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The day the solar wind almost disappeared:

a preliminary analysis of the geomagnetic response in the recovery phase.

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Abstract. On May 10–12, 1999 a prolonged interval of extremely low solar wind density led to a huge distension of the Earth's magnetosphere. We discuss some aspects of the geomagnetic response observed on May 12, i.e. in the recovery phase of the SW density. The experimental observations confirm a strong morning/afternoon asymmetry in ground observations, and reveal sharp differences in the geomagnetic response in different sectors of the prenoon quadrant. These results suggest that ionospheric contributions might extend to a portion of the prenoon sector larger than predicted.

Key words. SI – Geomagnetic response

1. Introduction

As extensively discussed in a number of papers (Farrugia et al., 2000; Jordanova et al., 2001; Le et al., 2000; Fairfield et al., 2001), on May 10–12, 1999 a prolonged interval of extremely low solar wind (SW) density led to a huge distension of the Earth's magnetosphere. In the present paper we conduct a preliminary analysis of the geomagnetic response to the variable SW conditions observed on May 12, i.e. in the recovery phase of the SW density. In particular we focused attention on a Sudden Impulse (SI, ∼1550 UT) related with a sharp SW pressure variation observed by Wind spacecraft at ∼1537 UT, at a radial geocentric distance of $\sim 56\ R_T$. A more definite discussion of this event will be presented in a forthcoming paper.

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2. An analysis of the geomagnetic response.

We examined ground observations in the Northern hemisphere at geomagnetic latitudes ranging between $23° - 64°$. As shown in figure 1, the impact of the SW pressure pulse provides a remarkable geomagnetic field variation at each station. However, a simple visual inspection of figure 1 reveals explicit differences in the experimental observations at different sites which, in our opinion, are more significant than in other cases (Araki, 1994). According

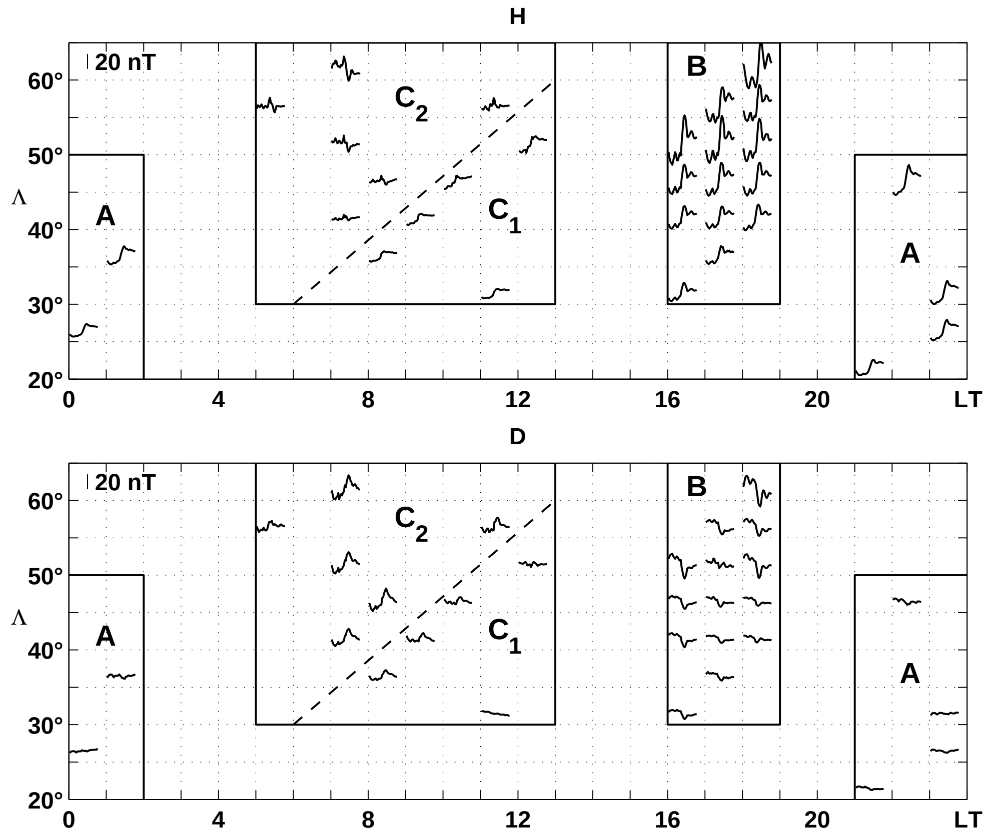

Fig. 1. Ground magnetic field observations (1 min) for the time interval 1545–1615 UT. H component (North/South) is in the upper panel and D component (East/West) in the lower panel.

to morphological aspects, these observations can be tentatively organized in several groups, although the physical characteristics of events progressively evolve from one to another group.

Group A. Basically, in the nighttime hours (21–2 LT), the geomagnetic field behavior is mostly characterized by an explicit variation of the H component which identifies the SI occurrence. In this case the D component only shows minor amplitude fluctuations.

Group B. In the afternoon sector (16–19 LT), the behavior of both components is more structured and explicit variations are observed also in the D component. For this group of events there is a clear evidence for a positive enhancement in the H component preceding the SI. This component also shows peak overshoot values.

