Journal of Fundamental and Applied Sciences

ISSN 1112-9867

Available online at http://www.jfas.info

Research Article

Special Issue

# MINOR IMPACT OF SOLAR FLARE EVENTS ACCOMPANIED WITH SRBT III TO THE TOP OF EARTH'S ATMOSPHERE

M. O. Ali, Z. S. Hamidi*, N. H. Zainol, N. Husien and S. N. U. Sabri

Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia

Published online: 15 January 2018

## ABSTRACT

The solar flare phenomenon is one of the powerful events on the Sun that had been discovered in 1859 by Carrington and Hodgson. The characteristics of X-ray flares are important tools to determine the particle acceleration and the variable effect on the Earth. In order to get further information on electron acceleration sites in the corona, the observations of spikes at higher frequencies combined with type III at lower frequencies and X-ray observations are significant. The dynamical behavior of the Sun exhibits a variety of physical phenomena, some of which are still not at all or only barely understood due to the complexity of the structure of the Sun. The aim of this study is to investigate the correlation of solar flare event and solar radio bursts type III that happen on 23rd July 2017. These events were reported to cause minor impact to the earth such a blackout of shortwave radio transmissions.

**Keywords:** solar flare; type III solar radio burst (SRBT III); flare classes.

Author Correspondence, e-mail: zetysh@salam.uitm.edu.my

doi: http://dx.doi.org/10.4314/jfas.v10i1s.31

## 1. INTRODUCTION

Solar flare phenomenon is one of the powerful events on the Sun that had been discovered in 1859 by Carrington and Hodgson. This violent phenomenon has becoming topic of interest among solar astronomer. Flares, filament eruptions and coronal mass ejections (CMEs) are three aspects that manifest themselves following the destabilization of the coronal magnetic field [1]. Theoretically, there are four phase of flare event which are as shows in Table 1 [2].

The composition of overall flare process is x-ray flare and it is closely related with the particle acceleration process in the corona. The features of x-ray flares are important clues to predict the particle acceleration and the possible effects on the earth [3]. A sudden increase of x-ray radiation from a solar flare causes consequential ionization in the lower region of the ionosphere producing ionospheric disturbance of radio signals, abrupt phase anomalies, sudden enhancement of signal and short wave fade [4].

In recent years, flares are classified in several classes according to X-ray flux which are A, B, C, M and X-class according to the peak flux of soft X-rays. X-class flares that can trigger worldwide radio blackouts and radiation storms in the upper atmosphere are very serious events. Meanwhile, M-class flares that are medium-sized which can cause brief radio blackouts in the polar regions and C-class flares that are very small and can cause few noticeable effects on earth [5]. The characteristics of X-ray flares are important tools to determine the particle acceleration and the variable effects on the Earth [6].

**Table 1.** Phases of flare

| Phase | Explanation |
|---|---|
| Preflare | Phase the coronal plasma in the flare region slowly heats up and is visible in soft X-rays and EUV. |
| Impulsive | A large number of energetic electrons and ions is accelerated and most of the energy is released. |
| Flash | The energy after an impulsive phase is more gently released, manifest in decametric pulsations and further distributed. |
| Decay | The coronal plasma returns nearly to its original state, except in the high corona where magnetic reconfiguration, plasma ejections and shock waves continue to accelerate particles, causing meter wave radio bursts and interplanetary particle events. |

Flare is definitely as a relatively rapid brightening in the photon spectrum of the Sun caused by a choking off the normal energy from the corona by the strong closed magnetic field of a place. Magnetic [14] field in both active and quiet regions of the Sun can be observed in radio region. Indirect evidence of electron acceleration sites in the corona first came from broad band radio spectral observation [7].

During maximum and minimum cycle of the Sun solar radio emission become increasingly interested in attempts to understand the Sun's activities [8]. In order to get further information on electron acceleration sites in the corona, the observations of spikes at higher frequencies combined with type III at lower frequencies and X-ray observations are significant [7]. These type III radio bursts are formed in a two-step process. Solar flares rich of electrons will accelerated to energies of some keV and expelled away from the Sun. Besides, the electrons also excite plasma oscillation locally all the way from the corona into distant heliosphere. Plasma oscillations are also known as Langmuir waves will undergoes non-linear wave-interaction and will transformed to escaping electromagnetic radiation [9]. The eruption mechanism of solar flares and type III are currently an extremely active area of research especially during the solar cycle is towards maximum. Table below shows the characteristic of solar radio burst type III (SRBT III) [10]. Table 1 shows the characteristics of solar radio burst type III.

