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FTE LIKE VARIATIONS IN THE GEOMAGNETIC FIELD AT GROUND BASED CONJUGATE STATIONS IN THE CUSP REGIONS

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RESUMO - NOTAS / ABSTRACT - NOTES

We have carefully studied magnetic field data acquired at the "conjugate" pair stations Frobisher Bay/South Pole to examine the nature of the magnetic signatures indentified (Lanzerotti et al., 1986) as possible ionosphere signatures of flux transfer events (FTEs). We find, in an examination of data over the interval July-November 1985, many events, covering a wide range of amplitudes, that are suggestive of intense field-aligned currents convected over the observing stations. We find all of the events to thave a half-width in time of a few minutes and to be conjugate. All of the events have vertical magnetic field perturbations which imply field-aligned currents in the same direction (either into or out of the ionosphere) in both hemispheres. The implications of these results for the identification of these events with FTEs and contemporary models for dayside reconnection and field-aligned current systems will be discussed.

OBSERVAÇÕES / REMARKS

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"FTE like variations in the geomagnetic field at ground based conjugate stations in the cusp regions"

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FTE LIKE VARIATIONS IN THE GEOMAGNETIC FIELD AT GROUND BASED CONJUGATE STATIONS IN THE CUSP REGIONS

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ABSTRACT

We have carefully studied magnetic field data acquired at the "conjugate" pair stations Frobisher Bay/South Pole to examine the nature of the magnetic signatures indentified (Lanzerotti et al., 1986) as possible ionosphere signatures of flux transfer events (FTEs). We find, in an examination of data over the interval July-November 1985, many events, covering a wide range of amplitudes, that are suggestive of intense field-aligned currents convected over the observing stations. We find all of the events to have a half-width in time of a few minutes and to be conjugate. All of the events have vertical magnetic field perturbations which imply field-aligned currents in the same direction (either into or out of the ionosphere) in both hemispheres. The implications of these results for the identification of these events with FTEs and contemporary models for dayside reconnection and field-aligned current systems will be discussed.

INTRODUCTION

The nature of solar wind induced convection in the outer magnetosphere has been investigated ever since the open magnetosphere model was proposed by Dungey (1961). Even now how solar wind transfers energy to the terrestrial magnetosphere is not completely understood. Hence considerable attention has been given to process of magnetic field reconnection at dayside magnetopause. Russell and Elphic (1978, 1979) reported "flux transfer events" FTE's from geomagnetic measurements at the dayside magnetopause conducted by ISEE spacecrafts. They also interpreted that FTE's are due to localized reconnection of magnetopause with southward interplanetary magnetic field Bz. Haerendel et al. (1978) also reported similar magnetic field variations in the magnetospheric boundary layer. Rijnbeek and Cowley (1984), Paschman et al. (1982), Daly et al. (1981, 1984), Saunder et al. (1984), have studied FTE's as an evidence of quasi-steady or transient reconnection of magnetic fields at dayside magnetopause. The nature of reconnection in terms of theory and computer simulation was treated by Cowley (1982), Lee and Fu (1985), Lee (1986), Sonnerup (1986) and Sato et al. (1986). The response of polar ionosphere to FTE's was treated by Goertz et al. (1985), Southwood (1985), Lee (1985), Todd et al. (1986) and Sandholt (1986).

The signature of FTE in the geomagnetic field variations observed on the ground was reported by Lanzerotti et al. (1986), (hence forward referred to as paper 1). They presented in paper 1 data from a magnetic station at South Pole (geographic) situated near the magnetospheric cusp. The two events presented in paper 1 and its physical explanation based on the work of Lee and Fu (1985) are reproduced in Figures 1 and 2, respectively. The footprint of an FTE in the ionosphere of southern cusp latitudes based on the injection of the field currents when $J_{||} > 0$ (upward direction from the polar ionosphere) and $B_y > 0$ would be as illustrated in Figures 1 and 2.

The Hall current loop J_H was considered responsible for the magnetic signature seen on the magnetogram at the south pole. In the case of IMF By < 0 the field aligned current would flow downward to the ionosphere (J|| < 0) and the sense of Hall current loop would be reversed.

