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Study of environment change due to the geomagnetic field decreasing

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Abstract

The observation of upper atmosphere phenomena in the Brazilian geomagnetic anomaly region was started in cooperation with Japan and Brazil from 1996.The main objective of our study is to examine the future earth environment under the weak geomagnetic field. Several instruments are installed at two places in Brazil for investigation of ionospheric disturbance, natural wave excitation, Gamma ray radiation, Ozone depression and optical emission.

INTRODUCTION

It has been observed that the geomagnetic field (dipole field) has been monotonically decreasing over the last 1000 years. If the geomagnetic field intensity continues to decrease at the present rate, Earth magnetic field will disappear in less than 1500 years. It should be also noted that the total geomagnetic field intensity in the southern part of Brazil is especially weak(Figure 1) and the geomagnetic field in this and its surrounding area will disappear within 400 years (Makita,1996). Recent satellite observation indicates that a large quantity of radiation belt particles (>MeV) are precipitating into the Brazilian area on account of the very weak geomagnetic field (Konho et al.,1990). Due to the significant amount of high energy particle precipitation over the Brazilian region, electric devices on board the satellite are affected. It is also reported that X-ray caused by high energy particles in this region interfere with measuring system on board the satellite. If the decreasing of geomagnetic field continues in future, the number flux of precipitating particle will increase and also the intense precipitating region will expand to the other area. At the present, it is not well understood how our earth environment will change in association with the decreasing of geomagnetic field. The objective of our study is to examine the upper atmosphere phenomena in Brazil due to the energetic particle precipitation and predict the future earth environment under the weak geomagnetic field.

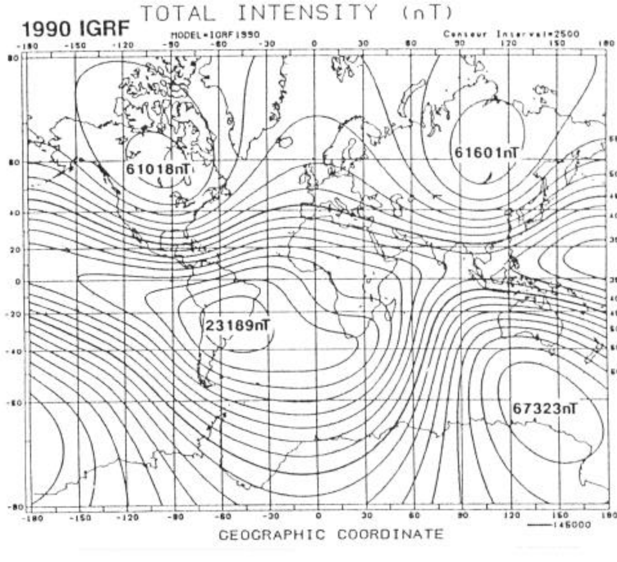

Fig. 1. Contour map of total geomagnetic Intensity in 1990 IGRF model. (Data catalogue, Kyoto Univ.1993)

OBSERVATION SYSTEM

The observation instruments are installed at two places in Brazil. One place is San Martinho da Serra and another place is Cachoeira Paulista. The following is the description of observation system at two stations.

- San Martinho da Serra Observatory -

San Martinho da Serra Observatory is about 50km away from Santa Maria City. The observatory is constructed in December 1996 and operated by INPE and Santa Maria University.The location of this observatory is 29°42'35"S, 52°49'22"W in geographic coordinate. From the geomagnetic field measuring by proton magnetometer, the total intensity of geomagnetic field is about 23100nT in this place. In 1996, Riometer, ELF / VLF/LF receiver, high sensitive TV camera were installed and in 1999, photometer and UVB meter are newly installed. The block diagram of the system is illustrated in Figure 2.
The riometer detects the cosmic noise signal (38.2MHz) and monitors the quantity of energetic particle precipitation . The energetic particle precipitation induces the enhancement of electron density and so cosmic noise signal is absorbed in D layer. The small 1m square antenna (N=200 turns) measures ELF/VLF emission. The signal is separated into three band pass filters, 0.8, 1.6 and 4.0kHz, respectively. The large 10 m triangle antenna (N=2 turns) measures including LF emission. The received signal is amplified for wide frequency range from 100Hz to 100kHz. The wide band signal is separated into three band pass filters, 0.4, 2.0, 10. 0 kHz, respectively. High sensitive TV camera consists fish-eye lens, night viewer and CCD camera. The sensitivity of this camera is about 500R luminosity. Riometer signal is recorded every 0.1 second and ELF/VLF/LF signal are recorded every 1 second by 128MB MO diskette. PC time is automatically adjusted by GPS time keeping system. All-sky TV camera data is recorded by VHS video recorder mixing with video timer signal.

