Study of Pc3 Magnetic Pulsations Observed From MAGDAS in Indonesia

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ABSTRACT

It has been known for decades that solar activity influences the near-earth environment through the solar wind variable flow and energetic particles emissions. The interaction between solar wind and Earth's magnetic field generated various hydromagnetic signal. The Pc3 magnetic pulsations is one of the hydromagnetic signal with period between 10 – 45 seconds. These pulsations can be observed in a number of ways and one of the most successful methods is application of ground based magnetometer arrays. MAGDAS, the Magnetic Data Acquisition System, is an important component, that is dedicated to observed the magnetic field for supporting the space weather studies. In this study we used the MAGDAS datas of Kupang, Manado and Pare-pare to analyzed the effect of the solar wind structure changes on these pulsations. To extract Pc3 magnetic pulsations we applied second order of butterworth filter and fast fourier transform. The result showed that solar wind controls of Pc3 magnetic pulsations occurrence.

INTRODUCTION

- Magnetic pulsations is a kind of hydromagnetic oscillation in the Earth's magnetosphere where those oscillations are also contained in the ground-based geomagnetic field variations [Yumoto, K, J.-Geophy., 1986]. Those pulses are Alfven waves [Robert L. McPherron, Surv. Geophys., 2005].
- The Pc3 magnetic pulsations is one of the hydromagnetic signal with period between 10 – 45 seconds (Jacobs, J. A. , 1964).
- Pc3 geomagnetic pulsations can be generated either externally or internally with respect to the magnetosphere.
  1. External sources (originate from solar wind such that they relate to solar wind parameters: solar wind speed and solar wind dynamic pressure).
  2. Internal sources (originate from wave-particles under fields interactions such as mirror drift instabilities).
- The aim of this to study charateristic of Pc3 magnetic pulsations and its associated with conditions of the solar wind.

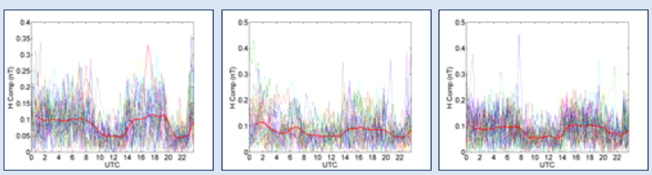

Figure 1. Daily variation of Pc3 magnetic pulsation at (a) KPG, (b) MND and (c) PRP February 2010. Horizontal and vertical axis represents hour in UTC and amplitude of Pc3 magnetic pulsation, respectively.

DATA AND METHODOLOGY

- In this study we used data of magnetic field variation that recorded by ground-based magnetometer at KPG (Kupang, East Nusa Tenggara) (-10.2^{0}S, 123.4^{0}E, LT=UT+8), MND (Manado, North Sulawesi) (1.44^{0}N, 124.84^{0}E , LT=UT+8), and PRP (Pare-Pare, South Sulawesi) (-3.6^{0}S, 119.4^{0}E , LT=UT+8) during period 2010-2011.
- The signal of Pc3 magnetic pulsation was extracted from data of magnetic field variation where the data have time resolution 1-second.
- Extraction of the Pc3's signal was performed by using FFT with applying 2nd-order of Butterworth filter and Hamming windowing.
- In this study we only consider on H-D component and the amplitude of Pc3 magnetic pulsations was calculated as maximum amplitude for the each range 20 minutes.
- We also used data of solar wind to analyze relationship between the Pc3 with speed of solar wind and IMF, which are recorded by ACE (*Advanced Composition Explorer*).

CONCLUSIONS

Study of Pc3 magnetic pulsations during 2010-2011 has been performed. The result showed that increasing the speed of the solar wind is also accompanied by an increasing the amplitude of Pc3 magnetic pulsation, this could be related to wave surface propagation at magnetopause. The orientation of the polarization Pc3 magnetic pulsation indicates that the propagation from external sources tend to have the spread towards the west (westward) in the morning and towards the east in the afternoon. This means that solar wind controls Pc3 magnetic pulsations occurrence.

