Cluster-C1 observations of non-train magnetic decreases in the solar wind at 1 AU

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Abstract

By using the magnetic field and plasma data of Cluster-C1 from 2001 to 2009, we have investigated the magnetic field and plasma properties around the linear and nonlinear non-train magnetic decreases (MDs) in the solar wind. Compared with the nonlinear non-train MDs, linear non-train MDs occurred in regions with relative low magnetic field strengths and large densities. It is found that the occurrence rate of linear (nonlinear) non-train MDs decreases (increases first, and then decreases) with magnetic field strength increases, and have no significant change (increases first, and then decreases) when the density increased. In addition, the occurrence rates of linear non-train MDs are basically the same from 2001 to 2009 (nearly one solar cycle), however, the occurrence rates of nonlinear non-train MDs have two peaks in 2003 and 2008 respectively.

1. Introduction

Magnetic decreases (MDs) are defined as structures which have significant decreases in magnetic field strength. The non-train events are the MDs which have just one or two dips within 5 minutes, and the events which have more than two dips in a row are MD trains [1]. In this paper, only the non-train MD events are investigated. The MDs with no or little change of the field orientation are linear MDs [2, 3, 4]. Xiao et al. (2010) reported that the occurrence rate and geometrical shape of linear MDs (included the non-train and train events) in the solar wind at 1 AU were consistent with Zhang et al. (2008)'s results obtained from Venus Express data at 0.72 AU [3, 4], indicated that the linear MDs had been formed and fully developed before. Xiao et al., (submitted to Solar Physics, 2013) have investigated the magnetic field and plasma properties around the linear and nonlinear MD trains. There are several generation mechanisms of MDs (see the review paper of Tsurutani et al. (2011) [5] and references therein).

Here we show the magnetic field and plasma properties in the background of linear and nonlinear non-train MDs. The occurrence rates of linear and non-linear MDs are investigated from 2001 to 2009 (nearly one solar cycle).

2. Observations

Using the magnetic field and plasma data of Cluster-C1, 2143 linear (4328 nonlinear) non-train MDs are defined and studied. Figure 1 show the magnetic field and ion number density in the average solar (red dished lines), the occurrence rates of linear (nonlinear) non-train MDs versus with the magnetic field strengths and ion

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number densities. The average magnetic field strengths are 5.5nT and 5.9nT in the backgrounds of linear and nonlinear non-train MDs respectively, while it is about 6.0nT in the average solar wind. Figure (a) ((c)) is the number of non-train MDs normalized by the total time of every 2nT bin, from which we can see that the occurrence rate of linear (nonlinear) non-train MDs decreases (increases first, and then decreases) when the magnetic field magnitude increases. Figure (b) ((d)) shows the occurrence rate of linear (nonlinear) events have no significant change (increases first, and then decreases) with the ion number densities increases. We also find that the linear non-train MDs occurred in regions with relatively high (6.9/6.7cm^{-3}) density than the average solar wind, however, the nonlinear ones observed in regions with lower (5.7/6.7cm^{-3}) ion number densities than the average solar wind.