**Table 2.** Characteristics of solar radio burst type III (SRBT)

| Parameter | Type III |
|---|---|
| Characteristics | Fast frequency drift bursts. Usually in groups, can occur singular or storms (often with underlying continuum). Can be accompanied by a second harmonic. |
| Duration | Single burst: 1-3 seconds<br>Group: 1-5 minutes<br>Storm: minutes-hours |
| Associated phenomena | Active regions, flares |
| Frequency range | 10 kHz-1 GHz |

The conditions on the Sun and in the solar wind, magnetosphere, ionosphere and thermosphere is known as “space weather”. The performance and solidity of space-borne and ground-based technological systems can be influenced by space weather [15] and can affect human life and health [9]. The dynamical behaviour of the Sun exhibits a variety of physical phenomena, some of which are still not at all or only barely understood due to the complexity of the structure of the Sun [10]. In this paper, the solar flare event that accompanied by solar radio bursts type III that happen on 23rd July 2017 were discussed.

## 2. METHODOLOGY

The CALLISTO is an acronym from Compact Astronomical Low frequency Low cost Instrument for Spectroscopy and Transportable Observatories. It is a solar radio spectrograph developed by engineers at ETH Zurich for radio solar observation. Its main objectives are to be an instrument that is used to study the dynamics of solar corona and to carry out the meter and decimeter wavelength radio observation to diagnosis the solar atmosphere progression [11].

The idea of the Callisto project is to produce a simple and low-cost instrument, which can be sited in places of low infrastructure or remote locations [12]. CALLISTO aimed to study solar [17] activities relating to solar flare or coronal mass ejections (CME), which are identified sometimes being escorted by solar bursts [11]. At present, more than 66 instruments have been installed at more than 35 locations with users from more than 92 countries in the e-CALLISTO network [13]. Other than that, the information of flares were taken from space agency such Solar Monitor, Space Weather Prediction Centre and SOHO Observatory that make their data available online so that the observation can be made more detail. In this study the data of solar radio burst was taken from Bleien's CALLISTO Spectrometer that operating within 45MHz-870MHz.

## 3. RESULTS AND DISCUSSION

Several events of type III solar radio bursts were detected by CALLISTO system in Blein on 23rd July 2016. The first burst known as group type III radio burst which occurred approximately at 05:08UT till 0512 UT. The second burst occurs at 05:27UT, which is 16 minutes just after the first event. Both burst having a fast drift due to the short time of the occurrence. Coincidentally, there were two events of solar flare observed throughout the day. These were because AR 2565 and AR 2567 were erupted and both active regions believed to produce these M class flares at different levels as shown in figure. The first flare was detected at 0211 UT and registered as M5 class flare. Few hours after the first flare event, it is followed by a bigger flare which M7.6 class at 0516 UT. Detailed variation of X-ray flux is illustrated in Fig. 1.

