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ON THE SOLAR AND INTERPLANETARY ORIGIN OF INTENSE GEOMAGNETIC STORMS AND GROUND COSMIC RAY RESPONSE

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ABSTRACT

Geomagnetic Storms are episodes of extraordinary fluctuation of the Terrestrial Magnetic Field (Gonzalez et al., 1994). It is believed that the physical mechanism responsible for the transfer of energy from the Solar Wind to the Magnetosphere is the reconnection between the Interplanetary Magnetic Field and the Terrestrial Magnetic Field (Tsurutani and Gonzalez, 1997). For the occurrence of such a mechanism, it is necessary that the Interplanetary Magnetic Field possesses substantial component in the negative Z direction considering the system of coordinates Sun-Magnetosphere, or Bs, South. The present work has as objective to identify the types of interplanetary structures that caused the Geomagnetic storms during period close to the maximum of the Solar Cycle 23, from 2002 to 2003. During this period there were observations of cosmic rays from the International Muon Detector Network, of which the Southern Space Observatory-SSO (OES/CRSPE/INPE) started to participate since 2001. These observations are being used for the forecasting of the occurrence of these Geomagnetic Storm with high efficiency, up to 8 hours in advance of alert (Munakata et al., 2000). The identification of the interplanetary structures that caused intense storms in this period is very important for a future comparison with the observations of cosmic rays (muons), allowing the verification wheter there is some preferential type of structure that can be detected by the muon detector network.

INTRODUCTION

It is believed that the physical mechanism responsible for the energy transfer from the solar wind to the Earth's Magnetosphere is magnetic reconnection between the Interplanetary Magnetic Field (IMF) and the Earth's Magnetic Field (Tsurutani and Gonzalez, 1997) as represented in Figure 1.

An interplanetary disturbance, propagating from the Sun to the Earth, affects the galactic cosmic ray population in many ways. One of the most known is the "Forbush decrease". Some interplanetary disturbances like the interplanetary counterparts of coronal mass ejections (CME) can cause depressions in high energy cosmic rays along the IMF main direction, being detected before the arrival of the CME to the earth (Munakata et al., 2000), according to the diagram shown in Figure 2.

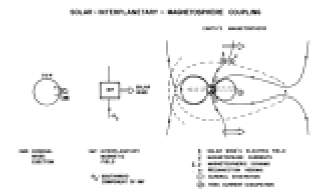

Figure 1

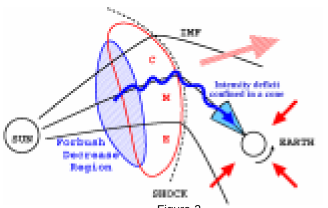

Figure 2

Figure 1. Schematic of interplanetary-magnetosphere coupling, showing the reconnection process and energy injection into the nightside magnetosphere, which leads to the formation of the storm-time ring current (Gonzalez and Tsurutani, 1992). Figure 2. Loss-cone precursors. Nagashima et al. [1992], Ruffolo [1999]

OBJECTIVES

- To identify the types of interplanetary structures that cause geomagnetic storms during the maximum of solar cycle 23.
- To verify if has some preferential type of structure that can be detected by the international muon detector network.

METHODOLOGY OF ANALYSIS

1) We use observations of the Dst index of the Kyoto University, to identify intense geomagnetic storms.
2) Plasma data - speed of the solar wind, temperature, and density of prótons and interplanetary magnetic field had been taken from instruments of ACE satellite.
3) Analyze of the Forbush decrease had been used given of muon telescope located in São Martinho da Serra, RS, Brasil.

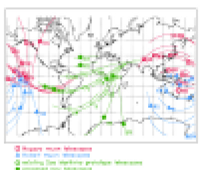

Figure 3. Muon Telescope in the Southern Space Observatory - São Martinho da Serra, RS, Southern Space Research Center – CRSPE

RESULTS AND DISCUSSION

The main structures that had caused intense geomagnetic storms in the period of Solar Cycle 23.

- Sheath field
- *Corrotanting interaction region – CIR*
- Magnetic cloud proceeding from a Coronal Ejection of Mass (CME)

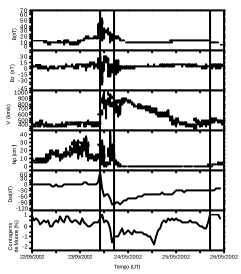

Figure 4

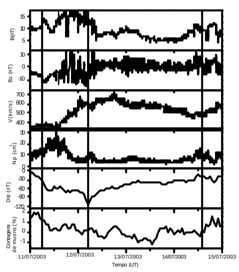

Figure 5

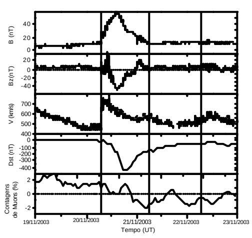

Figure 6

Figure 4. Example of Geomagnetic Storms caused for sheath field. Figure 5. Example of Geomagnetic Storms caused for Corrotanting interaction region – CIR, Figure 6. Example of Geomagnetic Storms caused for Magnetic cloud proceeding from a Coronal Ejection of Mass (CME).

CONCLUSIONS

1) In the Period of January of 2002 to the December of 2003, 22 Intense Geomagnetic Storms had occurred (Dst < - 100 NT). 15 storms had been analized, therefore of the 22, 7 had presented problems in the data of the detector of muons.
2) We saw during the work that the structures of the type "magnetic clouds" are very important in this study of the Space Weather. We can observe clearly in the graphical diagrams that have some Geomagnetic Storms caused by a magnetic cloud, which are identified by a rotation in the component z of the interplanetary magnetic field.
3) Important data that we observe in the analyzed Magnetic Storm events are that during the arrival of one it has shocked, characterized for the abrupt jump of the plasma parameters, occur a sudden increase in the interplanetary magnetic field strength. Fields compressed in the case soon after the shock are between the main intense storm causes, together with magnetic clouds.
4) We got good data with relation to the decrease in the count rate of muons during the Geomagnetic Storm occurrence, in average we have a decrease of 1,5% approximately.

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