RESULT

In the Fig .2 for speeds less than 700 (km / sec) relation between amplitude of Pc3 magnetic pulsations with the solar wind speed is almost linear or an exponential function with a small coefficient. This can be interpreted that, the energy of Pc3 magnetic pulsation which is the square of amplitude is proportional to the kinetic energy of the solar wind particles which is determined by the square of its velocity.

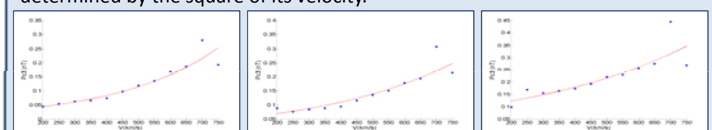

Figure 2. The dependence of Pc3 magnetic pulsation on the solar wind velocity (Vsw) during 2010-2011 at (a) KPG, (b) MND and (c) PRP. Horizontal and vertical axis represents of solar wind velocity and amplitude of Pc3 magnetic pulsation, respectively.

In order to better analyze the relationship between Pc3 frequency and IMF strength, we visually selected for both stations the clearest wave packets and estimated their frequency from the power spectra. Fig.3 shows the scatter plots of the selected frequencies versus the corresponding IMF strength. It can be seen at both stations the correlation between two parameters is good (r = 0.7688 at KPG; r = 0.6862 at MND and r=07688 at PRP); with gives the empirical relationships: f(mHz) = ~5.2B(nT), f(mHz) = ~4.9B(nT), f(mHz) = ~4.7 B(nT) at KPG, MND and PRP.

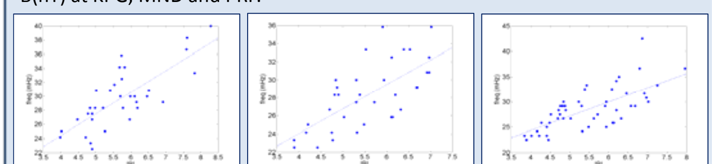

Figure 3. The dependence of the frequency of selected Pc3 wave packets at KPG (upper panel), MND (middle panel), and PRP (lower panel) on the IMF strength. Dashed lines are the linear regressions.

Polarization analysis on the Pc3 magnetic pulsation show that the polarity orientation is anti-clockwise direction (counter-clockwise) with orientation of the ellipse at NW-SE axis (NorthWest - SouthEast) in the morning and by noon local time. At the afternoon the polarization orientation changes clockwise (counter-clockwise) with orientation ellipse in NE-SW axis (NorthEast - SouthWest). This indicates that the propagation from external sources tend to have the spread towards the west (westward) in the morning and towards the east in the afternoon.

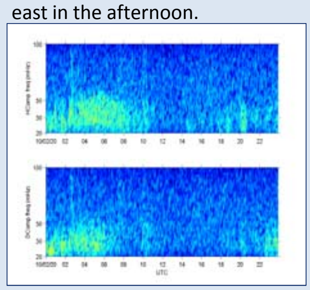

Figure 4. Dynamic power spectra of the H components (upper panels) and D components (lower panel) at KPG on Febuary 2, 2010.

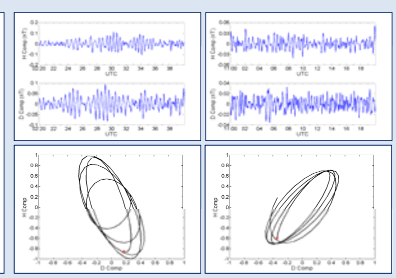

Figure 5. Low-pass fltered (22±100 mHz) H and D data at KPG in the time intervals 02:20-02:40 UT (left) and 11:00-11:20 UT (right), together with the hodograms for two selected wave packets; the red dot indicates the initial point.

ACKNOWLEDGEMENT

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