Journal of Applied Science and Engineering Methodologies
Volume.2, No.3, (2016): Page.326-329
www.scientistlink.com/jasem

Coronal Mass Ejections in Solar Cycle 24

Bidhu S S[1], A Iren Sobia[2]
Research Scholar,
[1,2]Physics Research Centre, Nesamony Memorial Christian College,India
[1]bidhuss@gmail.com, [2]irensobia@gmail.com

Abstract

I*n this paper we have presented the properties and recent results on coronal mass ejections(CMEs), obtained from the Solar and Heliospheric Observatory (SOHO) during 2008–2015. In Cycle-24 CMEs expand anomalously due to the reduced ambient pressure. SOHO/LASCO CMEs, were obtained from the LASCO catalogue respectively. Solar wind linear speed and its angular width determine the nature of CMEs.We report on a comparison between space weather events that occurred around the two peaks in the sunspot number (SSN) during solar cycle 24. The two SSN peaks occurred in the years 2012 and 2014. Even though SSN was larger during the second peak, we find that there were more space weather events during the first peak.*
Keywords: *coronal mass ejections, sunspot number, solar cycle*

1. INTRODUCTION

The most dynamic and energetic aspects of solar activity, Coronal mass ejections (CMEs) affects the terrestrial environment. Interplanetary coronal mass ejections (ICMEs) are the drivers of the most intense geomagnetic storms (e.g., Gosling et al., 1990; Koskinen and Huttunen,2006). They carry enhanced magnetic fields, usually at a speed higher than the background solar wind. CMEs are closely related to a variety of phenomena such as Long Duration Events (LDEs), sprays, erupting loops and filaments. For establishing a physical relationship between the solar origin and the final geomagnetic effect, it is therefore required to monitor the CMEs right from the solar surface through the interplanetary medium till they reach the earth. More recently, with the launch of Solar and Heliospheric Observatory (SoHO), it has become possible to track a CME from the solar surface using Extreme Ultraviolet Telescope (EIT) images, generally in 19.5 nm [Dela-boudinie ́re et al., 1995] to the outer corona in white light with the Large Angle Spectrometric Coronagraphs, LASCO-C2 and C3 [Brueckner et al., 1995], which have a combined field of view ranging from 2 to 30 R #

Solar cycle 24 has been extremely weak as measured by the sunspot number (SSN) and is the smallest since the beginning of the Space Age. The weak activity has been thought to be due to the weak polar field strength in cycle 23 The weak solar activity has been felt throughout the heliosphere, with diminished solar wind speed, density, and magnetic field (McComas et al., 2013; Gopalswamy et al.,2014a,b).t is well known that most solar cycles show a double peak due to the out-of-phase activity in the two hemispheres. The double peak in SSN during cycle 24 is unusual in that the second peak is larger than the first one by ~20%. Such a behaviour was observed only a few times since the 1800s (Gopalswamy et al., 2015a).Therefore, it is of interest to study the behaviour of CMEs during the second peak in solar activity and compare it with the first in order to understand the space weather events of different intensity during the SSN peaks.

A halo coronal mass ejection (CME) appears to surround the occulting disk of the observing coronagraph in sky-plane projection. Halo CMEs were first reported by Howard et al. (1982) and only a handful were recorded by the Solwind coronagraph onboard the P78-1 mission (Howardet al. 1985). Halo CMEs constitute only ~3%) of all CMEs and represent an energetic population because most of the CMEs that produce large solar energetic particle (SEP) events and major geomagnetic storms are halos (Gopalswamy et al. 2010b). Halo CMEs generally originate from close to the disk centre, while ~10% originate close to the limb (Gopalswamy et al. 2010c). In limb halos, the disturbance appearing over the opposite limb is likely to be a shock (Gopalswamy et al. 2010c).

In this paper, we investigate the different types solar CMEs according to their linear speed and angular width and halo CMEs ascending and maximum phase of solar cycle 24, 2008-20015, observed by LASCO coronagraphs on board the Solar and Heliospheric Observatory (SoHO) spacecraft. The investigation is based on several data sets obtained in different wavelengths, which yield specific information on the CME mechanism.

2. DATA ANALYSIS

In order to compare various signatures of solar activity around the two SSN peaks, we use the CME data available online at the CDAWData Center (cdaw.gsfc.nasa.gov, Gopalswamy et al.,2009). This uniform and extended CME data base has become critical in understanding the long-term eruptive behaviour of the Sun [Gopalswamy et al. 2009a].CMEs during the Two Activity Peaks in Cycle 24 and their Space Weather Consequences obtained by the Large Angle and Spectrometric Coronagraph (LASCO, Brueckner et al., 1995) on board the Solar and Heliospheric Observatory (SOHO) mission. Since halo CMEs are one of the indicators of energetic CMEs, we make use of the halo CME catalog available at the CDAW Data Center (http://cdaw.gsfc.nasa.gov/CME_list/halo/halo.html,Gopalswamy et al., 2010a). We take the events in the years 2012 and 2014 as representative of the first and second SSN peaks, respectively.

