Riometer observation in Geomagnetic Hole in South Atlantic Anomaly Region

Makita K*., M. Hoshino（Takushoku University）,
Y. Tanaka （National Institute of Polar Research）,
Y. Kato, M. Nishino （Nagoya university, STE Lab.）,
T. Ookawa （Kakioka Geomagnetic Observatory）,
R. Monreal （Magalhanes University）,
A.Foppiano （Concepcion University）,
J. Gianibelli （La Plata University）,
N. J. Schuch（INPE Southern Space Center）

Copyright 2009, SBGf - Sociedade Brasileira de Geofísica

This paper was prepared for presentation during the 11th International Congress of the Brazilian Geophysical Society held in Salvador, Brazil, August 24-28, 2009.

Contents of this paper were reviewed by the Technical Committee of the 11th International Congress of the Brazilian Geophysical Society and do not necessarily represent any position of the SBGf, its officers or members. Electronic reproduction or storage of any part of this paper for commercial purposes without the written consent of the Brazilian Geophysical Society is prohibited.

Abstract

The geomagnetic field intensity is especially weak in the southern part of Lateen America. Since the geomagnetic field is so weak that high energetic particles are easily precipitating in this region. We named this weak geomagnetic field region as **Geomagnetic Hole,** where energetic particles are directly precipitating from the radiation belt In order to examine the precipitating phenomena in Geomagnetic Hole, we installed 1ch riometer, 4×4 imaging riometer(IRIS) and also polarization rioemeter at Southern Space observatory (SSO) in Brazil, Concepcion and Puntarenas in Chile and Trelew in Argentina. We also installed similar kinds of riometer at Kakioka in Japan for the comparison of Geomagnetic Hole CNA phenomena.

In this paper, we report two topics as follows.

(1) Observations of imaging riometer during geomagnetic storm period

(2) Polarization riometer observation

(1) The characteristics of cosmic noise absorption (CNA) during large magnetic storm period on the basis of imaging riometer(IRIS) data

So far, it was reported that CNA phenomena were observed in **Geomagnetic Ho**le during large magnetic storm period (Nishino et al.,2006). However, CNA phenomena were also observed not only during magnetic storm period but also during weak geomagnetic activity period. Therefore, we analyzed CNA phenomena before and after the large magnetic storm period.

- September 17, 2000 event -

Magnetic storm began at 14h24m UT on September 17, 2000. During this storm, Dst maximum value is 193nT. After 16h on September 17, magnetic activity increases in magnetometer at Kakioka, According to satellite particle data in Figure 1, energetic particles are remarkably decreasing after 21h UT..

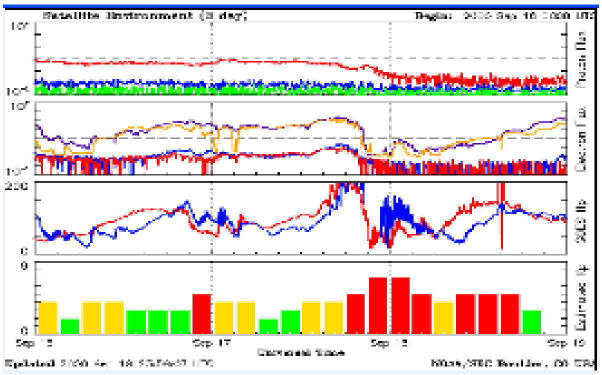

Figure 1

During this magnetic storm period, CNA event was examined by using IRIS data at Santa Maria, Brazil (SMR).CNA event was observed before the beginning of magnetic storm day. Figure 2 shows IRIS data obtained on 16 September 2000. 8 channels among 4×4 data were shown in this figure. Upper panel shows N2E1, N2E2, N2E3, N2E4 data and lower panel shows N1E2, N1E2, N1E3, N1E4 data. Each dotted line indicates the quiet cosmic noise intensity level.. Upward direction shows CNA. In this figure, remarkable CNA was recognized in N1E2, N1E2, N1E3, N1E4 channels after 21h UT on September 16.The magnitude of absorption is larger than 1 dB.

