

Understanding Climate Changes in Malaysia Through Space Weather Study

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ABSTRACT

Space weather has a close connection with the interaction of the Earth and the Sun. As equatorial country, the characteristic features of the climate of Malaysia are uniform temperature, very high humidity and copious rainfall. Malaysia has an average of temperature of 26.7 °C per year. Therefore, it is suitable to monitor the Sun. In the following work, we will emphasize the development of Sun monitoring in Malaysia. The number of observatories are increasing. A dedicated work to understand the Sun activity in radio region is a part of an initiative of the United Nations together with NASA in order to support developing countries participating in 'Western Science' research. Realizing how important for us to monitor the space weather, therefore, we have been utilizing the new radio spectrometer, CALLISTO (*Compound Low Cost Low Frequency Transportable Observatories*) spectrometer. Malaysia is one of the earliest country from South- East Asia (ASEAN) that involve this research. One of the advantages to start the solar monitoring in Malaysia is because our strategic location as equator country that makes possible to observing a Sun for 12 hours daily throughout a year. We strongly believe that Malaysia as one of contributor of solar activity data through E-CALLISTO network. This is a very good start for developing a space weather in Malaysia. With the implementation of CALLISTO systems and development of solar monitoring network, a new wavelength regime is becoming available for solar radio astronomy. Overall, this article presents an overview of space weather in Malaysia. With the present level of the international collaboration, it is believed that the potential involvement of local and international scientist in space weather will increase.

Keywords: Space Weather; Sun; Compound Astronomical Low-cost Low-frequency Instrument for Spectroscopy in Transportable Observatories (CALLISTO); solar activity

1. INTRODUCTION

Space weather is one of the important issue in global society. It has a connection with a climate changes that could affected the Earth. This study also has a close connection with the

solar activity. The solar activity can be characterized with a pattern so-called solar cycle. Currently, we are in the cycle of 24th which was started since 4th January 2008. It is believed that the 24th solar cycle will be less energetic than the last maximum in 2002 - 2003. Overall energetic eruptions seem to be less frequent in cycle 24 as shown by the lower number of type II radio bursts, full halo CMEs, and interplanetary shocks. The profile of cycle 24 was determined by the maximum phase of cycle 23 and the deep minimum of the preliminary phase of cycle 24. Decade observations have also revealed that solar protons could sometimes be accelerated up to tens of GeV in some intense solar energetic process. The latest observations are extremely deficient in the radio and X-ray synoptic and diagnostic influence on these coronal phenomena rich of physics they could reveal.

A number of dedicated studies of the solar radio burst have made great progress in more than a decade beginning with ground observation and become one of the most significant current discussions on space weather issue. The solar flare and CMEs (Coronal Mass Ejections) that can affect life on the surface of the Earth, particularly the increasingly technologically sophisticated devices that are part of modern life [1]. Solar radio observation has been carried out since 1944 when J.S Hey discovered that the Sun emits radio waves [2]. This radio region covers from 15 MHz to 30 GHz while optical region from 1.3343×10^{-15} Hz – 2.3349×10^{-15} Hz.

The Coronal Mass Ejections (CMEs), a multi-thermal radiation has been studied extensively since 1970s. The CME phenomenon was discovered only in 1971 [3] but has become the most important form of solar activity because it is the most energetic phenomena on the Sun with a wide range influence throughout the heliosphere. The front speeds could exceed up to 3000 km/s [4-6]. As the largest scale eruptive phenomenon in the solar atmosphere, it can be observed as enhanced brightness propagating out from coronal-loop-sized scale (10^4 km), expand to cover a significant part of the solar surface which is responsible for the most extreme space weather effects on Earth. This phenomenon can exhibit a variety of forms, some having the classical “three-part” structure [7].

Previous study shown that CMEs associated with solar flares have a higher median speed than those associated with eruptive filaments and that the median speed of CMEs associated with strong flares is higher than that of weak-flare - associated CMEs. Solar flare is considered as a high energetic and complicated phenomenon in which mass eruptions occur, energetic particles are generated and highly energy radiations are emitted. During a flare, large quantities of energy are transferred between the corona and chromosphere through thermal conduction, non-thermal particle beams, radiation transport and mass motions. This event is triggered by fast drift of individual sunspot proper motion within the complex magnetic configuration due to instabilities of equilibrium of coronal magnetic field.

