Solar Wind Penetration into the High-latitude Magnetosphere:

Cluster Observations

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Abstract

In this paper, using Cluster multi-spacecrafts observation data during January to April of each year from 2001 to 2006, we have studied the solar wind penetration events into the Earth's high-latitude magnetosphere. When the IMF is northward, although the formation of the entry layers depends on the direction of IMF, we pointed out that it mainly depends on the IMF Bx component and the influences of IMF By component could be weak.

1. Introduction

According to the results of previous studies, when the interplanetary magnetic field (IMF) is southward, most of the solar wind plasmas can entry into the magnetosphere through the low-latitude magnetic reconnection process [1,2]. However, when the IMF is northward, the transport mechanism of entry plasmas is still controversial. There are many possible mechanisms such as high-latitude magnetic reconnection [3,4], impulsive penetration [5], the low latitudes instabilities [6] and gradient drift [7].

During the quiet times when the interplanetary magnetic field (IMF) is northward, using Cluster multi-spacecrafts observation data between August to October each year from 2002 to 2004, Shi et al. (2013) reported some new regions of solar wind entry into the Earth's high-latitude magnetosphere tailward of the cusps where the solar wind plasmas penetrate into magnetosphere through the mechanism of high-latitude magnetic reconnection. In this paper, we used another period Cluster data which is between January to April each year from 2001 to 2006 to make further research on the transmission characteristics of the solar wind plasmas.

2. Observations

2.1 Cluster observations of entry regions on March 15, 2005

In order to ensure the reliability of each event, we plot the parameters including the ion energy flux, particle density, magnetic field and interplanetary magnetic field of all events and check it one by one. Fig. 1 shows an example on March 15, 2005, from

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top to bottom: the ion energy flux, particle density, magnetic field, interplanetary magnetic field and from left to right: sheath, lobe, inner magnetosphere. The black box indicates the lobe region and the Pink box indicates the events. According to the parameters within our events, when the IMF is northward, the ion energy flux and the particle density is much higher than these in the lobe.