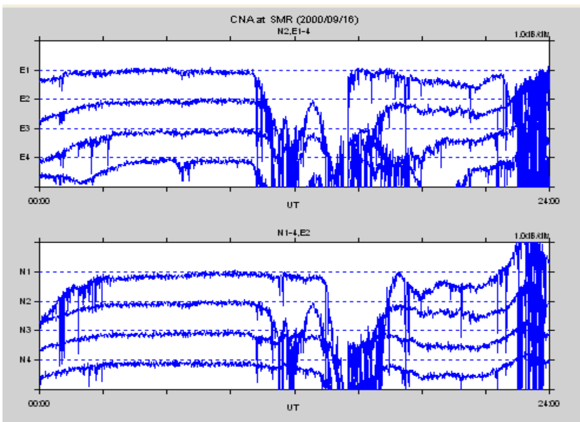

Figure 2

Figure 3 shows CNA image data from 22h00m to

23h50m (every 10 minutes interval images). The CNA was intermittently observed in the northern part (equator side) of SSO. The strong absorption was seen around 23h10m UT. This result may indicate that particle precipitations or anther variations was started before the beginning of geomagnetic storm.

22h00m to 23h50m UT on September 16,2000

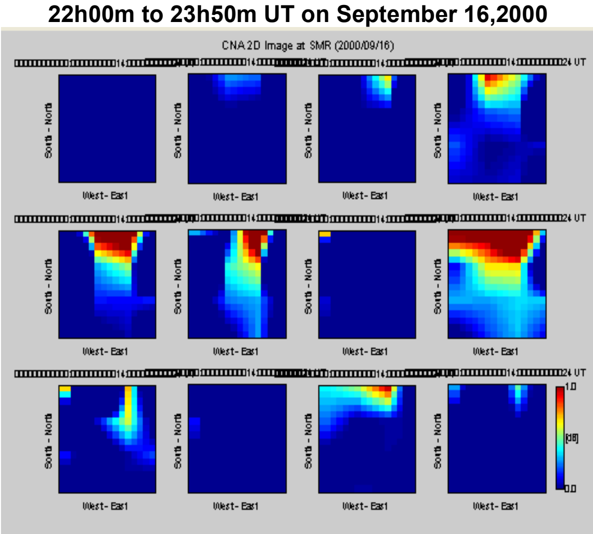

Figure 3

Magnetic storm began at 14h24m UT on September 17, 2000. The IRIS data was shown in Figure 4.Typical CNAN was observed after 22h UT as shown in N2E1 and N1E2 antenna.

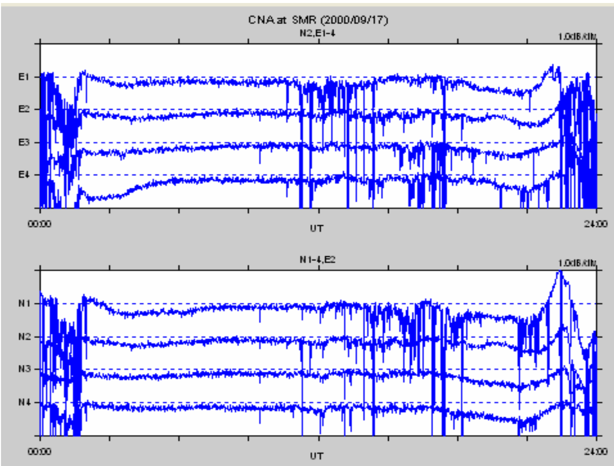

Figure 4

CNA image data from 23h00m to 23h55m were shown in figure 5. It shows that the strong absorption were recognized in the south – west region. Its absorption intensity is larger than 1dB.It is general that strong absorption were observed at SSO during large magnetic storm period.

2000/09/17 23h00m — 23h55m (UT)

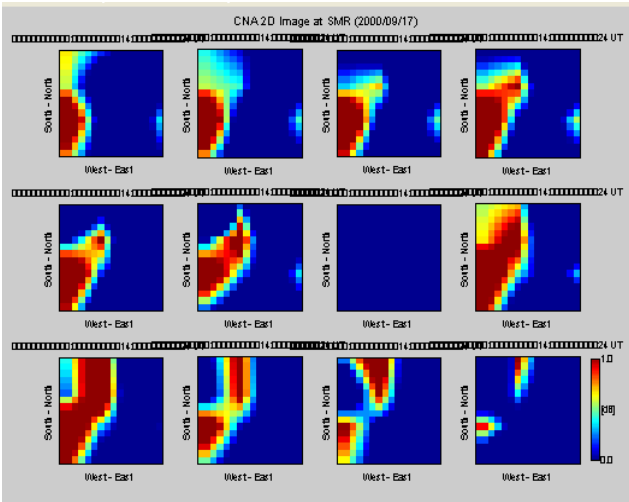

Figure 5

After the magnetic storm period (corresponding to recovery phase) on 18 September 2000, weak CNA phenomena were observed at SSO. Antenna N2E1 and N1E2 shows absorption around 15h – 16h UT. as shown in Figure 6.