Lanzerotti et al. in paper 1 also suggested that these ideas should be tested by examining many FTE's from simultaneous geomagnetic data of South Pole station and Frobisher Bay on Baffin Island in the Canadian Northwest territory. The magnetic stations, South Pole station and Frobisher Bay are nearly conjugate locations near L=14. If the signatures of FTE in the geomagnetic field at the cusps showed By(IMF) dependence, then according to the ideas of Lee and Fu (1985), the Hall current loops would have opposite senses in each of the hemispheres. Thus the signatures of the vertical field of the earth at South Pole would be in the opposite sense compared to Frobisher Bay and vice versa would be true. Lanzerotti et al. (1986) reported an attempt to verify governing physical process of FTE at conjugate cusp stations, viz. South Pole and Frobisher Bay. In this attempt on October 16, 1985, when Sondre Stromfjord incoherent scatter radar facility observed convection reversal boundary and field aligned current filament was inferred in the cusp ionosphere, the magnetic records at both South Pole and Frobisher Bay were examined. The magnetic records referring to this event showed that probably the field aligned current filament was on close field lines and hence the said event may not be a flux transfer event.

In this work we have examined available magnetic data of the two cusp region conjugate stations to get more statistical information on FTE's. The period of the data examined is from July 1985 to December 1985. Above mentioned conjugate point stations situated in the magnetospheric cusps are South Pole station in the Antarctica (SP; local time LT=UT-3.5 hours) and its near conjugate point Frobisher Bay on Baffin Island of Canadian northwest territory

(FB; local time LT=UT-3.5 hours). The magnetometers employed were three axis fluxgates of the type described by Trigg et al. (1971). The details of the installations were discussed by Lanzerotti et al. (1982) and Wolfe et al. (1986). The data were recorded digitally. The fluxgate sensors were oriented in such a way that in the northern (southern) hemisphere increase in the vertical component of geomagnetic field was in the downward (upward) direction. The criteria used for selecting the flux transfer type events were following:

(1) The vertical field should show unmistakable change positive or negative and with a duration of three to six minutes period.

(2) The event should occur between 10 and 20 hours UT that is only the daytime events.

(3) The events were selected examining only Frobisher Bay data. The South Pole station data were consulted only later to avoid any bias during the selection.

A numerical filter was devised for an automatic detection of FTE's using a computer. However we have ignored the selection of FTE's by a computer method since the evidence was overwhelmingly clear. We have restricted the present discussion to a few large amplitude clear cut events encountered during the period from July to December 1985. The events selected for the present study are listed in Table 1. Figures 3 and 4 show representative FTE's at both Frobisher Bay in the northern cusp and South Pole station in the southern cusp. The events of 19th August 1985 and 11th. November 1985 were chosen for the diagrams as on each day there are two events in succession. All the events listed in Table 1 show exactly the same behavior. Figure 5 shows an event that exhibited decrease in z-component on the South Pole station. However it could be noted that Frobisher Bay also exhibited similar variation.

CONCLUSIONS

In the examples encountered, the physical process as interpreted by Lee and Fu (1985) and Lanzerotti et al. (1986) does not find support. It appears that these events are independent of By(IMF) component and probably occur on closed field lines. According to Russell and Elphic (1978), Lee and Fu (1985), Rijnbeek et al. (1984) the FTE events occur every eight to fifteen minutes. However the magnetometer recordings on the ground at the magnetospheric cusps showed far less frequent occurrence of FTE. During the period from July to December 1985 only fourteen events with amplitudes over hundred gammas were noticed.

It seems from the present study that FTE's registered on the ground at cusp latitudes may occur on close field lines and very likely independent of By(IMF) component. It needs to be investigated what happens to large number of FTE's occurring frequently at dayside magnetopause with much less frequent signatures on the ground magnetometers.

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FIGURE CAPTIONS

Fig. 1 - Two separate flux transfer events observed at South Pole station for IMF By < 0 (upper panel) and IMF By > (lower panel).

