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Study of Stealth CMEs and associated ICMEs

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Abstract. Generally Coronal Mass Ejections (CMEs) are large eruptions of plasma and magnetic field from the Sun into interplanetary space. CMEs are most frequently associated with a variety of phenomena occurring in the lower corona before, during and after onset of eruption and generally are visible in coronagraph observation. Stealth CMEs do not obviously exhibit any of the low-coronal signatures (LCS) like solar flares, flows, jets, coronal dimmings or brightenings, filament eruptions or the formation of flare loop arcades. In this study, five stealth CMEs are selected using LASCO/SOHO CME catalogue and associated ICMEs (Interplanetaty CMEs) are identified using data from STEREO, ACE and WIND.

Keywords. Coronal Mass Ejections, Stealth CMEs, LCS, ICMEs

1. Introduction

Coronal mass ejection (CME) is a large eruption of plasma and magnetic field from the Sun, propagating into interplanetary space. Therefore, this encompasses both the phenomena that we traditionally term as CMEs and ICMEs. CMEs are very frequently accompanied by eruptive dynamical phenomena, low in the solar atmosphere known as Low Coronal Signatures (LCS). A class of CMEs that cannot be associated with any of these LCS of eruption have been difficult to observe and to identify their source region, are called Stealth CMEs (Robbrecht *et al.* 2009; Ma *et al.* 2010). In the present study we have studied 5 stealth CMEs, which did not show any LCS. We also identified the associated ICMEs for three of the ICMEs arrived at L1 and which produced strong geomagnetic storm with Dst index $\sim$ -100 nT or less. The remaining two events were not Earth directed but, were observed at STEREO S/C. Solar eruption without any LCS can lead to unexpected space weather impacts, since early warning signs for the same are not present in these events. Sometimes these CMEs reach the Earth and create moderate geomagnetic storms.

2. Observational data

We have examined coronagraphic images from COR coronagraphs of STEREO S/C https://stereo-ssc.nascom.nasa.gov and LASCO, onboard SOHO S/C https://cdaw.gsfc.nasa.gov/CME_list/ WIND and OMNI data https://omniweb.gsfc.nasa.gov/form/sc_dist_min.html are also used. To study interplanetary signatures of the CMEs, solar disk images are taken from AIA (Atmospheric Imaging Assembly), onboard SDO https://sdo.gsfc.nasa.gov/assets/img/browse in different wavelengths.

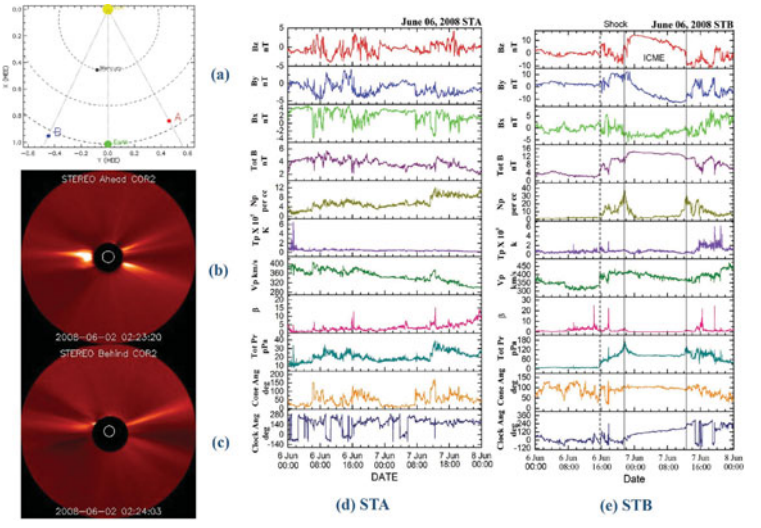

Figure 1. (a) STEREO position on 2^{nd} June, 2008 (b) COR2 STA (c) COR2 STB (d) & (e) ICME parameters for 6^{th} June, 2008 recorded at STA and STB respectively

3. Analysis and discussion

For the purpose of this study, we have considered 5 stealth CME events during 2008 - 2016. Here, we report analysis of 1 event out of 5 stealth CME events.

2^{nd} June 2008 Stealth CME

A stealth CME observed on 2^{nd} June, 2008 at 4:46 UT, with a speed of 192 Km/s in STEREO images and SDO/AIA images. No LCS was observed for this CME. It was not Earth directed but was observed by both STEREO Ahead (STA) and STEREO Behind (STB) spacecraft. It was faint in the STB image as compared to the STA image (fig 1 b & c)and reached at STB at 15:50 UT on 6^{th} June, 2008. ICME parameters for plasma as well as magnetic field in twin S/C are plotted in fig 1 (d & e). The ICME did not arrive at STA or at L1. In fig 1 (e), there was a mild shock and the structure bounded by 2^{nd} and 3^{rd} vertical line in figure is a MC, with high B $\sim$ 14.7 nT, low temperature $\sim 10^{4o}$ k for approximately 6 hours. It can be seen from fig 1 (e) that, it would have produced a geomagnetic storm if it was Earth directed as the total magnetic field B and southward component of interplanetary magnetic field Bz are $\sim$ 14.7 nT and -8.7 nT respectively.

4. Conclusion

All the stealth CMEs studied here have low initial speed ($\leqslant$300 Km/s). All these stealth CMEs were associated with mild shocks. In case of 2^{nd} June, 2008, the shock in ICME structure arrived at STB but did not arrive at Earth. If this event was Earth directed then it would have produced a moderate geomagnetic storm.

Therefore, study of stealth CME is important because sometimes they turn out to be missed alarms and can produce moderate to strong geomagnetic storm.

References

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