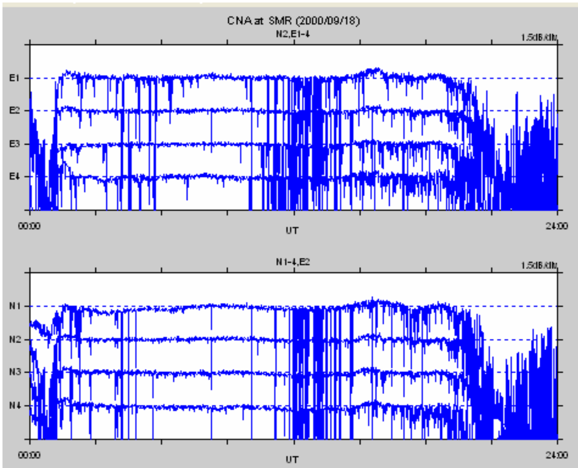

Figure 6

The characteristic of the absorption during recovery phase shows quite different structure from the main phase of magnetic storm. Fig.7 shows the absorption image data from 15h00m to 15h11m on 18 September, 2000. The absorption shows strip like structure at 15h08m UT in Figure 7. It is reported that similar these structures are frequently observed by GPS observation when traveling ionosphere disturbance (TID) were occurred. Therefore, this strip like absorption structure may relate to TID event.

2000/09/18 15h00m — 15h11m (UT)

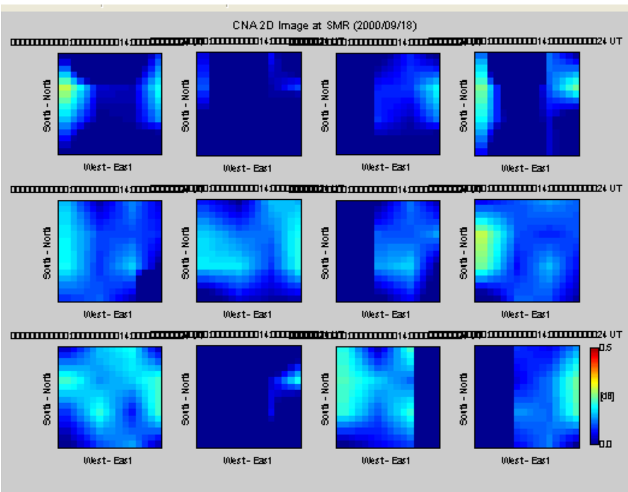

Figure 7

(2) Polarization riometer observation

2A Purpose of polarization riometer observation High energetic particles are precipitating in Geomagnetic Hole and those relativistic particles must excite a few tens MHz wave by synchrotron radiation. We intend to distinguish between Cosmic Noise propagating from Galaxy and synchrotron radia waves excited by precipitating particles in the Geomagnetic Hole. Since Cosmic Noise propagate through a long distance scattering with cosmic particles, so its polarization must be linear. On the other hand, the synchrotron radiation wave excited by relativistic particles near Earth must have circular polarized waves (right or left polarization).

2B Polarization riometer system

Fig.8 shows the schematic diagram of polarization riometer receiver system. Magnetic North–South(N-S) direction and East–West(E-W) direction antennas are installed as likely as two antennas are crossing with 90 degrees. On the basis of N-S and E-W antennas signals, we make 0 phase shift and –90 degrees phase shift, respectiv

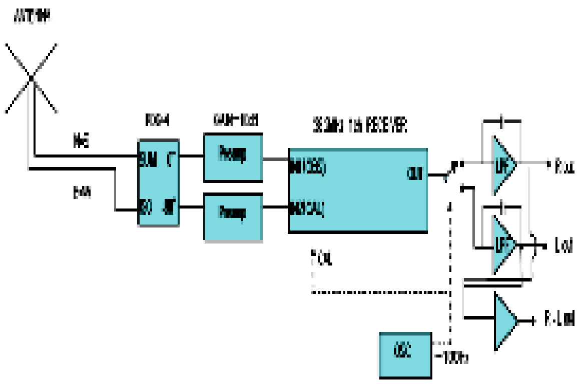

Figure 8

The detail circuit of phase shift and added signals are shown in figure 9..For example, input E-W signal (0 phase shift) and –90 degrees phase shift N-S signal are added. These added signal outputs is corresponding to channel 1. In the similar way, original N-S signal(0 phase shift) and –90 degrees phase shift E-W signal are added. These added signal output is corresponding to channel 2. These added signals are amplified and output to channel 1 (R polarization mode) and channel 2 (L polarization mode), respectively.

If observed wave has right or left polarization, ch1 or ch2 output signal is always larger than another channel and R-L value is plus or minus value. On the other hand, for linear polarized wave, ch.1 and ch.2 output signals are nearly same value and so R-L value must be nearly 0.