3. OBSERVATION AND DISCUSSION

CMES observed by sOHO-LASCO for ascending and maximum phase of solar cycle 24 i.e.; 2008-2015 October was taken for investigation. Solar cycle 24is characterized with twin peaks; in 2012 and in 2014. A total of 12917 CMEs were observed by spacecraft from 2008 to October 2015. Among this 687 CMEs are halo CMEs. Fig. 1 gives daily sunspot number and no of CMEs according to its speed during the study period but Fig. 2 shows daily sunspot number and no of CMEs according to its angular width of events of the same period. Fig. 3 gives daily sunspot number and no of halo CMEs classification.

3.1. CME and linear speed

According to linear speed, CMEs are classified as strong(S), Common(C), Occasional (O), Rare CMEs (R). The velocity range corresponds to below 500km/s for S CMEs, 500-1000km/s for C CMEs, 1001-1999 km/s for O CMEs and above 2000km/s for R CMEs.

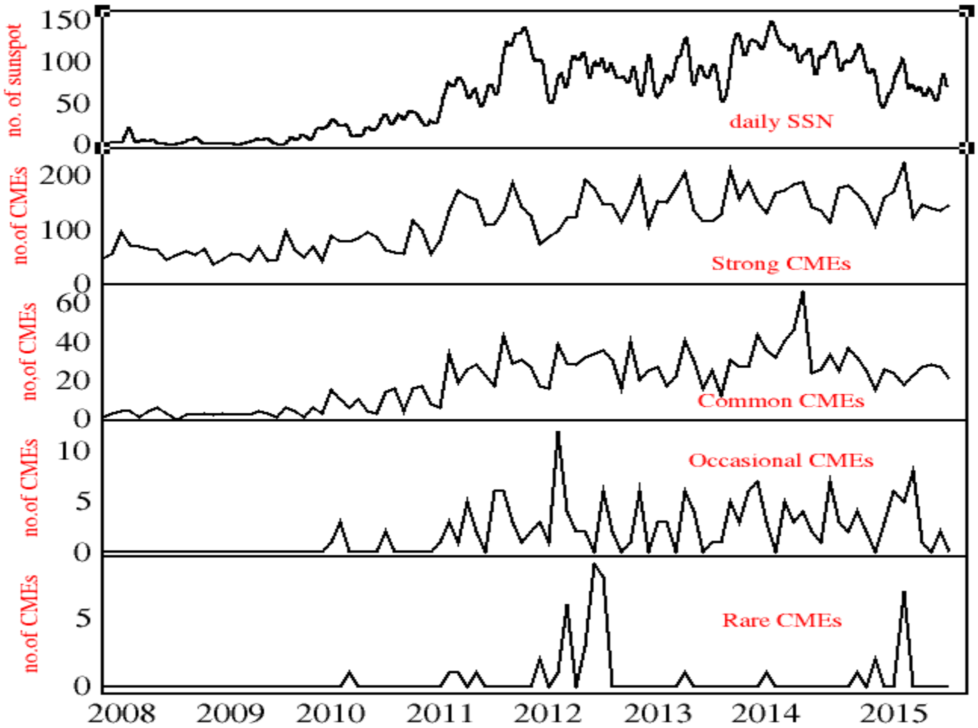

Fig1: From top to bottom daily sunspot number,CME classification(linear speed)

A lot of CMEs were ejected in 2012 and 2014, the maximum activity phase. In 2012, the 7 rare CMEs and 12 occasional CMEs were present. The observed S CMEs were in 200-230 range. The common CMEs were more in 2014. As daily sunspot shows twin peak, the SOHO-LASCO observed a number of CMEs ejected near the twin peak. The strong CMEs ranges 40-230, common CMEs ranges 2-65, occasional CMEs ranges 0-12 and rare CMEs ranges 0-8 within the analysed time interval.