The results obtained in the prenoon quadrant appear strongly dependent upon latitude and LT.

Group C1. These events reveal, in general, a minor amplitude geomagnetic response of the whole pattern. Peak overshoot values are now observed in the D component, while the H component shows almost constant values after the main variation.

Group C2. For this group of events, the D component reveals approximately

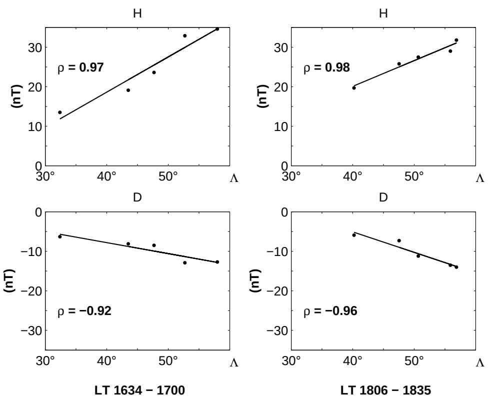

Fig. 2. The asymptotic variation observed in narrow LT strips in the afternoon sector for the H and D component (ρ is the correlation coefficient with latitude).

the same behavior as in group C1, although with greater amplitude variations. Conversely, the H component shows striking differences with respect to C1 events and reveals clear evidence for a positive then negative variation.

In order to compare the present results with those provided by previous investigations, we found interesting to estimate the average latitudinal dependence of the asymptotic variation in narrow LT strips in the afternoon sector, where it more explicitly emerges: the experimental results (figure 2) show a strong correlation between the asymptotic variation and the geomagnetic latitude, and suggest an average latitudinal rate for the H component of 0.9 nT/° in the 1634–1700 LT quadrant, and 0.7 nT/° in the 1806–1835 LT quadrant; in the same sectors the D component shows gentler latitudinal gradients, such as –0.3 nT/° and –0.5 nT/°, respectively.

The global polarization pattern of the main field variation (figure 3) confirms the major importance of the H and D component in the night and morning sector, respectively. As can be seen, a tendency for an elliptical clockwise (CW) polarization (as seen from above the Earth surface) can be detected in the afternoon sector, where it becomes more clear at higher latitudes after 17 LT.

3. Summary and discussion.

We examined some preliminary aspects of the geomagnetic response to SW pressure variations which were observed on May 12, 1999, i.e. in the recovery phase after the day the SW almost disappeared.

The results of our analysis confirm a strong morning/afternoon asymmetry in the geomagnetic response (Russell and Ginskey, 1995, Francia et al., 1999, 2001). Several aspects of the present investigation find correspondence in the current understanding of the SI manifestation (Araki, 1994). They assume, however, greater relevance than in previous investigations and reveal clear differences between different sectors in the prenoon quadrant which suggest that ionospheric contributions play a major role also at low latitudes in particular in the morning sector. Our results also confirm the major important of the D component for a definite evaluation of several aspects of the geomagnetic response (Tsunomura, 1998).

According to early investigations (Wilson and Sugiura, 1961), from low to high latitudes in the Northern hemisphere, the polarization of the SI field is often elliptical and the polarization pattern is CCW, between 22–10 LT, and CW between 10–22 LT. However, this conclusion was criticized by Matsushita (1962, see also Araki and Allen, 1982), who reported that only two fifths of analyzed SIs indicated elliptical polarization, and only half of those agree with the proposed pattern. In the present case the polarization pattern is mostly linear, and some evidence for an elliptical CW polarization is observed only in the 16–18 LT sector, at higher latitudes. In this sense, it is interesting to remark that our results can find correspondence in those recently obtained (although in the micropulsation band) at low latitudes by Vellante et al. (2001). They conducted,

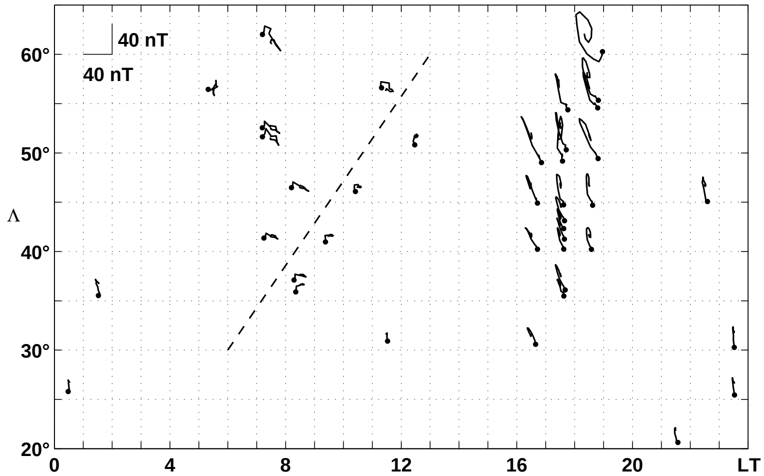

Fig. 3. The polarization pattern at different ground stations.

indeed, a statistical analysis of the propagation characteristics of ULF waves and found that, while for the entire day a linear polarization was strongly dominant, some evidence for an elliptical polarization was identified only around sunrise and sunset times. In addition, for selected polarized events (10–40 mHz), a dominant CW polarization was observed only between 16–20 LT.

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