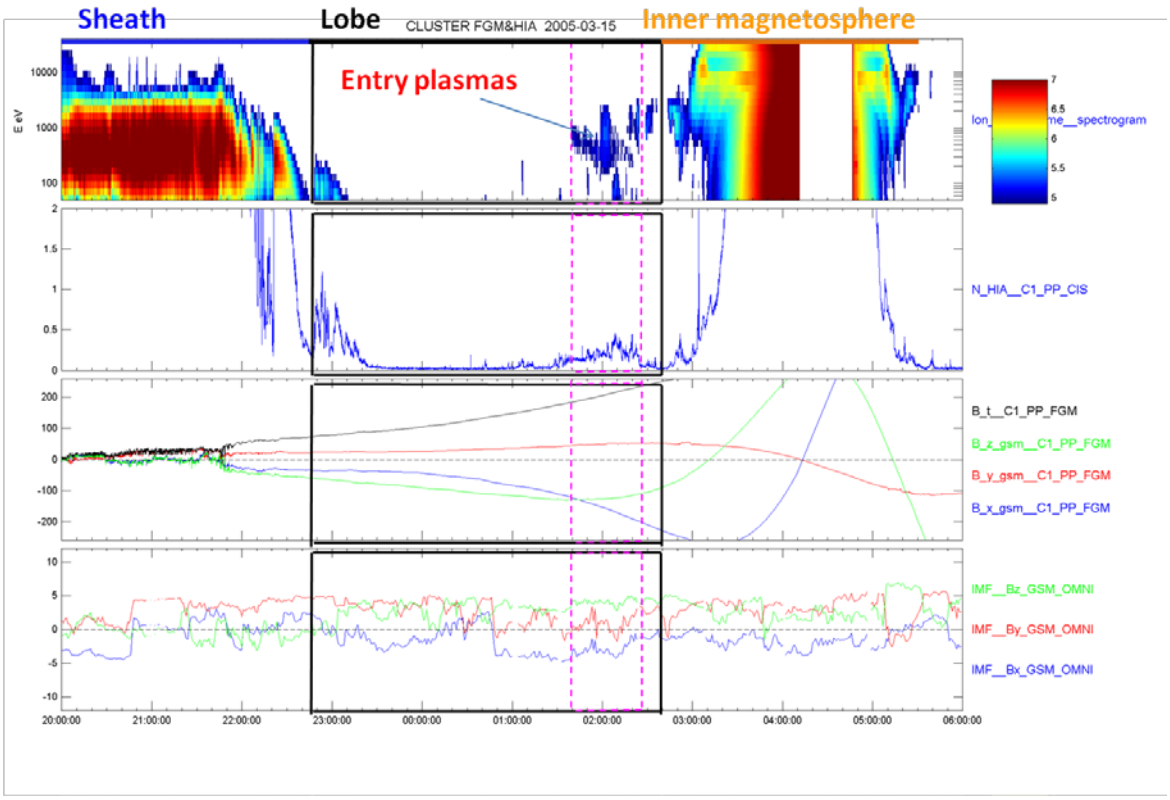

Figure 1. One example for the entry plasmas observed at the high latitude magnetosphere on March 15, 2005. The black box means the lobe region we selected and the Pink box means the entry events.

2.2 Statistical results

Using the Cluster data which is between January to April each year from 2001 to 2006, we have found the new locations of events in the Y_{GSM}-Z_{GSM} plane under the different conditions of IMF By. From Fig. 2 the left shows the locations of events in the Y_{GSM}-Z_{GSM} plane when the IMF By is positive and the right shows the locations of events in the Y_{GSM}-Z_{GSM} plane when the IMF By is negative. According to the theory of inference [8], when the IMF By is positive, the magnetic reconnection probability is higher in the region A and B. On the contrary when the IMF By is negative the magnetic reconnection probability is higher in the region C and D. But this isn't consistent with our statistical results, the distribution of events is scattered shown at Fig. 2.

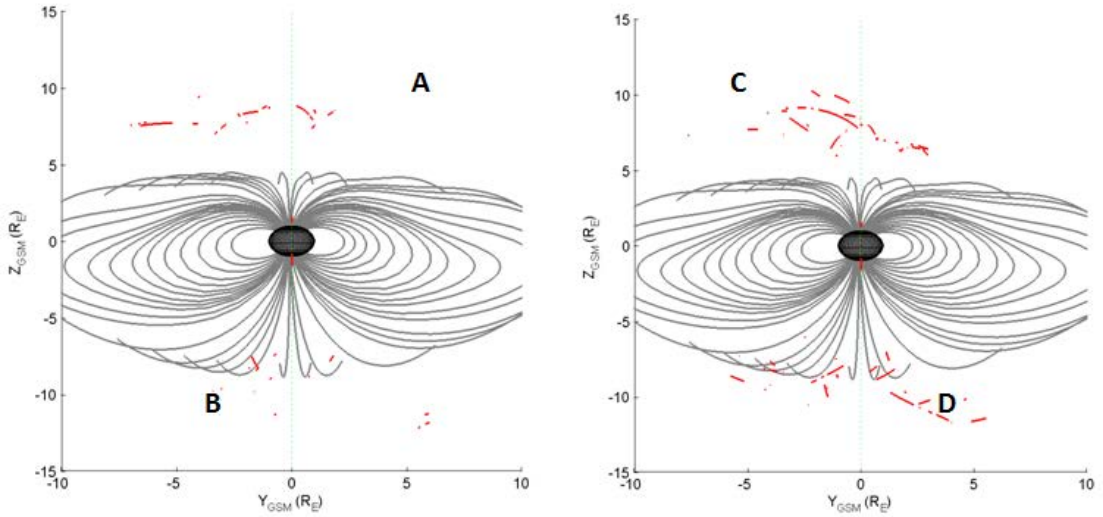

Figure 2. The left-hand image shows the locations of events in Y_{GSM}-Z_{GSM} plane when the IMF By is positive and the right-hand image shows the locations of events in Y_{GSM}-Z_{GSM} plane when the IMF By is negative (Jan. to Apr.).

3. Conclusion and discussions

Many people concentrate on the mechanism of the solar wind plasma entry into the magnetosphere during the IMF northward period, such as the high-latitude magnetic reconnection [3,4], impulsive penetration, the low latitudes instabilities or gradient drift. In this paper, we find that when the IMF is northward, although the formation of the entry layers depends on the direction of IMF, we pointed out that it mainly depends on the IMF Bx component and the influences of IMF By component could be weak.

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