3.2. CME and angular width

Figure 2 shows, daily sunspot number and CME s classification according to angular speed. CMEs are classified as type I,type II,type III and type IV as its angular width corresponds to below 90^{0}, 90-180^{0}, 181-

270^0 and 271- 360^0,

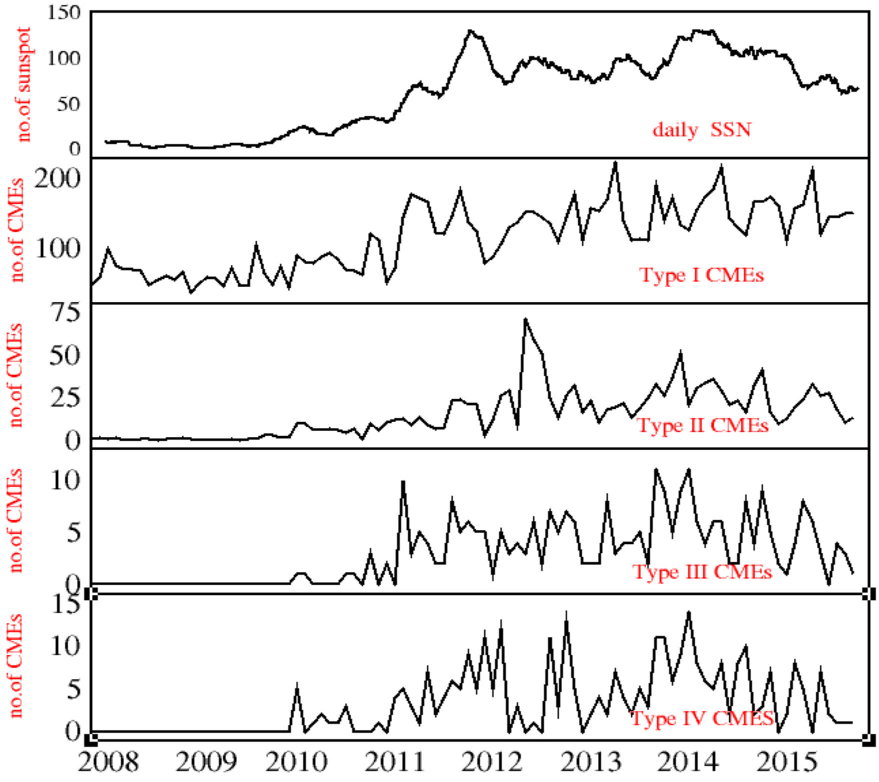

Fig2: From top to bottom, daily sunspot number,CME classification(angular width)

The maximum activity phase, 2012 and 2014 a lot of CMEs were ejected in, 2012, the 14 type IV CMEs and 12 type III CMEs were present. The observed type I CMEs were in 80-220 range. The type II CMEs were more in 2012. As daily sunspot shows twin peak, the SOHO-LASCO observed a number of CMEs ejected near the twin peak. The type I CMEs ranges 35-220, type II CMEs ranges 0-70, type III CMEs ranges 0-12 and type IV CMEs ranges 0-13 within the analysed time interval.

3.3. Halo CMEs

The halo CMEs, which are directed to the Earth, have special interest. Halo CMEs (width = 360) are particularly interesting. Due to projection effects, they appear in coronagraphs around the entire occulting disk. Halo CMEs are of interest due to their increased geo-effectiveness. These events seem to be faster and wider than the whole population of CMEs

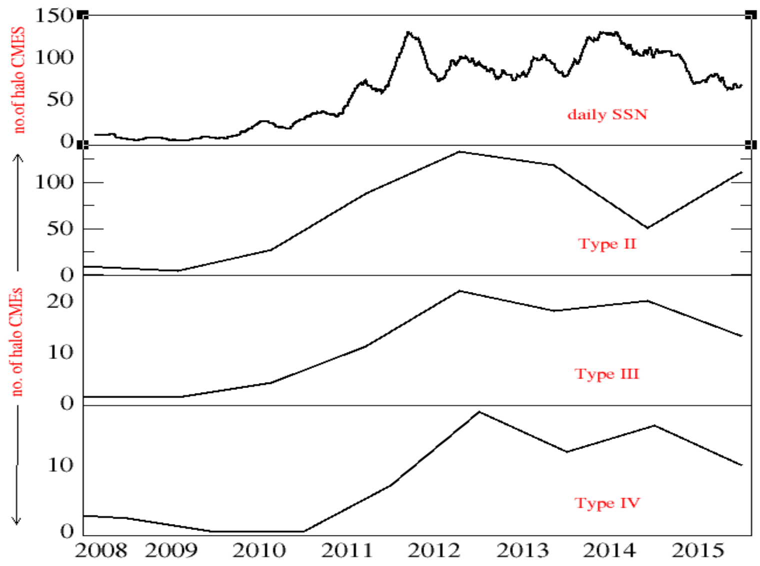

fig 3: halo CME classification

We note that the halo CME rate has the largest peak coinciding with the second peak in SSN. All types of halo CMEs were ejected as its maximum magnitude in 2012. Type II halo CMEs were more abuntant during solar activity maximum phase. The type II halo CMEs ranges 0-130 type III halo CMEs ranges 0-25 and type IV CMEs ranges 0-17 within the analysed time interval.

