Properties of Interplanetary Coronal Mass Ejections (ICMEs) at 1 AU over the Solar Cycle

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Abstract

Here we present a detailed list of ICMEs at 1 AU for the period 1995-2004 based on Vt, Vp, and AE observations. In the course of the study, we find that phenomena and periodic patterns (Pp) are a very effective complementary criterion to distinguish ICMEs from solar wind disturbances such as stream interactions, and to characterize ICME strength. Of the 277 ICMEs, 67% are associated with shocks. We classify 200 of the ICMEs into three groups based on the characteristic temporal variations of Vt, Vp, and AE. A forward event (Ptpp) is defined as the center of the ICME and shows evidence for enhanced magnetic flux. An event is classified as a shock event (Pp) if there is a Vt/Vp ratio > 2.5, and the magnetic field is tangential to the shock. A reverse event (Ptpp) is defined by a Vt/Vp ratio < 1.5 with perpendicular magnetic field. Pp is a sequence of forward events, Ptpp is a sequence of reverse events, and the reverse events (Ptpp) is confined to magnetic clouds, MCs, and confined to MCs.

Introduction

Interplanetary Coronal Mass Ejections (ICMEs) are a key component of the dynamic solar wind. Eruptions of the Sun can rapidly drive enormous mass and energy into the heliosphere, and ICMEs are a major factor in the acceleration of solar energetic particles. The identification of ICMEs is based on parameters of change in the interplanetary medium, such as the magnetic field and solar wind velocity. An ICME is defined as a sequence of three or more consecutive magnetic cloud (MC) crossings with a significant enhancement of the magnetic field strength, and a decrease of the solar wind speed.

In this study, we classify 200 of the ICMEs into three groups. Table 1 presents a detailed list of ICMEs for the period 1995-2004. The list includes ICMEs with characteristics of Vt, Vp, and AE, and provides information on the time and location of the observations. Table 2 lists the number of ICME events, the number of shocks, and the number of magnetic clouds. We also list the maximum and minimum values among all events during the 10 years. The ICMEs are associated with shocks in 67% of cases. We have found no ICMEs associated with forward shocks. This number is 36% of all ICMEs. Additionally, Figure 3 shows the solar cycle variations of Vp and AE parameters. In Table 3, Figure 5 also displays the variation of density, Vt, Vp, and solar wind speed. For Table 4, Vp is 0.5 AU, and ICs are 0.25 AU, and the maximum and minimum values among all events during the 10 years. The ICMEs are associated with shocks in 67% of cases. We have found no ICMEs associated with forward shocks. This number is 36% of all ICMEs. The solar cycle variations of Vp and AE are also shown in Figure 3.

In conclusion, the occurrence rate of ICMEs has a clear solar cycle variation. The occurrence rate of ICMEs in 1995 was 38% in 1998, 60% in 1999, and 30% in 1998. The correlation between the occurrence rate of ICMEs and solar activity is significant. The occurrence rate increase and decrease of ICMEs both have a clear solar cycle variation. The occurrence rate is 0.5 AU in 1997 and 0.25 AU in 1998, with the average value 0.62 AU. The occurrence rate is 0.62 AU in 1997 and 0.25 AU in 1998, with the average value 0.62 AU. The occurrence rate is 0.62 AU in 1997 and 0.25 AU in 1998, with the average value 0.62 AU.

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