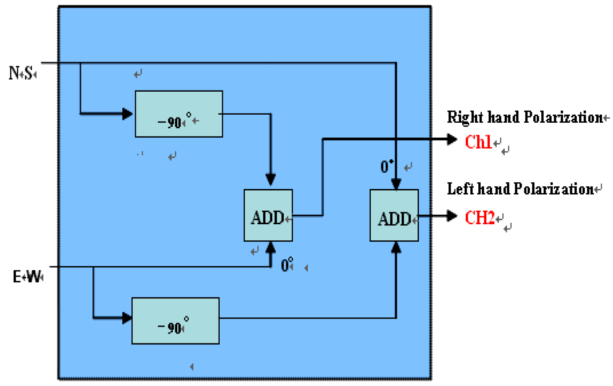

Figure 9

2C Summary of Polarization riometer observation

We constructed polarization riometer (observation frequency is 38.2 MHz) and started test observation at Kakioka Geomagnetic Observatory in Japan on December, 2008. Furthermore, we also installed same polarization riometer at Southern Space Observatory (SSO), RS. Brazil on February, 2009.

Figure 10 shows the polarization riometer data obtained at Kakioka, Japan. In this figure, Blue line shows channel 1 output (right hand), brown line shows channel 2 output(left hand).and orange line shows R-L value, respectively It indicates that blue and brown line shows same Cosmic Noise daily variation and R-L value is nearly 0. Therefore, Cosmic Noise is linear polarized wave as we expected.

If there exists circular polarized waves excited by synchrotron radiation in Geomagnetic Hole, polarization will be shown right or left hand. In order to examine such tendency, we just started the polarization riometer observation at SSO, Brazil and so those results will be reported at BGFS meeting.

Polarization riometer Kakioka, Japan.
2008/12/30

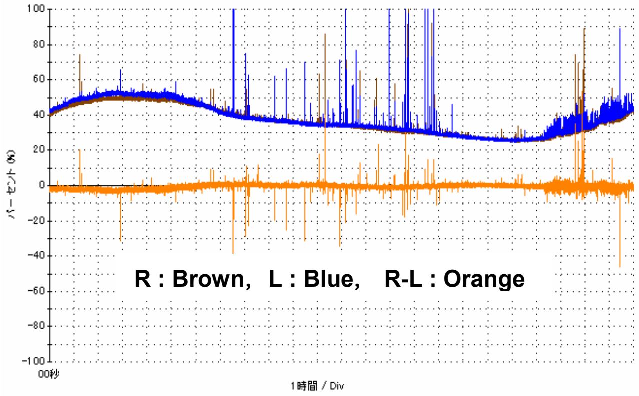

Figure 10

Conclusions

From imaging riometer data analysis, cosmic noise absorption (CNA) is observed not only the main phase of geomagnetic storm but also before and after period of magnetic storm. We consider that CNA before magnetic storm period may indicate the existence of any presage phenomena which affects to ionospheric disturbances. During main phase of magnetic storm, precipitation of energetic particle induces CNA in **Geomagnetic Hole**. Other hands, CNA after magnetic storm period must be related to the traveling ionospheric disturbances(TID) as reported by Ogawa et. Al.(2002).

From polarization riometer data analysis, we found that cosmic noise shows linear polarization. If synchrotron radiation is excited by particle precipitation in **Geomagnetic Hole** as reported by Dyce and Nakada(1959) , such wave will show the right or the left hand polarization. Since we started the observation of polarization riometer recently, so such radiation is not obtained yet. However, we expect that such radiation will be detected during geomagnetic storm period.

Acknowledgments

This study were supported by Faculty of Engineering, Takushoku University. Travel expensive were supported by Prof. Yumoto (Kyushu Univ.) and also STE lab., Nagoya University..We sincerely appreciate all persons who took care riometer instrumentsand others at Brazil, Chile, Argentina and Japan.

References

Nishino, M., K. Makita, K.Yumoto, N.J.Schuch and M. A. Abdu., Energetic particle precipitation in the Brazilian geomagnetic anomaly during “Bastille Day Storm” of July 2000, Earth Planets Space,58,607-616,2006

Ogawa, T., N., Balan,. K. Shiokawa, C .Ihara, T.Shimomai, and A. Saito, Observations and modeling of 630.0nm airglow and total electron content associated with traveling ionospheric disturbances over Shigaraki, Japan, Earth Planet Space, 54,45-56,2002.

Dyce,R.B, and M.P.Nakada, On the possibility of detecting synchrotron radiation from electrons in ths Van Allen Belts, J .Geophys. Res,64, 9, 1163-1168,1959