4. CONCLUSION

Using SOHO/LASCO data covering solar cycles 23 and 24, we investigated the different types solar CMEs according to their linear speed and angular width and halo CMEs ascending and maximum phase of solar cycle 24, 2008-20015. The S.C, O, R CMEs were active during maximum phase. Also type I, type II, type III and type IV active during this time interval. Halo CMEs are as abundant in cycle 24. Also we found that even though Ssn was larger during the second peak, there are more space events during the first peak.

5. ACKNOWLEDGMENT

The CME catalog is generated and maintained at the CDAW Data Center by NASA and The Catholic University of America in cooperation with the Naval Research Laboratory. SOHO is a project of international cooperation between ESA and NASA. The authors would like to thank for the excellent LASCO-CME catalogue, which includes supportive data the back-bone of our paper.

REFERENCES

1.Brueckner, G. E., et al., The Large Angle Spectroscopic Coronagraph,(LASCO), Solar Phys., 162, 357, 1995
2.Delaboudinie ́re, J.-P., et al., Extreme Ultraviolet Imaging telescope for the SoHO mission, Solar Phys., 162, 291, 1995.
3.Gopalswamy, N.: 2009, in T. Tsuda, R. Fujii, K. Shibata, and M. A.Geller (eds.), Climate and Weather of the Sun-Earth System(CAWSES): Selected Papers from the 2007 Kyoto Symposium,Terrapub, Tokyo, p. 77.
4.Gopalswamy, N., S. Yashiro, G. Michalek, G. Stenborg, A. Vourlidas, S. Freeland, R. A.Howard, The SOHO/LASCO CME Catalog, Earth, Moon, and Planets, 104, 295,2009a
5.Gopalswamy, N.: 2010a, in A. G. Kosovichev, A. H. Andrei, and J.-P.Rozelot (eds.), Proc. IAU Symposium, vol. 264, Cambridge Univ.Press,Cambridge,p.326,doi:10.1017/S1743921309992870.
6.Gopalswamy, N., Akiyama, S., Yashiro, S., and Mäkelä, P. 2010b, Coronal Mass Ejections from Sunspot and Non-Sunspot Regions, Magnetic Coupling between the Interior and Atmosphere of the Sun, Astrophysics and Space Science Proceedings, ed S. S. Hasan and R. J. Rutten (Berlin,Heidelberg: Springer), p. 289
7.Gopalswamy, N., Yashiro, S., Michalek, G., Xie, H., Mäkelä, P., Vourlidas, A. and Howard, R.A. 2010c, SunGeo, 5, 7Gopalswamy, N., et al.: 2014a, Geophys. Res. Lett. 41, 2673, doi:10.1002/2014GL059858.
8.Gopalswamy, N., Yashiro, S., Xie, H., Akiyama, S., Mäkelä, P. 2010c, Advances in Geosciences, 21, 71Gopalswamy, N., et al.: 2014b, Earth, Planets, and Space 66, 104,doi: 10.1186/1880-5981-66-104.
9.Gopalswamy, N., et al.: 2015, Astrophys. J. 804, L23, doi:10.1088/2041-8205/804/1/L23
10.Gosling, J.T., Bame, S.J., McComas, D.J., Phillips, J.L.: 1990, Coronal mass ejections and large geomagnetic storms. Geophys. Res. Lett. 17, 901 – 904. doi:10.1029/GL017i007p00901.
11.Howard, R. A., Michels, D. J., Sheeley, Jr., N. R., & Koomen, M. J. 1982, ApJ, 263, L101
12.Howard, R. A., Sheeley, N. R., Jr., Michels, D. J., Koomen, M. J. 1985, JGR, 90, 8173
13.Koskinen, H.E.J., Huttunen, K.E.J.: 2006, Geoeffectivity of Coronal Mass Ejections. Space Sci. Rev. 124, 169 – 181. doi:10.1007/s11214-006-9103-0.
14.McComas, D. J., et al.: 2013, Astrophys. J. 779, 2, doi:10.1088/0004-637X/779/1/2.
15.Petrie, G. J. D.: 2013, Astrophys, J. 768, 162, doi: 10.1088/0004-637X/768/2/162.
16.Wang, Y., and Colaninno, R.: 2014, Astrophys. J. 784, L27, doi:10.1088/2041-8205/784/2/L27.