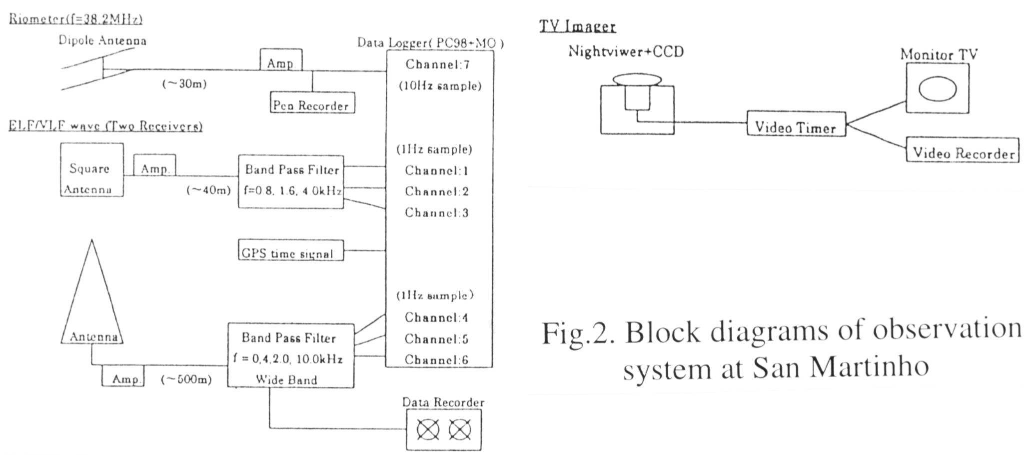

Fig.2. Block diagrams of observation system at San Martinho

- Cachoeira Paulista Observatory -

Cachoeira Paulista Observatory is 22°42'22"S, 45°00'33"W in geographic coordinate. From the geomagnetic field calculated by IGRF model, the total intensity of geomagnetic field is about 23500nT in this place. In 1996, γ ray spectrometer and UVB meter were installed. The block diagram of the system is illustrated in Figure 3. γ ray spectrometer detect 240 energy channels from 0 eV to 7.4 MeV. It is generally known that the energy lower than 3 MeV is radiated from the earth crust and cosmic origin is higher than 3 MeV. The sampling rate of this detector is every 2 hours. UVB meter measures the wave length from 280nm to 315nm. Since the intensity of these wave range correlate with total ozone content, so UVB intensity indicates the ozone depression due to the high energy particle precipitation. UVB data is collected every 1 minute and is stored by floppy diskette.

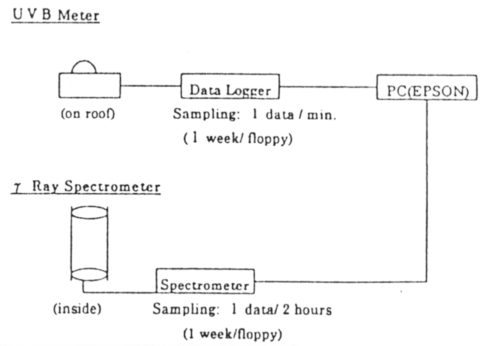

Fig.3. Block diagrams of observation System at Cachoeira Paulista

SUMMAR AND DISCUSSION

All instruments installed at Brazil are almost working well. The new observatory building at San Martinho da Serra is constructed at the end of 1998 and the observation circumstance became good. Since the solar activity is increasing now, we hope to collect data continuously and find typical phenomena related to geomagnetic anomaly region. It is noted that the amount of low energy particles(10eV – 10keV) related to aeronomy phenomena is not so large, although high energy particles(>30keV) are enhanced in this region. According to Gledhill and Hoffman(1981), total electron energy flux of 0.2 – 26keV is estimated at about 10^{-3} erg/cm^2.s in this region. This value is weaker than that of auroral region by about 2 digits or less. It means that high sensitive detector must be installed in order to find typical aeronomy phenomena. in this region. At the present, unfortunately, installed instruments seem to be not enough sensitivity to detect such phenomena. However, the number flux of radiation belt particles increase by about 2 digits during strong magnetic storm. If these particles actually precipitate in the low altitude of geomagnetic anomaly region, some aeronomy phenomena will be observed by our instruments. From this point of view, it is necessary to continue our observation for a long period to reach a final conclusion.

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