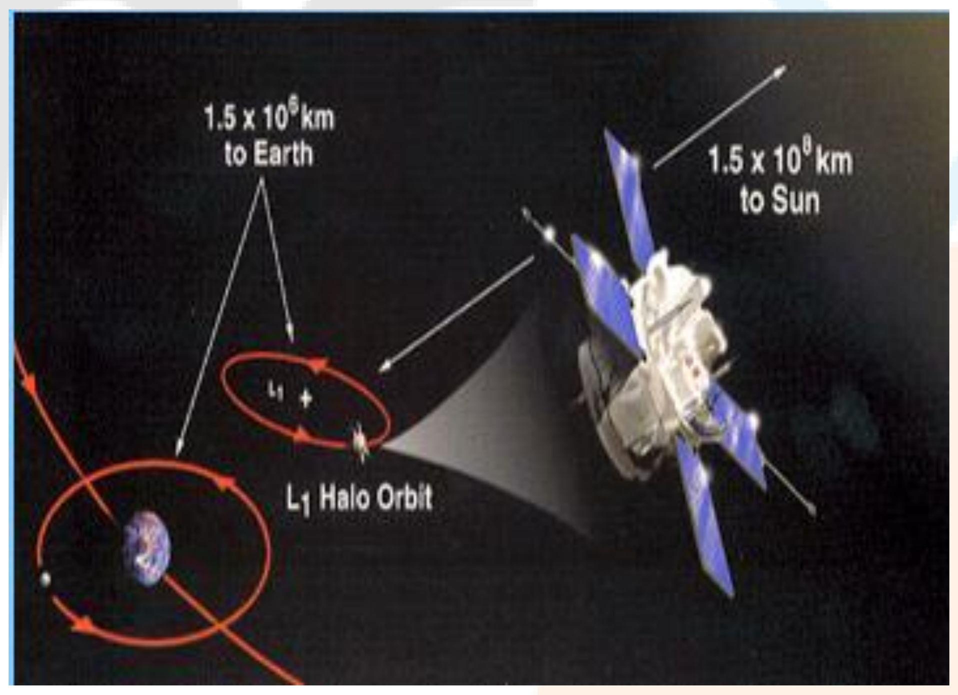

Figure 2 - Advanced Composition Explorer (ACE), Lagrangian point L1.
Source : **srl.caltech.edu/ACE/ace_mission**

Methodology and Data Acquisition

The geomagnetic field data collection and processing are accomplished in the Southern Space Observatory and in the Vassouras Geomagnetic Observatory stations. The data used in the study were obtained with the SSO's fluxgate magnetometer (saturated core) NAROD system (Figure 4), which performs data acquisition every 2 seconds in the three orthogonal vector components H, D and Z of the geomagnetic field.

We made comparisons between the geomagnetic variations detected at São Martinho da Serra and Vassouras with ACE satellite data for the solar plasma in the interplanetary medium at the Lagrangian point L1 provided by NOAA (National Oceanic and Atmospheric Administration). In order to find correlations between the parameters of the interplanetary solar wind and the geomagnetic field (Figures 11-12 and 13-14), in the region of the South Atlantic Magnetic Anomaly - SAMA, data at different phases of the solar cycle (Figure 3) were adopted.

To select the days of major and minor magnetic disturbance, the DST index was used (Figures 5-6), provided by Kyoto University ,(World Data Center for Geomagnetism).