2. SOLAR OBSERVATION

In this work, our discussion of the development solar radio astronomy in Malaysia will be highlighted. This is not only from scientific aspects, it is also covered from antenna design to communication and radar technologies [8-11]. Malaysia becomes the 19th countries that involve this research. We started by proposing this research in early 2011, through the National Space Agency of Malaysia (ANGKASA), University of Malaya (UM), National University of Malaysia (UKM) and the MARA University of Technology (UiTM) [12].

Previous studies investigated the indication of radio frequency interference (RFI) [13-15]. In the future, we plan to implement the method of the Very Long Baseline Interferometer

(VLBI) observations in Malaysia may encounter [16,17]. By 2011, we have constructed 6 meters Log Periodic Dipole Antenna (LPDA) and successfully set-up the CALLISTO system at National Space Centre, Banting Selangor on 20th February 2012 [11,18]. Start from that, a daily data beginning from 7.30 am to 19.30 pm is automatically stored [19]. This data also accessible on CALLISTO website: <http://www.e-callisto.org/> and can be compared with other sites. The current distribution of CALLISTO system is illustrated in Figure 1.

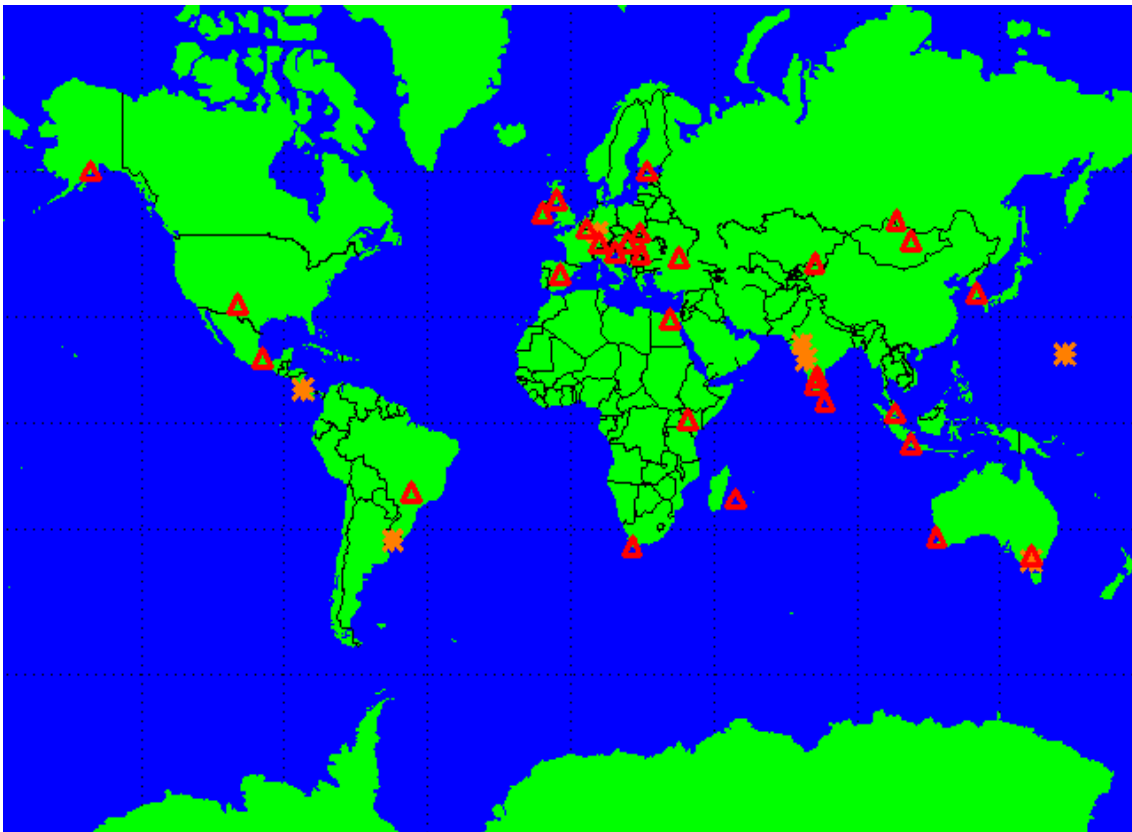


Figure 1. Map of current distribution of Callisto instruments in March 2014.