Fig. 2 - The velocity ($V_\perp$), electric fields (E) and current patterns in the polar ionosphere which is connected to the helical flux tubes formed at the magnetopause by a flux transfer event (FTE). Shown in the case of the Southern (Northern) hemisphere, Pre-noon (postnoon) for By < 0 (By > 0). Here J_H is the ionospheric Hall current, J_P is the Pedersen Current density, and $J_{||}$ is the field-aligned current. Inside the flux tube $J_{||}$ is downward for the stated conditions; the upward return currents are located outside the flux tube.

Fig. 3 - Flux Transfer Event on November 11, 1985.

Fig. 4 - Flux Transfer Event on August 19, 1985.

Fig. 5 - Flux Transfer Event on November 3, 1985.

TABLE 1

LIST OF FLUX TRANSFER EVENTS

DAY	DATE	TIME
228	17 Aug 1985	1745 U.T.
230	19 Aug 1985	1230 U.T.
232	21 Aug 1985	1130 U.T.
233	22 Aug 1985	1220 U.T.
238	27 Aug 1985	1135 U.T.
298	26 Oct 1985	0920 U.T.
299	27 Oct 1985	0944 U.T.
300	28 Oct 1985	1243 U.T.
302	30 Oct 1985	1112 U.T.
306	03 Nov 1985	1820 U.T.
312	09 Nov 1985	1346 U.T.
313	10 Nov 1985	1335 U.T.
314	11 Nov 1985	1415 U.T.
315	12 Nov 1985	1300 U.T.