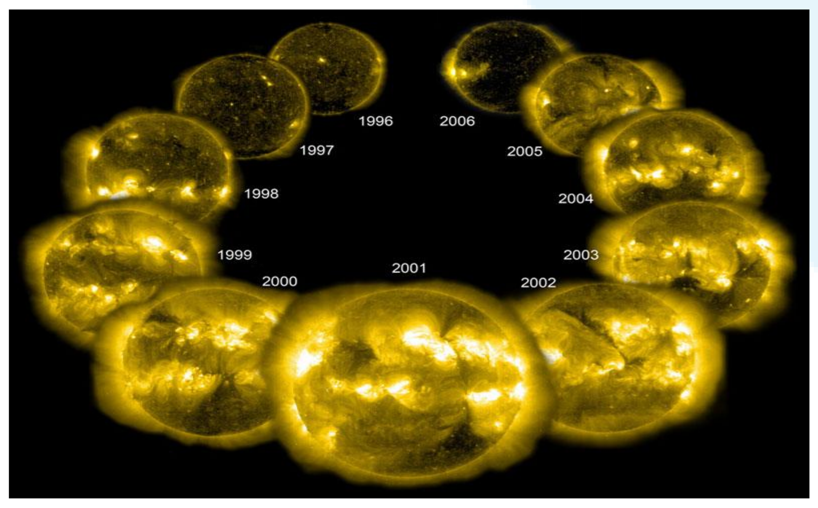

Figure 3: Solar Cycle No. 23.
Source: http://apod.nasa.gov/apod/ap071203.html

Figure 4: Circuit NAROD magnetometer.
Source: CRS /CCR/INPE–MCT.

Results

We selected two events: one during the 2004/11/08 geomagnetic storm (solar downward) and the another during a geomagnetic quiet day (solar minimum) on 2008/11/20 (Figures 7-8).

Solar wind parameters were obtained for the selected days: Speed, Density and Temperature of the solar wind, Figures 9-10. The Bz component of the interplanetary magnetic field (IMF) is also used in the analysis. These parameters are used to identify the interaction between the particles emitted by the Sun (during a Flare or Coronal Mass Ejection (CME) and the geomagnetic field.

