UNIVERSITI TEKNOLOGI MARA

CHARACTERIZATION OF LOW FREQUENCY VARIATIONS DUE TO SPACE WEATHER CONDITIONS AT LOW LATITUDE REGION

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ABSTRACT

The process of interaction between space weather conditions and Earth's magnetic field is one of the factors that lead to the variation effect of both ultra-low frequency (ULF) and very low frequency (VLF) waves which can be observed in space and on the ground. These variations are recorded in the frequency range of ULF and VLF with 1.7 - 500 mHz and 3-30 kHz respectively. Study on both ULF and VLF at low latitude region is still not well established, due to the lack of understanding in ULF and VLF. Therefore, this study investigates the characteristics of both ULF and VLF due to space electromagnetic perturbations at low latitude region. In the first part of this study, solar wind (SW) parameters were analyzed during a maximum solar cycle of 24. Solar wind (SW) parameters that considered in this analysis are solar wind speed, Vsw (km/s), solar wind input energy,ε (ergs/s) and solar wind dynamic pressure, P_{dyn} (nPa). The observation period covers on year 2012 (for ULF) and 2013 (for VLF). In the second part, the recorded ULF magnetic pulsations are extracted from Magnetic Data Acquisition System (MAGDAS) magnetometer was observed at low latitude stations; Langkawi (LKW), Malaysia and Tirunelveli (TIR), India. In the third part, VLF data were investigated from Atmospheric Weather Electromagnetic System for Observation Modeling and Education (AWESOME) VLF receiver located at Universiti Kebangsaan Malaysia (UKM), Malaysia, which received the signals from Katabomman (VTX), India and Lualualei (NPM), USA. The results of analysis show that Pc5 ULF pulsations have a positive correlation with the SW parameters. While for VLF variation, the result shows weak correlation with the SW parameters. To connect the solar wind with ULF and VLF variations, there are some possibilities that vary on both variations. The main source which effects on the Pc5 ULF pulsation is from coronal mass ejection (CME) and coronal hole (CH) which can produce high-speed solar wind (HSSW) traveling to the Earth. Both CME and CH influenced the variations of the Earth's magnetic field at all latitudes. However, for VLF, the variation is directly not affected by SW parameter due to ionospheric absorption at D-layer of ionosphere.

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CHAPTER ONE
INTRODUCTION

1.1 RESEARCH BACKGROUND

Space weather refers to the particle conditions in interplanetary space that may disturb space-borne, modern technologies and may affect human life or health [1]. It can influence the performance and reliability of technology on earth (electrical grid system and radio communication system) and space system (satellite system and space shuttle) [2]. Space weather has its cycle with solar activity rising and falling over ~11 years solar cycle [3]. In certain conditions, Sun will eject flares containing high energetic particles and these collide with the Earth at high speed during the reconnection process. This process occurs when the interplanetary magnetic field (IMF) turns southward in space and then penetrate into the Earth's ionosphere through the polar region and cause higher variations in the Earth's magnetic field [4]. Moreover, the high energetic particles can disturbance when the penetration of the solar wind (SW) and the Earth's magnetic field occur in the magnetosphere. Aurora, substorm and geomagnetic storm are the phenomena of the space weather effects on Earth. Substorms are caused by the energy transfer released from the solar wind to the magnetotail. This released energy creates changes in three conditions: 1) auroral morphology during substorms, 2) enhancement of currents flowing in the ionosphere and 3) disturbances in the Earth's magnetic field. Additionally, any variations of the radio signal for communication system on Earth are also affected by space weather phenomena.

Solar wind is defined as a stream charged particles emitted from the upper atmosphere of the Sun and one of the factors that lead to the variation of geomagnetic pulsation. The joining between IMF which is the extension of the Sun's magnetic field and Earth's magnetic field is called magnetic reconnection and both magnetic fields become a couple together, in which producing a tremendous electric generator which converts kinetic energy of solar wind into electrical energy [5]. Activities of the Sun will cause higher variation in solar wind speed and solar wind dynamic pressure which later will influence the amount of solar wind input energy. Hence, these three solar wind perturbations (SW speed, SW input energy, and SW dynamic pressure) being used