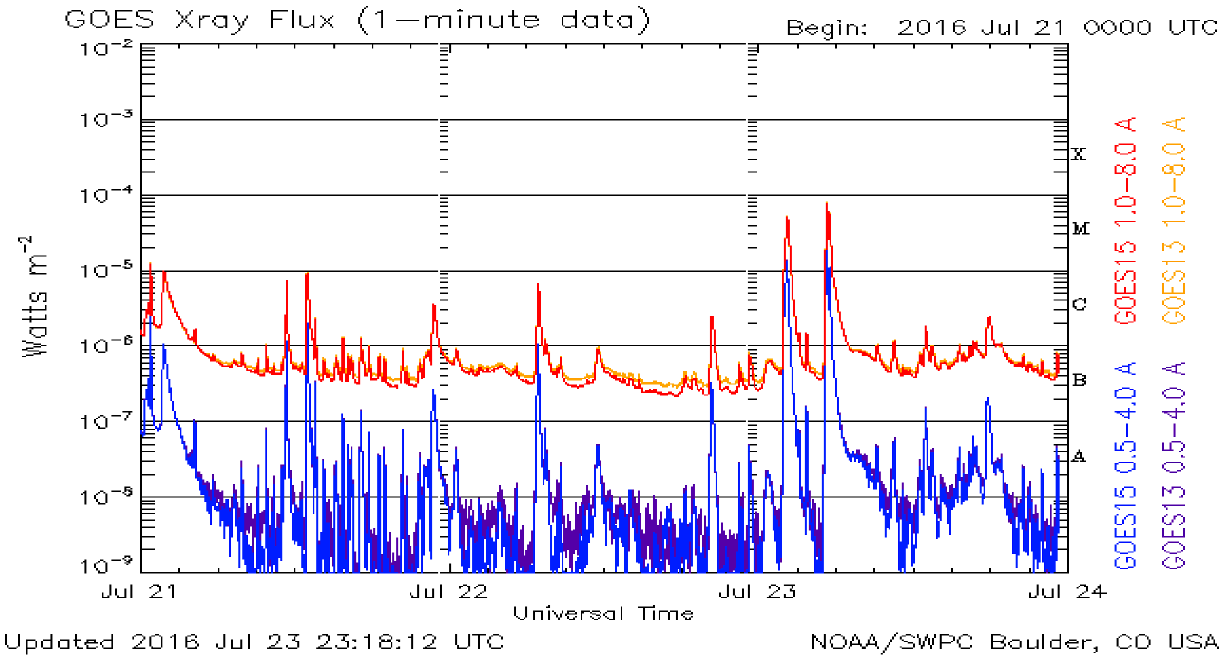


**Fig.1.** GOES X-ray flux data

From analysis, a few hours after M5 class flare detection, the group type III radio burst was tracked by CALLISTO spectrometer as shown in the Fig. 2 (left). In a short time interval, a M7.6 class flare was also detected just after group solar radio burst type III occurred. The M7.6 flare followed by a single type III solar radio burst 12 minutes after the flare happen as shown in Fig. 1 (right). M class flares are believed to cause brief radio blackouts in the polar region. These events were reported to cause a blackout of shortwave radio transmissions over the Pacific side of Earth due to pulses of radiation from the two flares that ionized the top of Earth's atmosphere.

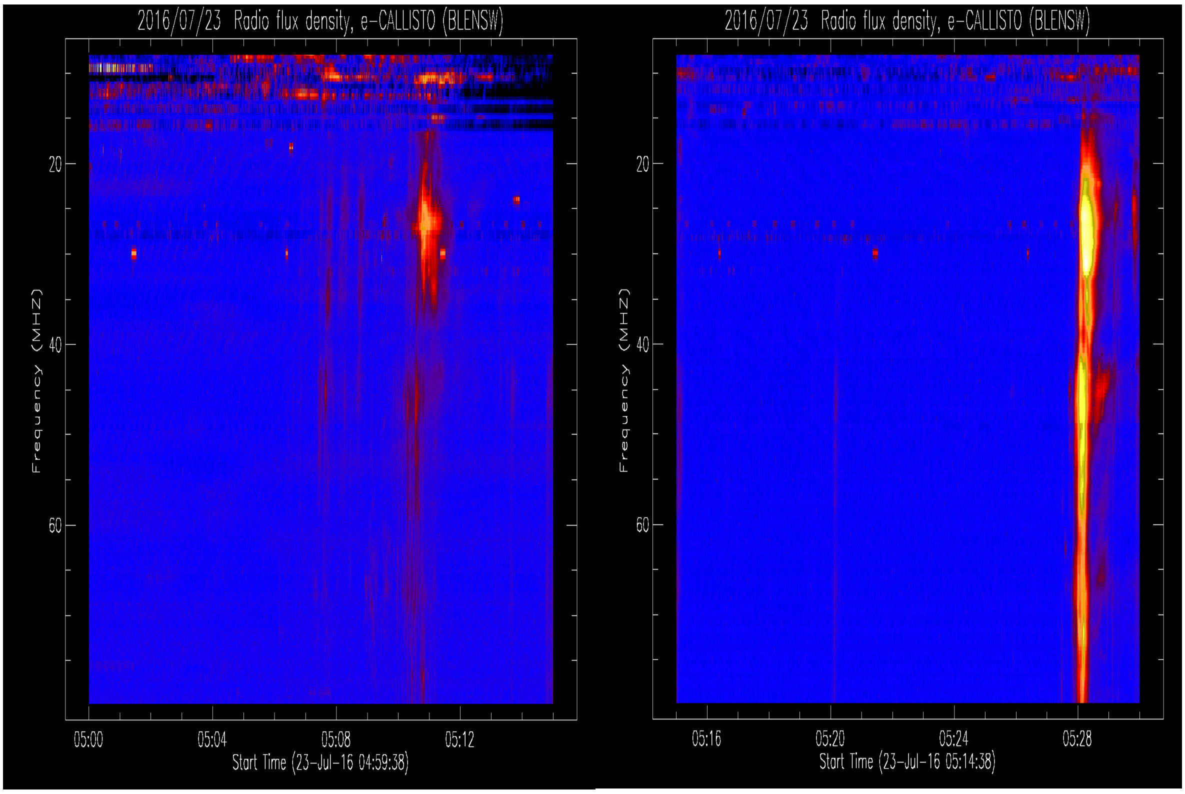


**Fig.1.** Solar Radio Burst Type III

## 4. CONCLUSION

The solar flare event seems to have a close correlation with SRBT III. Both M5 and M7.6 class solar flare events accompanied by group and single type III solar radio burst respectively. These events uniquely due to two active regions named AR 2565 and AR 2567. These events were reported causing minor impact to the earth [16] such a blackout of shortwave radio transmissions.