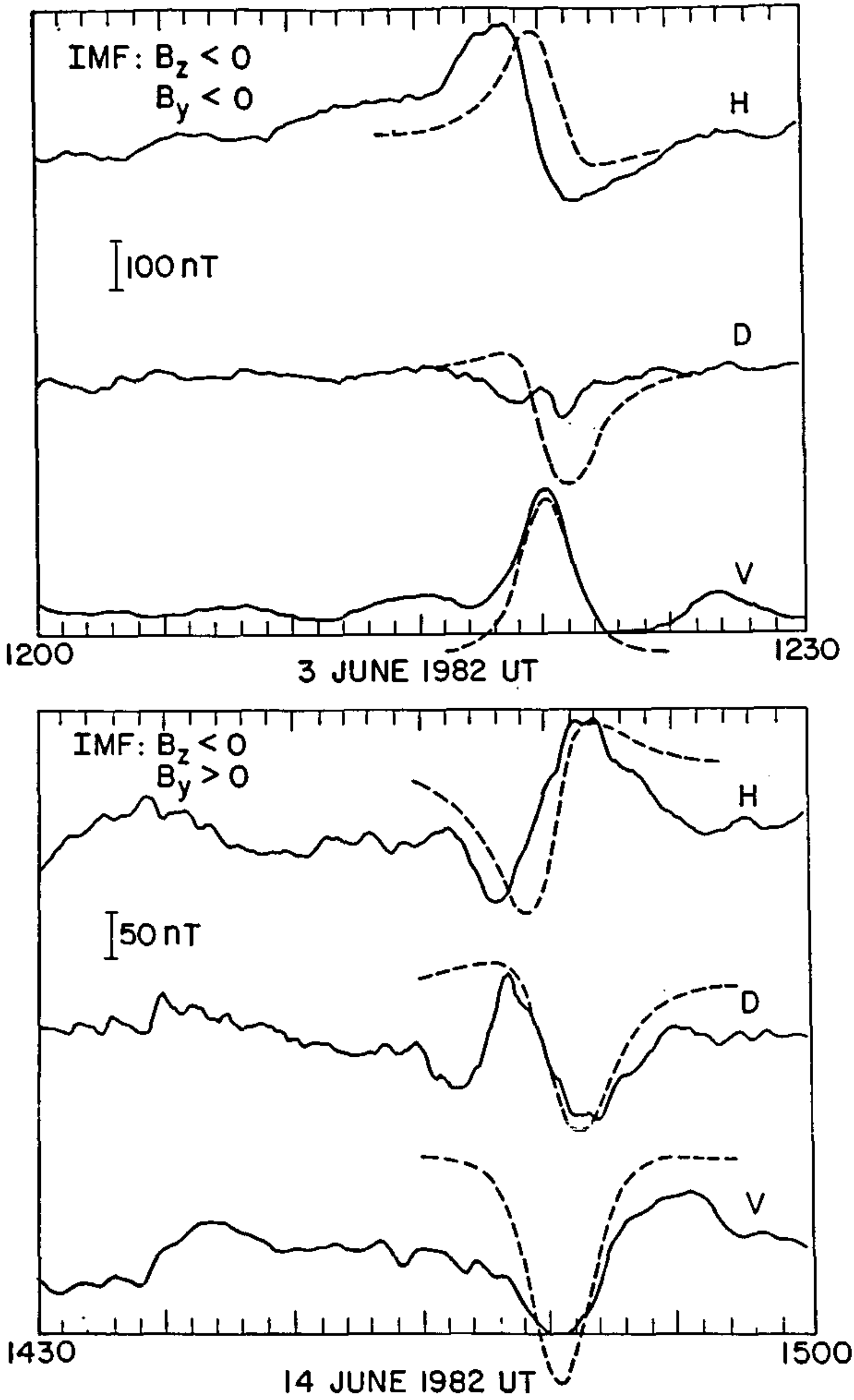
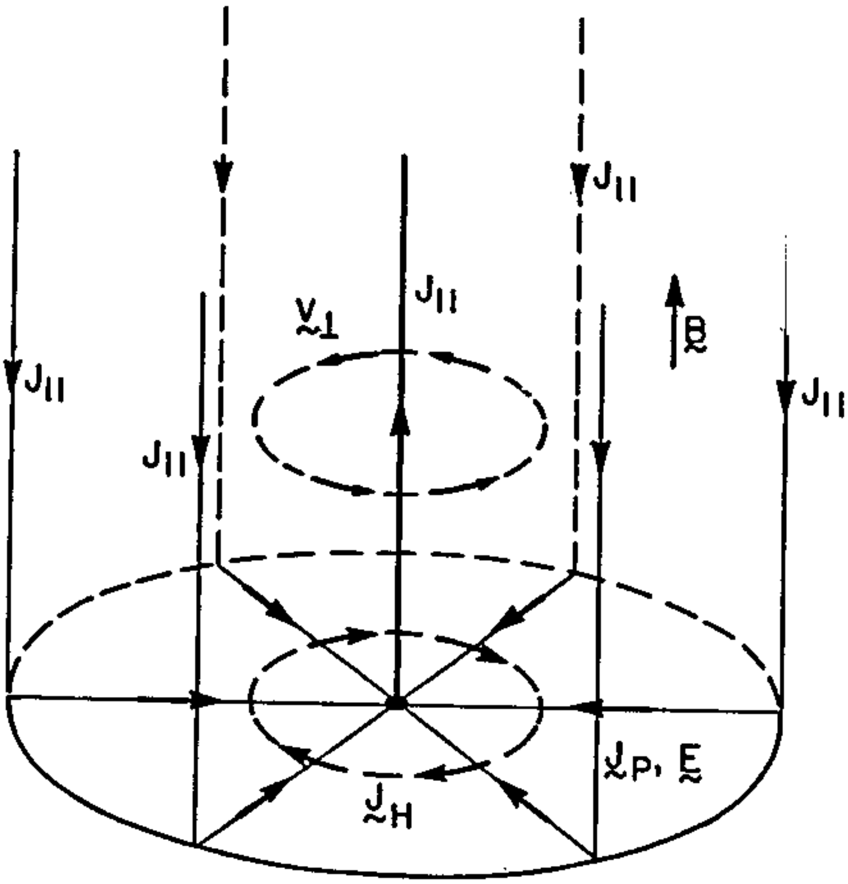