The (2004/11/08) geomagnetic storm

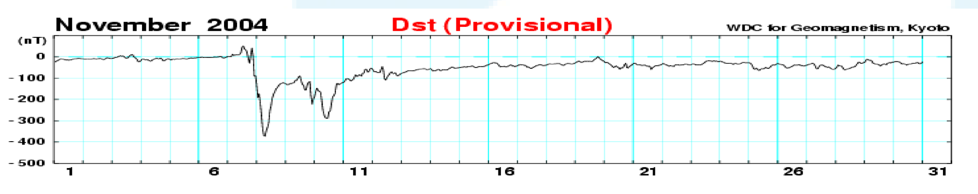

Figure 5 – DST Index, November2004.
Source: http://magdas.serc.kyushu-u.ac.jp/

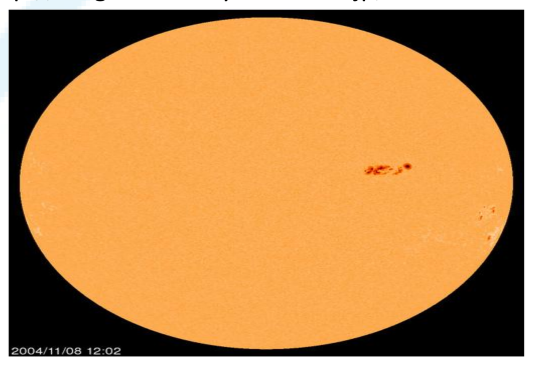

Figure 7 - Presence of sunspots 2004/11/08.
Source: SOHO / MDI

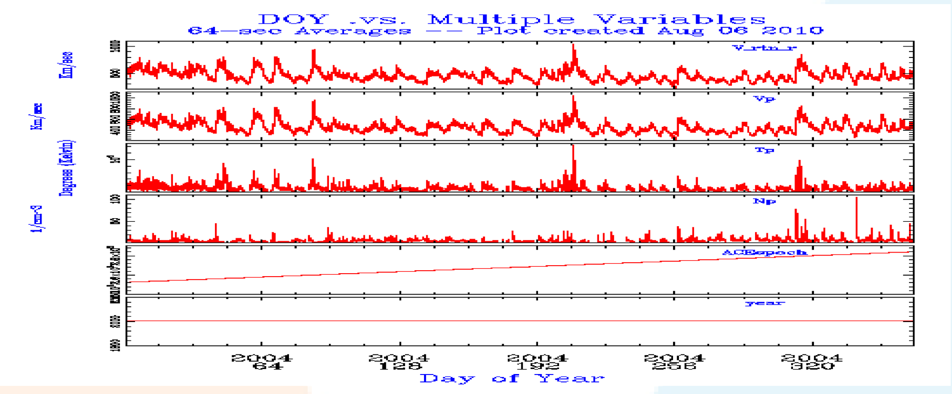

Figure 9 - Solar Wind Parameters for 2004/11/08.
Source: ACE / Caltech / NASA

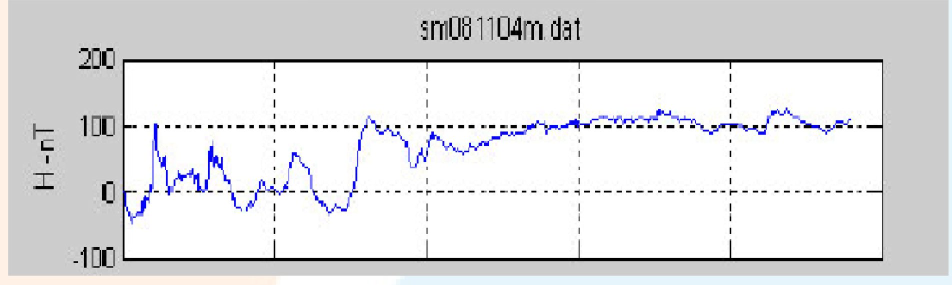

Figure 11 - Variation of the H component of geomagnetic field observed at the SSO/CRS/CCR/INPE–MCT for 2004/11/08.
Source: System Narod

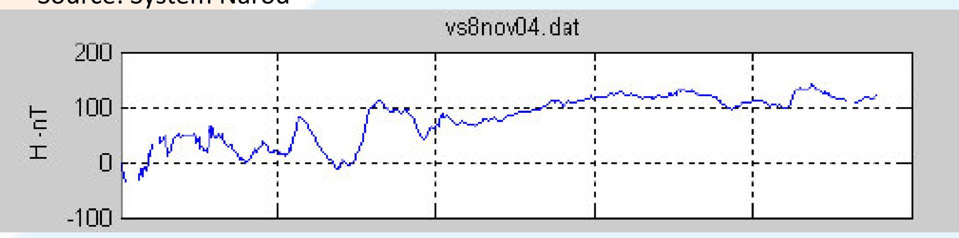

Figure 13 - Variation of the H component of geomagnetic field observed at the VSS/ON- MCT for 2004/11/08.
Source: System Narod

