Pc3 MAGNETIC PULSATION RECORDED BY GROUND-BASED MAGNETOMETER AT BIAK

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Abstract

Ground-based magnetometer at BIK records magnetic field variation with high sensitivity and 1-second time resolution. This paper will describe technique how to extract the Pc3 magnetic pulsation from data of ground-based magnetometer in BIK. We will also show that Pc3 magnetic pulsation has band-frequency in period between 10 – 45 second.

INTRODUCTION

Magnetometer fluxgate at BIK (Biak) is one of magnetometer in global magnetometer network of CPMN (Circum-pan Pacific Magnetometer Network) and setup at 1992 to study about physical process in interaction between interplanetary magnetic field and Earth's magnetosphere as well magnetospheric processes. The magnetometer records 3-component of magnetic field variations namely H-, D, and Z-component of magnetic field with high sensitivity and has 1-second time resolution. The H-, D- and Z-component of magnetic field represent the north-south, east-west and up-down of magnetic field component in dipole coordinate system, respectively. Example of magnetic field variation recorded at magnetometer fluxgate at BIK is shown in Figure 1.

Interaction between interplanetary magnetic field and geomagnetic field as well magnetospheric dynamic generate many phenomena that could be observed from ground. By using magnetometer fluxgate at BIK we can extracted magnetic pulsations such as Pc3. Pc3 magnetic pulsation is the magnetospheric phenomena related with dayside magnetic reconnection that generated Kelvin-Helmholtz instability at the Earth magnetopause. The magnetic pulsation is a quasi continue magnetic pulsation in the band-period between 10 to 45 seconds.

In this paper will describe how to extract Pc3 magnetic pulsations from data of ground-based magnetometer and also will be described its characteristics.

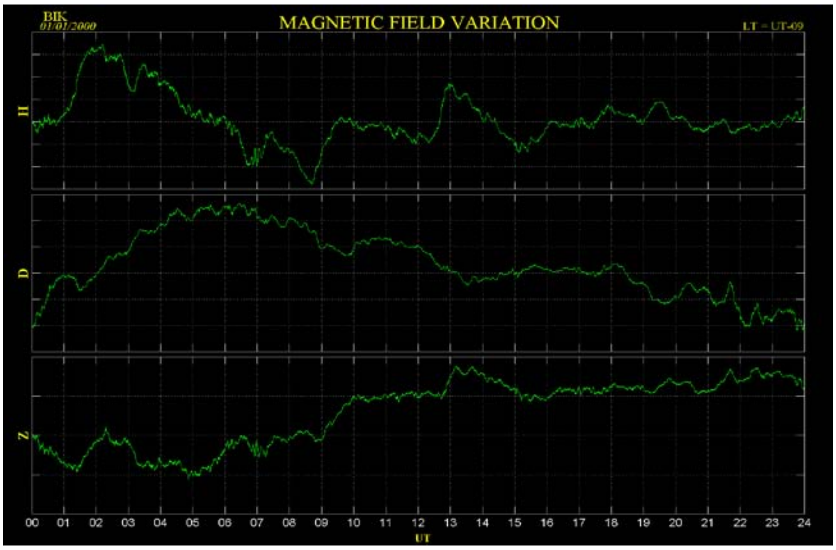

Figure 1: Three component of magnetic field variation recorded by magnetometer fluxgate at BIK at 1 January, 2000. Horizontal axis represent time in Universal Time (UT).

DATA AND METHODS

In this paper we use the data of magnetic field variations recorded by magnetometer fluxgate at BIK. The data have high sensitivity and 1-second time resolution, as shown in Figure 1.

To extract signal in the band frequency of Pc3 magnetic pulsation we use the Butterworth filter and Hamming windowing. The transfer function of Butterworth and Hamming window are given in equation (1) and (2), respectively.

$$H(z) = \frac{B(z)}{A(z)} = \frac{b(1) + b(2)z^{-1} + \ldots + b(n+1)z^{-n}}{1 + a(2)z^{-1} + \ldots + a(n+1)z^{-n}} \quad (1)$$

and

$$w[k+1] = 0.54 - 0.46\cos\left(2\pi\frac{k}{n-1}\right) \quad (2)$$

We are also apply the one-dimensional discrete fast Fourier transform (FFT) to show the frequency of magnetic pulsations. The discrete FFT and its inverse are given in equation (3) and (4), respectively.

$$X(k) = \sum_{j=1}^{N} x(j)\omega_N^{(j-1)(k-1)} \quad (3)$$

and

$$x(j) = \frac{1}{N}\sum_{k=1}^{N} X(k)\omega_N^{-(j-1)(k-1)} \quad (4)$$

RESULTS

By using the Butterworth filter and Hamming windowing to the magnetic field variation we extracted the ULF signal in the band period 10 to 1000 seconds. Example of the ULF signal is shown in Figure 2.