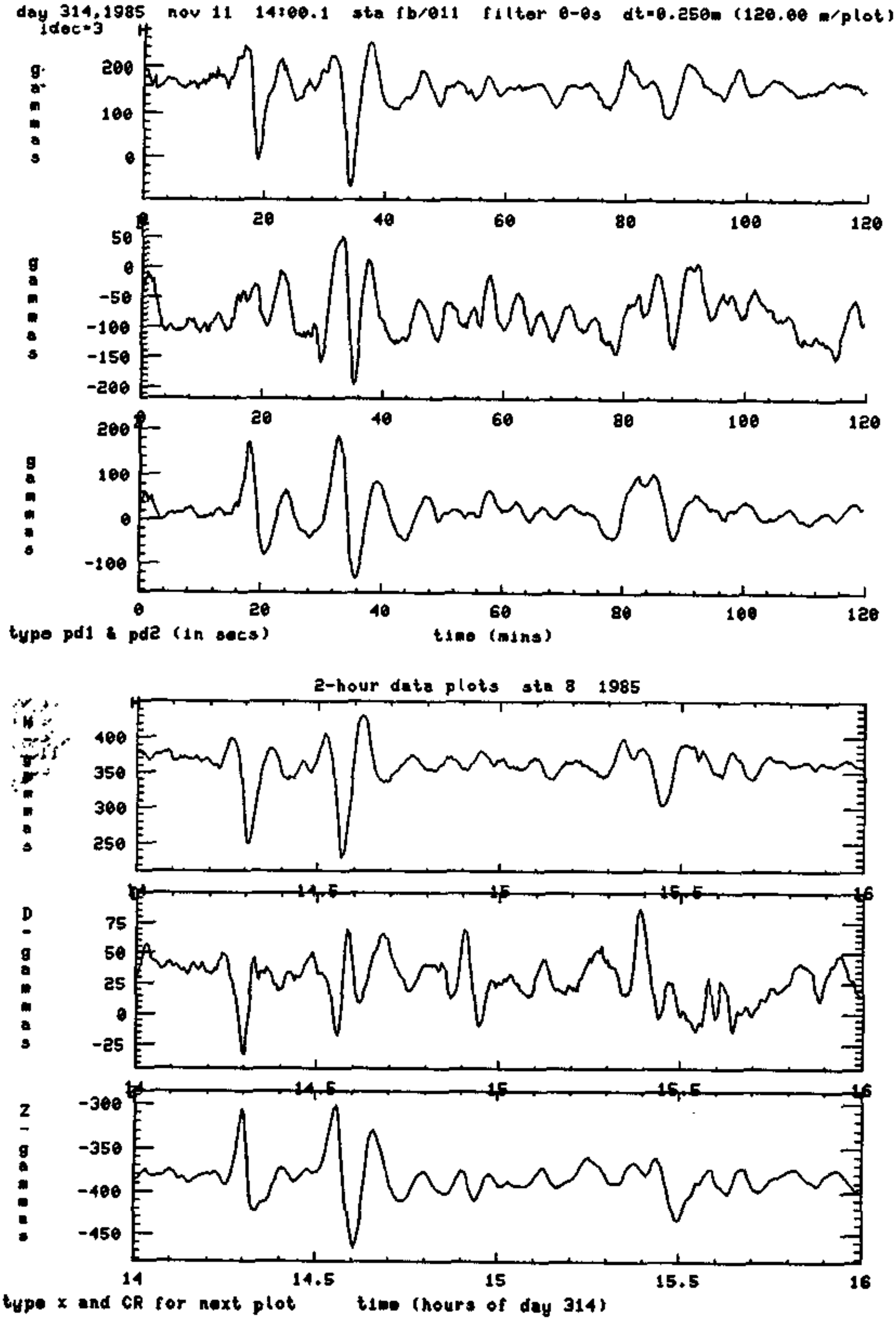