The (2008/11/20) geomagnetic quiet day

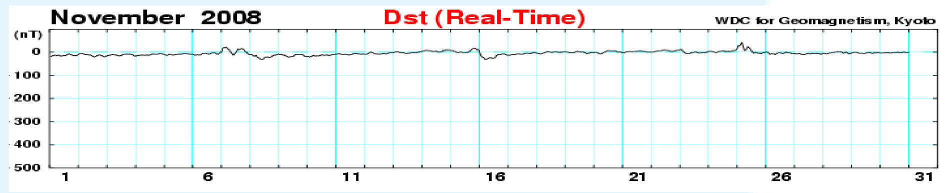

Figure 6 - DST Index, November 2008.
Source: http://magdas.serc.kyushu-u.ac.jp/

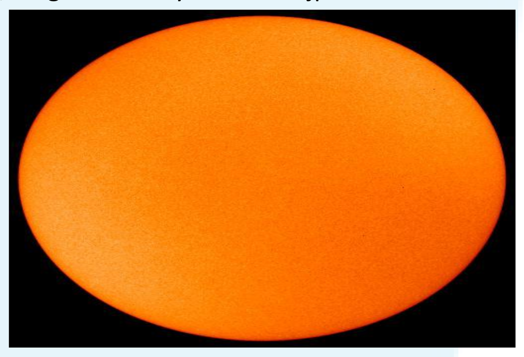

Figure 8 - No sunspots 2008/11/20.
Source: SOHO / MDI

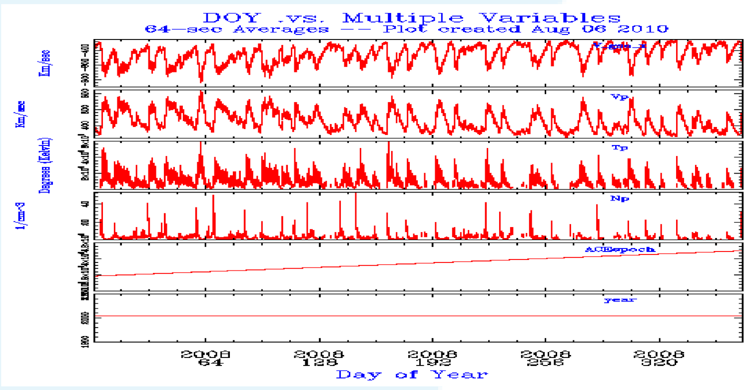

Figure 10 - Solar Wind Parameters for 2008/11/20.
Source: ACE / Caltech / ACE

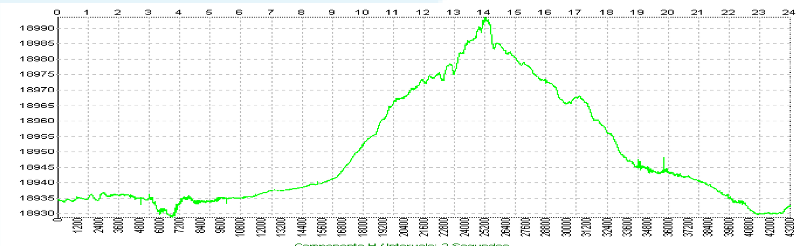

Figure 12 - Variation of the H component of geomagnetic field observed at the SSO/CRS/CCR/INPE–MCT for 2008/11/20.
Source: System NAROD

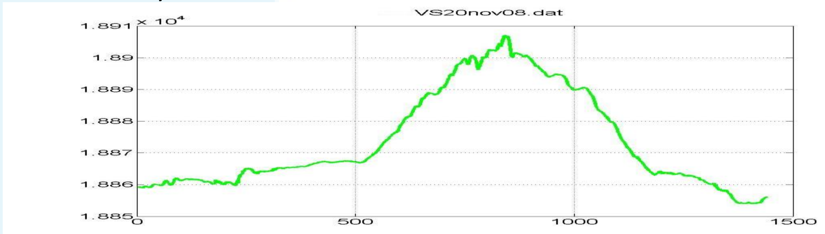

Figure 14 - Variation of the H component of geomagnetic field observed in the VSS/ON- MCT for 2008/11/20.
Source: System Narod

Conclusions

Through the analysis of the geomagnetic data, collected at Southern Space Observatory-SSO and at Vassouras Geomagnetic Observatory - OMV/ON, comparisons were made between the geomagnetic data with the solar plasma interplanetary region parameters, provided by the ACE satellite, correlations were performed.

Geomagnetically quiet days were characterized by low and decreasing solar wind speed, indicating low solar activity. The geomagnetic field behavior is very similar in both regions, at the edge (Figure 14) and at the center of the SAMA regions (Figure 12).

Geomagnetically disturbed days were characterized by a sudden increase in solar wind speed, density and temperature.

The amplitude of geomagnetic pulsations detected in magnetically disturbed days is greater next to the SAMA (Figure 11) center than those observed at the SAMA's edge (Figure 13).This phenomenon is probably related to the higher electrically charged particles precipitation in this region as a result of lower intensity of the geomagnetic field.

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