CORONAL MASS EJECTIONS AND INTERPLANETARY SCINTILLATION

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ABSTRACT

Here we report the Interplanetary Scintillation (IPS) observations of three events on April 2000, May 1999 and May 1997. The April 2000 observations are the interplanetary consequences of a halo Coronal Mass Ejection (CME). The May 1999 event is termed a solar wind disappearance event; it appears to be due the passage of a large void. The May 1997 event is that due to an Earth directed CME and the IPS observations of a radio source 3C48 show that the interplanetry disturbance due to this CME had density ~4 times more than the ambient, but moved slower than the ambient medium.

INTRODUCTION

An excellent set of observations of coronal mass ejections are now available from *Yohkoh* and *SOHO.* It has become possible to investigate the initial ejection and acceleration of these CMEs from these X-ray images. The monitoring of propagation of the coronal mass ejections away from the Sun in the heliosphere is possible by an indirect method of interplaneatry scintillation (IPS). In principle this phenomena is similar to the twinkling of stars and senses the presence and propagation of plasma irregularities crossing the line of sight to a compact radio source from the observing radio telescope. There are two radio telescopes operating at 327 and 103 MHz in Japan and Bharat, respectively, to observe this phenomena on regular basis. The passage of a coronal mass ejection through the heliosphere is usually termed an interplanetary disturbance (IPD). The statistical analysis of IPDs has shown that there are about three times more IPD events around the solar maximum phase than those around the solar minimum phase. Here we present the case studies of a few selected coronal mass ejections and their associated IPDs namely, April 2000, May 1999 and May 1997.

<u>April 2000 event:</u> One halo CME with a bright front (as seen by *SOHO*/LASCO) began on April 04, 2000 at about 1632 UT. This appeared to be associated with a C9 flare in AR 8933. With IPS observations at 103 MHz we detected the effect of this CME two days later at the line of sight of 3C459 and three days later at the line of sight of 3C2, 3C119 and 3C122. The observations of Jadhav *et al.* (2001) are shown in Figure 1. At the line of sight of 3C48 there appeared a very feeble effect of the passage of this CME. This could be due to the projection effect. The CME of April 4, 2000 produced a shock which was detected by *ACE* solar wind velocity detectors (the radial velocity increased from 375 km s^{-1} to 575 km s^{-1} at 16 UT on April 6, 2000). This shock led to a very large drop (~ 300 NT) in equatorial Dst and produced one of the largest geomagnetic storms on record.

<u>May 1999 event:</u> This event was popularly termed as "solar wind disappearance event". The in situ observations of several satellites showed that during this event the bow shock of the geomagnetic field was highly extended and had crossed 60 RE. In fact the IPS observations of Vats *et al.* (2001a) of two radio sources; (one sensitive to the IPM close to the Earth and the other one sensitive to the IPM away from the Earth) clearly showed that this was due to the passage of a large void, 150 R_E wide by 4000 R_E long..

May 1997 event

The IPS observations at 103 and 327 MHz showed an Earth-directed coronal mass ejection (CME), which occurred, near the center of the solar disk at 0435 UT on May 12, 1997. This event was associated with a two-ribbon flare. The ionospheric effects of soft X rays from this solar flare were observed by a digital ionosonde at Ahmedabad in the form of excess ionization (~1200 el cm^{-3}) in the *D* region of the ionosphere. The associated IPD was found to have plasma density ~ 4 times more than that of the ambient plasma at a distance of ~ 0.5 AU from the Sun. The most peculiar aspect of this CME, (Vats *et al.* 2001b), is that it appears that the disturbance moved slightly slower than the ambient medium (Figure 2). The *Solar and Heliospheric Observatory (SOHO)* and interplanetary scintillation (IPS) estimates of solar wind are quite different; it appears that the difference could be due to the projection effect of the *SOHO* image. Though the disturbance was not very severe, its impact on Earth's environment produced a geomagnetic storm.

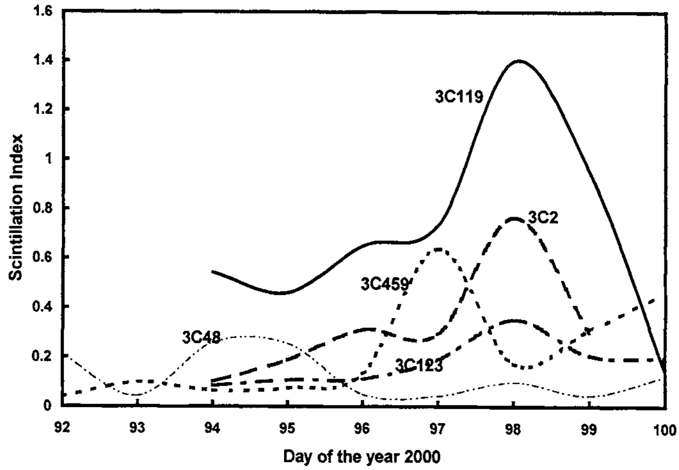

Fig. 1. Temporal variation of scintillation index at 103 Mhz.

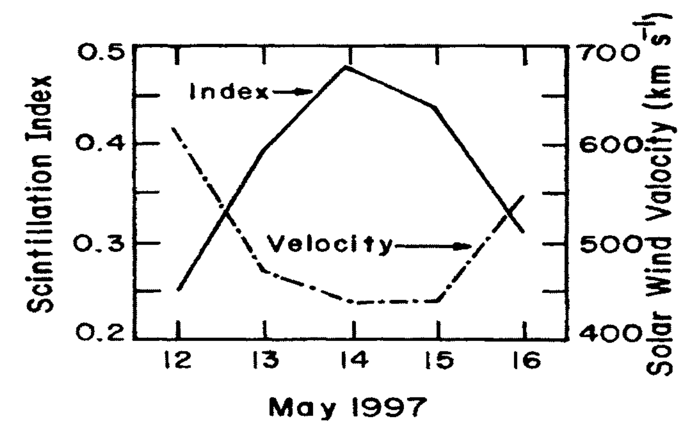

Fig. 2. Variation of scintillation index at 103 MHz and solar wind velocity at 327 MHz for the radio source 3C48

These events are a few of the many CME events that occur. Their interaction with the terrestrial environment produces several effects that are very important for space weather and for understanding the solar-terrestrial relationship.

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