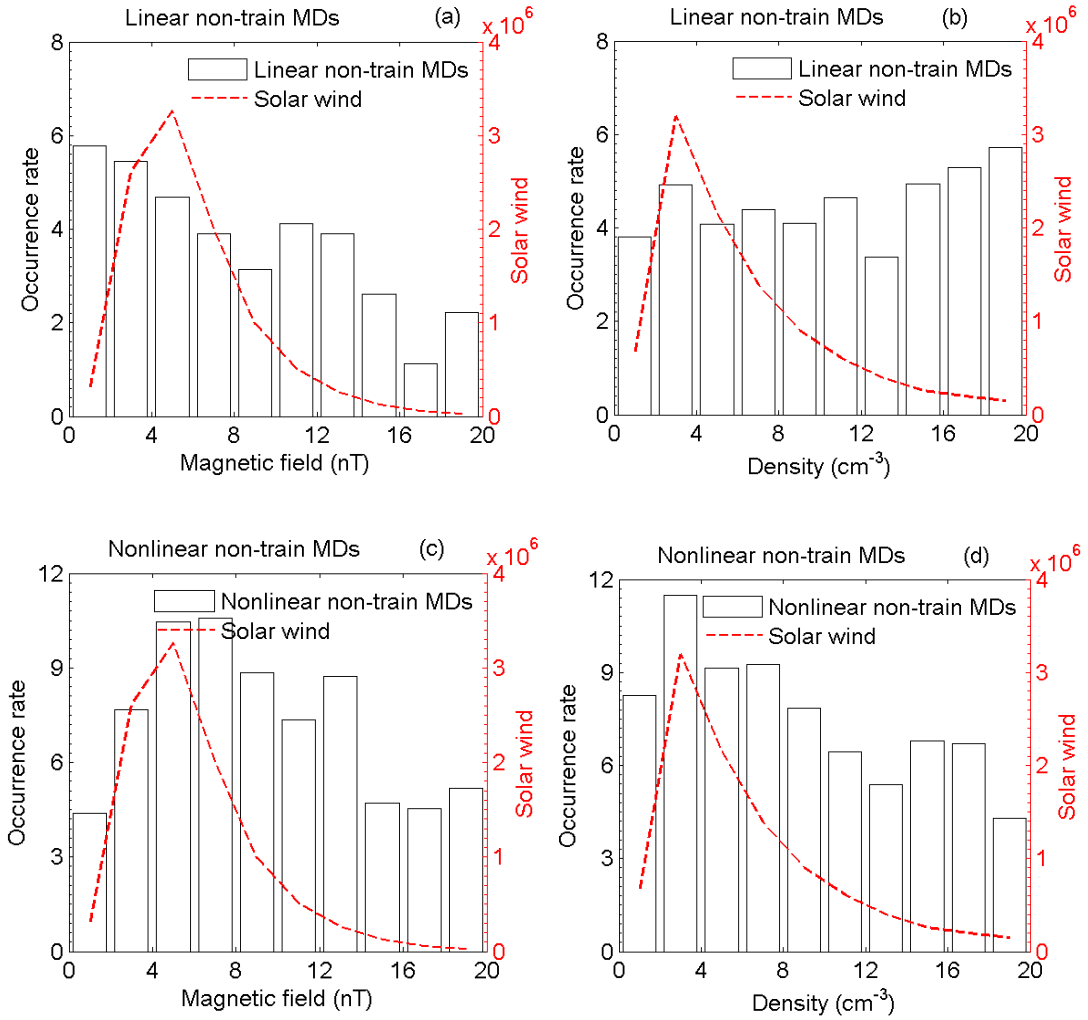

Figure 1.The magnetic field strength and ion number density in the average solar wind (red dashed lines). The occurrence rates of linear and nonlinear non-train MDs versus with the magnetic field strengths (histograms (a) and (c)) and ion number densities (histograms (b) and (d)). .

The occurrence rates of linear and nonlinear non-train MDs in different years are shown in Figure 2, from which it can be seen that there is a slight increase trend for

linear events, while two peaks for the nonlinear non-train MDs in 2003 and 2008 respectively. The average occurrence rate of linear (nonlinear) events is about 4.4 (8.8) MDs per day.

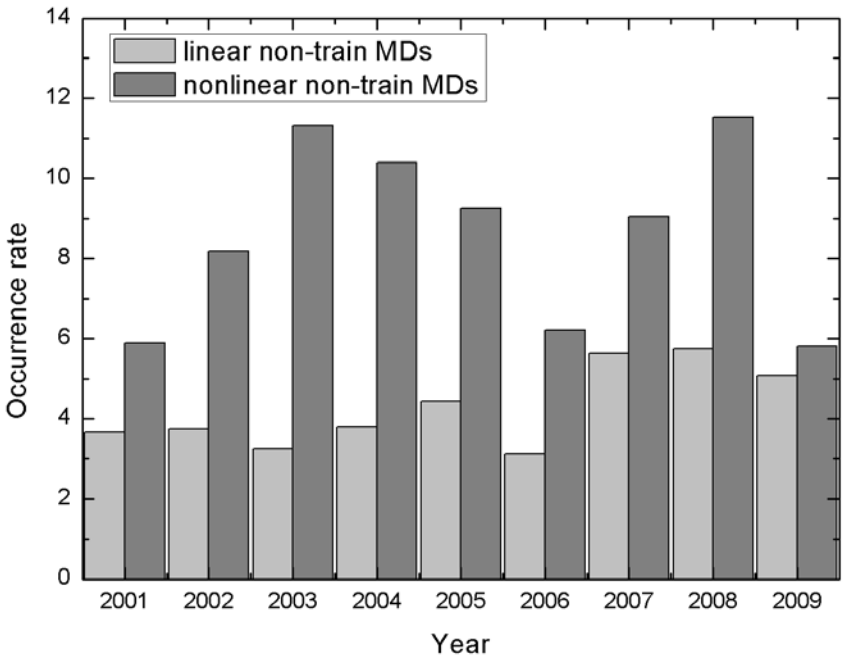

Figure 2. The occurrence rates of linear and nonlinear MDs from the year of 2001 to 2009.

3. Conclusion

Using the magnetic field and plasma data of Cluster-C1, we have investigated the linear and nonlinear non-train MDs in the solar wind. The occurrence rate of linear non-train MDs have no significant change from 2001 to 2009, however, there are two peaks for the nonlinear events in 2003 and 2008 respectively. Compared with the nonlinear non-train MDs, linear non-train MDs occurred in regions with relatively low magnetic field and high densities, indicating that the generation mechanism of linear non-train MDs may differ from the nonlinear ones.

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