## 5. ACKNOWLEDGEMENTS

We are grateful to CALLISTO network, NASA, STEREO, LASCO, SDO/AIA, NOAA and SWPC make their data available online. This work was partially supported by the FRGS grant, 600-RMI/FRGS 5/3 (0077/2016), 600-IRMI/MyRA 5/3/GIP (056/2017) and the *Kementerian Pengajian Tinggi* Malaysia. Special thanks to the National Space Agency and the National Space Centre for giving us a site to set up this project and support this project. Solar burst monitoring is a project of cooperation between the institute for Astronomy, ETH Zurich and FHNW Windisch, Switzerland, Universiti Teknologi MARA and University of Malaya. This paper also used NOAA Space Weather Prediction Centre (SWPC) for the sunspot, radio flux and solar flare data for comparison purpose. The research has made use of the National Space

Centre Facility and a part of an initiative of the International Space Weather Initiative (ISWI) program.

## 6. REFERENCES

[1] Schrijver C J. Driving major solar flares and eruptions: A review. Advances in Space Research, 2009, 43(5):739-755

[2] Webb D F, Howard T A. Coronal mass ejections: Observations. Living Reviews in Solar Physics, 2012, 9(1):1-83

[3] Ce G, Bing-sen X, Zhao-xiang L. Study on the prediction method of characteristic parameters of solar X-ray flares. Chinese Astronomy and Astrophysics, 2013, 37(3):255-265

[4] Omatola K M, Okeme I C. Impacts of solar storms on energy and communications technologies. Archives of Applied Science Research, 2012, 4(4):1825-1832

[5] Marusek J A. Solar storm threat analysis. Impact, 2007, http://breadandbutterscience.com/SSTA.pdf

[6] Benz A O. Flare observations. Living Reviews in Solar Physics, 2017, 14(1):1-64

[7] Pick M, Vilmer N. Sixty-five years of solar radioastronomy: Flares, coronal mass ejections and Sun-Earth connection. The Astronomy and Astrophysics Review, 2008, 16(1-2):1-53

[8] Hamidi Z S, Shariff N, Abidin Z, Ibrahim Z, Monstein C. Coverage of Solar radio spectrum in malaysia and spectral overview of radio frequency interference (RFI) by using CALLISTO spectrometer from 1MHz to 900 MHz. Middle-East Journal of Scientific Research, 2012, 12(6):893-898

[9] Schwenn R. Space weather: The solar perspective. Living Reviews in Solar Physics, 2006, 3(1):1-72

[10] Hamidi Z, Ibrahim U F, Salwa U F, Abidin Z, Ibrahim Z, Shariff N. Theoretical review of solar radio burst III (SRBT III) associated with of solar flare phenomena. International Journal of Fundamental Physical Sciences, 2013, 3(2):20-23

[11] Abidin Z Z, Anim N M, Hamidi Z S, Monstein C, Ibrahim Z A, Umar R, Shariff N N, Ramli N, Aziz N A, Sukma I. Radio frequency interference in solar monitoring using CALLISTO. New Astronomy Reviews, 2015, 67:18-33

[12] Zavvari A, Islam M T, Asillam M F, Radial Anwar A M, Monstein C. CALLISTO radio spectrometer construction at Universiti Kebangsaan Malaysia. IEEE Antennas and Propagation Magazine, 2014, 56(2):278-288

[13] Ali M O, Sabri S N, Hamidi Z S, Husien N, Shariff N N, Zainol N H, Faid M S, Monstein

C. e-CALLISTO network system and the observation of structure of solar radio burst type III. In IEEE International Conference on Industrial Engineering, Management Science and Application, 2016, pp. 1-5

[14] Azlee Z, Ihsan M Y, Mohamed H J, Zairi I R. Remote data acquisition and archival of the magnetic data acquisition system (MAGDAS). International Journal on Advanced Science, Engineering and Information Technology, 2017, 7(5):1722-1727

[15] Zakaria N A, Jusoh M H, Zaidi S Z, Rizman Z I. Development of space weather monitoring platform for space and earth's electromagnetism observation. ARPN Journal of Engineering and Applied Sciences, 2017, 12(10):3308-3311

[16] Farah A M, Khairunnisa N J, Norbi A A, Muhammad S J, Mohamad H J, Zairi I R. Implementation of earth conductivity experiment to evaluate underground parameters. ARPN Journal of Engineering and Applied Sciences, 2017, 12(10):3271-3277

[17] Afifah T, Nor A Z, Atiqah A R, Mohamad H J, Zairi I R. Variation of VHF/UHF of forward scattering radar due to solar radiation. ARPN Journal of Engineering and Applied Sciences, 2017, 12(10):3278-3284

**How to cite this article**:
Ali MO, Hamidi ZS, Zainol NH, Husien N, Sabri SNU. Minor impact of solar flare events accompanied with srbt iii to the top of earth's atmosphere. J. Fundam. Appl. Sci., 2018, *10(1S), 445-452*.