A new ICMEs catalogue: Tracking a CME from Sun to the Earth

E. Paouris and H. Mavromichalaki
Faculty of Physics, National and Kapodistrian University of Athens, 15784 Athens, GREECE

Abstract: It is well known that the interplanetary coronal mass ejections (ICMEs) play the most important role on the interactions with the magnetosphere as they are the dominant drivers of intense geomagnetic storms. A number of 266 ICMEs associated with CMEs were spotted from SOHO-LASCO coronagraph and their characteristics were calculated by in situ observations from ACE data covering the years 1996–2009. The result of this study is a new ICME catalogue which contains all the available information. Especially, characteristics of all the CMEs obtained from LASCO list which is responsible for the upcoming ICME, like the linear speed, the angular width and the coordinates on the Sun, the peak time and the active region of the associated solar flare, b) the initial/background solar wind plasma and magnetic field conditions before the arrival of the CME, such as the solar wind speed, the magnetic field B, the southward component Bz, the proton temperature and density, the ratio of alpha particles to protons and the plasma β, c) the sheath of the ICME, such as the presence or not of a shock wave, the arrival time of the CME-driven shock and the solar wind plasma and magnetic field conditions of the sheath, d) the main part of the ICME, like the solar wind plasma and magnetic field conditions, the duration of the ICME with start/end time and the transit velocity from Sun to Earth, e) the geomagnetic conditions of the ICME’s impact at Earth, such as Ap and Dst indices and the exact time of their maximum and minimum values, respectively and finally f) remarks on every event, are determined. Interesting results revealed from this study as the high correlation coefficient values of the magnetic field Bz component and the Ap index (r = 0.86), as well as the Dst index (r = 0.82), of the effective acceleration against the CME linear speed (r = 0.92) and of the transit velocity against the linear speed of the CME (r = 0.70). The amount of information makes this new catalogue the most comprehensive ICMEs catalogue for the solar cycle 23.

Introduction

Why ICMEs are so important?
(CMEs and high-speed streams of solar wind emanating from coronal holes are the dominant factors for geomagnetic storms. Previous studies have shown that intense geomagnetic storms are mainly caused by ICMEs usually associated with halo CMEs (Gopalswamy et al., 2007), while moderate and minor storms can be caused by both ICMEs or high-speed wind streams of solar wind (Zhang et al., 2007; Richardson and Cane, 2010).)

A new ICMEs catalogue
(The new perspective of the present study could be divided in two major contributions. These ICMEs and their events which are firstly spotted from SOHO/LASCO coronograph and then examined using in situ measurements from the ACE spacecraft. Furthermore, it is the first time that as many as possible information for each event is gathered in one catalogue...)

Tracking from SOHO/LASCO and in situ observations from ACE satellites
(Study of each ICME using magnetic fields and solar wind plasma ACE 68-s averaged data for the CME at first spotted by SOHO/LASCO, was performed. This new catalogue contains also information for the associated solar flares and the geomagnetic conditions on Earth...)

Statistical Analysis of ICMEs

Transit velocity and CME linear speed

 DST index and Bz component

 Ap index and Bz component

 Effective acceleration and CME linear speed

D m and Ap maximum occurrence times

CMEs and associated Solar Flares

Seasonal distribution of Major geomagnetic storms (Dst < -110 nT)

Conclusions

From the study of a number of 266 ICMEs it was concluded that:
- The minimum Bz value (in the sheath or in the ICME) and the Ap-index maximum values are highly correlated (r = 0.84).
- The transit velocity of the CME and the calculated effective acceleration of all the examined events, gives a cross correlation coefficient r = 0.92.
- A high correlation coefficient values of the magnetic field Bz component and the Ap index (r = 0.86), as well as the Dst index (r = 0.82), of the effective acceleration against the CME linear speed (r = 0.92) and of the transit velocity against the linear speed of the CME (r = 0.70).

Acknowledgements:
The authors thank all the data providers (SOHO, ACE) for their free availability of their data. We wish to acknowledge financial support of the University of Athens for supporting the Cosmic Ray and Solar Orbital Magnetic Waves research team.

References

Poster Number: 33
Session: 4
0
500
1000
1500
2000
1990
2000
2010
2020
Linear speed (km/s)
2000
1990
2000
2010
2020
Linear speed (km/s)
500
1000
1500
2000
1990
2000
2010
2020
Linear speed (km/s)
481.7 + 0.275 V_{Ap}
V_{cme} =
r = 0.59

Effective acceleration and CME linear speed

\alpha = 1.98 - 26.01 \cdot 10^{-7} u - 58.61 \cdot 10^{-10} u^2

r = 0.89

Heliographic coordinates of the Solar Flares

47 X-class SF

57 CMEs without solar flare

15 B-class SF

68 M-class SF

70 C-class SF

Seasonal distribution of Major geomagnetic storms (Dst < -110 nT)