The main objective is to monitor the solar activities (solar flares and CMEs) within 24 hours all over the world has positively turned to reality [20]. A combination of instrument deployment, analysis and interpretation of space weather data from the deployed instruments in conjunction with space data, and communicate the results to the public play an important role to make the aim become possible. One of the strategies is to develop the scientific insight necessary to understand the science, and to reconstruct and forecast near-Earth space weather. This includes instrumentation, data analysis, modeling, education, training, and public outreach. The Compound Astronomical Low-cost Low-frequency Instrument for Spectroscopy in Transportable Observatories (CALLISTO) spectrometer is a heterodyne receiver designing and leading by Christian Monstein and Radio and Plasma Physics Group from ETH Zurich, Switzerland [21]. There are a few designs of a frequency-agile or swept-frequency spectrometers, which are currently in operation in several places, including China, Hiraiso, Ondrejov, Sao Paulo and Trenseldorf. Up to 2014, there are 36 stations around the world that actively observe the Sun routinely. Up to date, this project has successfully achieved more than 90 % target in order to monitor the Sun within 24 hours. Due to 12 hours

monitoring, Malaysia almost covered fifty per cent of the CALLISTO data. This makes our data more consistent.

Observational data are limited only to a good range of frequency with minimum interference. In order to keep data only with high probability of containing solar radio flares, a filter method also be used from time to time. This data can also be compared with the National Oceanic and Atmospheric Administration (NOAA) list which is in an updated state. Data archive allows to store up to 10 TBytes of FIT-files. The archive is physically located at FHNW (Fachhochschule Nordwestschweiz) and managed from ETH in Zurich).

The construction of the antenna has started since December 2011 and was successfully installed at the National Space Center, Banting Selangor on 20th February 2012 [19]. We also do some testing and the antenna is supported by a 3 x 3 meter tripod. The system of CALLISTO is set up at the top of the building. In order to learn in detail regarding the operation of the CALLISTO system, we are attending the CALLISTO workshop organized by the ANGKASA (National Space Agency) that has been held from 22nd February – 26th February 2012. This workshop is conducted by Christian Monstein, from the Institute of Astrophysics, Switzerland. The location of the National Space Centre Banting is in Selangor, Malaysia as in Figure 2. The location of the system is strategic since the three universities are also located in the same state.



Figure 2. The location of the National Space Centre, Banting, Selangor, Peninsular Malaysia.



Figure 3. The installation of 5.5 meters Log Periodic Dipole Antenna at the National Space Centre Banting, Selangor Malaysia.



Figure 4. The workshop of analysis the CALLISTO data from 22nd of February – 26th of February 2012.

Figure 3 shows the installation of 5.5 meters Log Periodic Dipole Antenna (LPDA) and Figure 4 shows the participant that attend the workshop. This collaboration is the beginning of solar radio astronomy in Malaysia.

The new wavelength regime is becoming available for solar radio astronomy. Solar activities potentially affect the heliosphere in the short term (space weather) and in the long term (space climate) through numerous physical processes that exhibit similarities in various spatial domains of the heliosphere.

Understanding the nature of the motions associated with non-thermal line represents one of the major challenges of high resolution solar studies. On the basis of these works, we suggest that:

1. Future low-frequency imaging arrays are expected to greatly advance our understanding of the bursts and their relation to CMEs.
2. Observations for 24 hours on solar radio burst monitoring by e-CALLISTO, which will make it possible in a short period of time to make a new study focusing on modelling the solar radio data.

3. CONCLUSION

Overall, this article presents an overview of optical and radio astronomy in Malaysia. With the present level of the international collaboration, it is believed that the potential involvement of local and international scientist in solar astrophysics will increase. It is hoped that, these observations can bring upon large scale impact by illuminating the nature of the evolution of the solar burst and the role of that evolution in generating solar activity.

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BIOGRAPHY

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