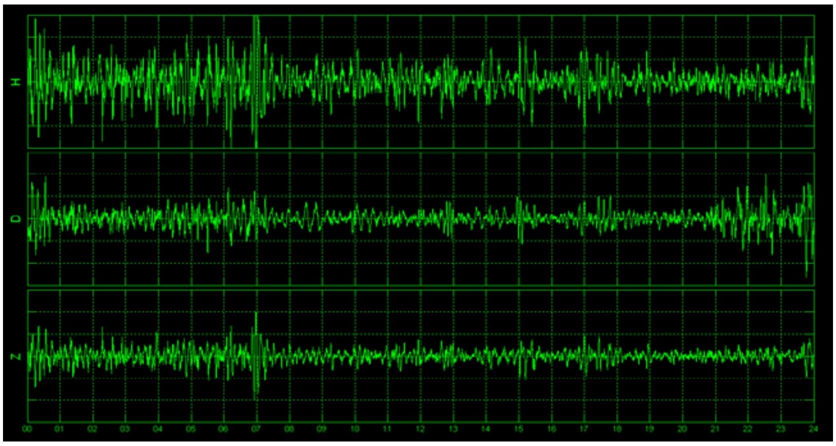

Figure 2: ULF signals in the band period 10 – 1000 seconds extracted from data of magnetometer fluxgate in BIK at 1 January 2000.

With applying the discrete FFT to the extracted ULF signal we can see dominant frequency content in the signal. In Figure 3, we present an example of plot of Power-frequency of the ULF signal for H-component at 00:00 – 00:15 UT for same date with ULF signal in Figure 2 . In the figure we can see some peak in power spectrum. This means that the ULF signal recorded by the magnetometer fluxgate at BIK contain ULF signal in several band periods that included the band frequency of Pc3 magnetic pulsations.

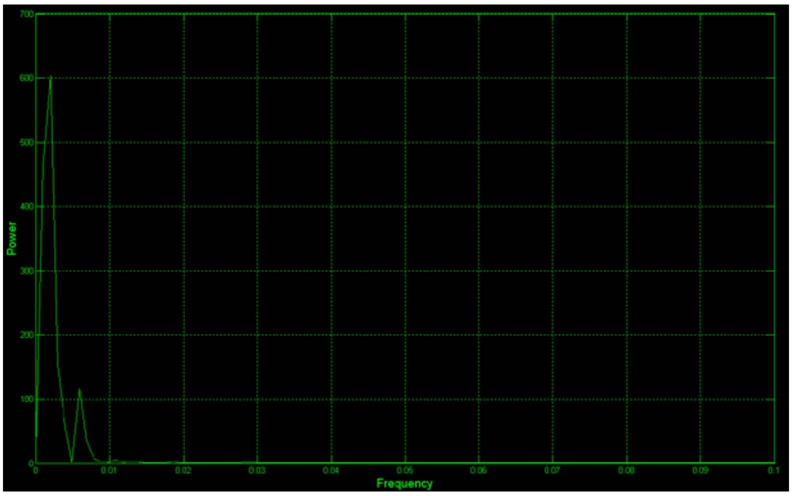

Figure 3. Spectrum frequency of ULF signal extracted from the data of magnetometer fluxgate at 00:00 – 00:15 UT, 1 January, 2000. Horizontal and vertical axis represents frequency in mHz and power spectrum of ULF signal, respectively.

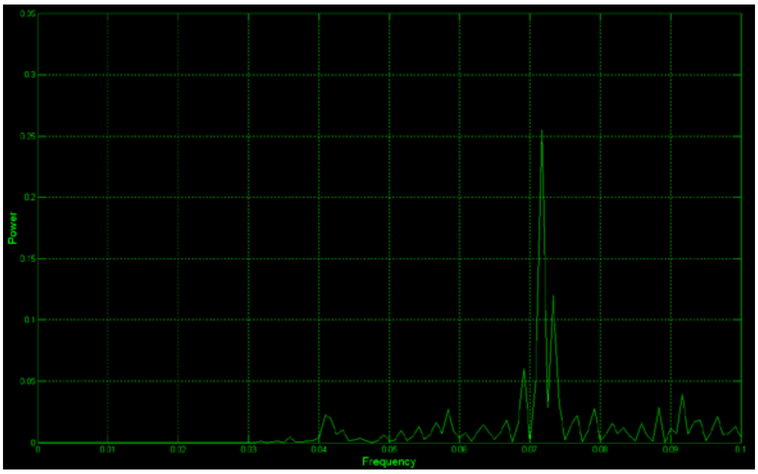

Figure 4. Spectrum frequency of ULF signal extracted from the data of magnetometer fluxgate at 01:00 – 00:20 UT, 1 January, 2000. Horizontal and vertical axis represents frequency in mHz and power spectrum of ULF signal, respectively.

A very clear power spectrum in the band frequency of Pc3 magnetic pulsation shown in Figure 4. Figure 4 presents the power spectrum of ULF signal at 01:00 – 01:20 UT, 1 January 2000. The peak of power spectrum shows the dominant frequency at 0.73 mHz where the frequency in the band frequency of Pc3 magnetic pulsations. This show that we can observe the Pc3 magnetic pulsation from data recorded magnetometer fluxgate at BIK.

CONCLUSIONS

We show method to extract ULF signal from magnetic variation recorded by ground-based magnetometer at BIK by using Butterworth filter and Hamming windowing. The data of magnetic field variation recorded by magnetometer fluxgate at BIK contain ULF signal in several band frequency. We also show that by using data of magnetic variation we can extract the Pc3 magnetic pulsation with period between 10 – 45 seconds. In future, we will use this results for study of effect interaction between solar wind and earth's magnetosphere and also to study the generation mechanism Pc3 magnetic pulsations.

Acknowledgement
We would like to thank you to Head of Pusat Pemanfaatan Sains Antariksa, LAPAN for supporting this study. In this study granted by Program Penelitian Regular, Pusat Pemanfaatan Sains Antariksa, LAPAN tahun anggaran 2009.