IMF: $B_z < 0$
$B_y < 0$
H
100 nT
D
V
1200
1230
3 JUNE 1982 UT
IMF: $B_z < 0$
$B_y > 0$
H
50 nT
D
V
1430
1500
14 JUNE 1982 UT

Fig. 1



B_Y (IMF)>0

FIg. 2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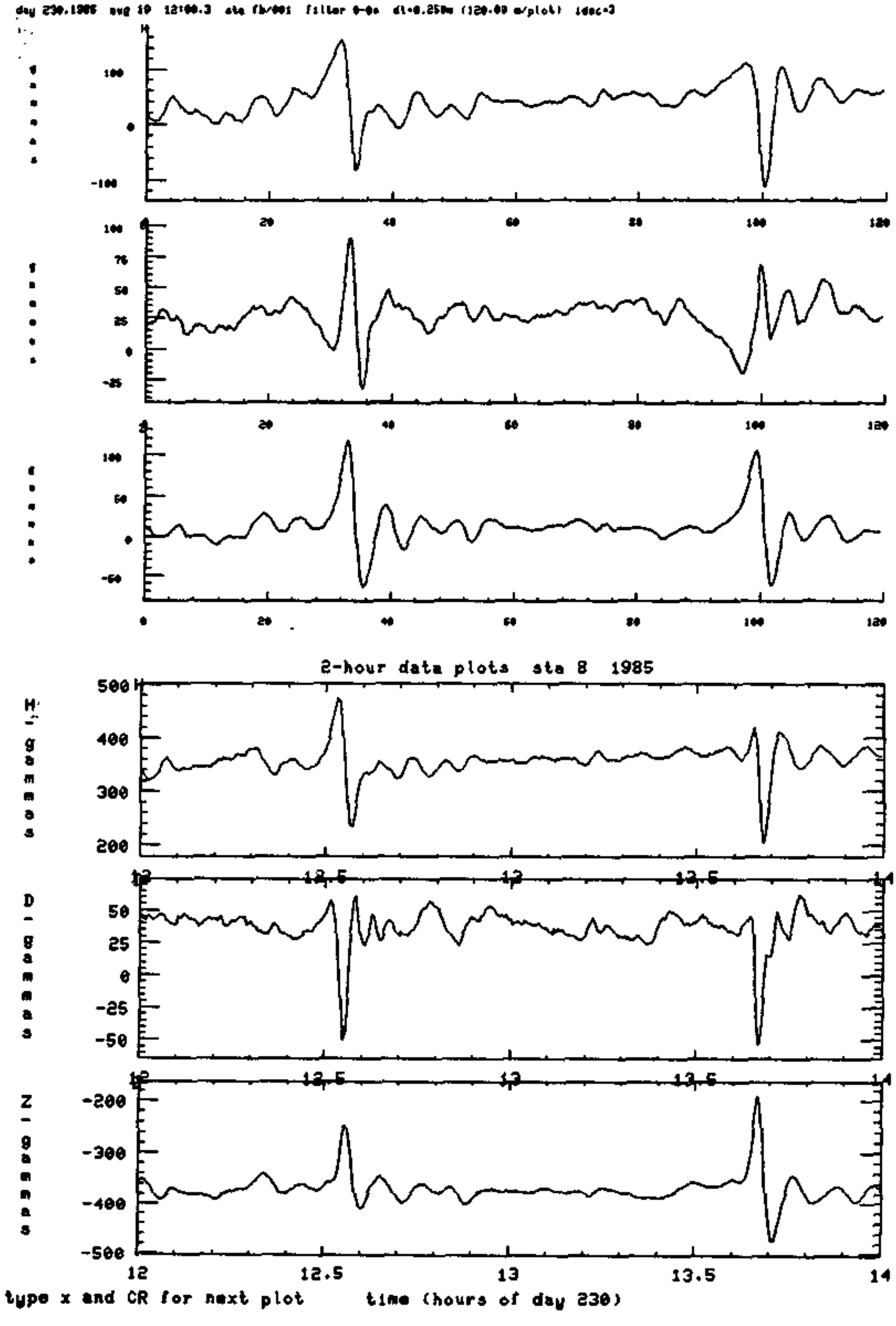
gammas
time (mins)
type pd1 & pd2 (in secs)
2-hour data plots sta 8 1985
D - gammas
Z - gammas
time (hours of day 314)
type x and CR for next plot

Fig. 3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H-gammas
D-gammas
Z-gammas
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12
12.5
13
13.5
14

Fig. 4

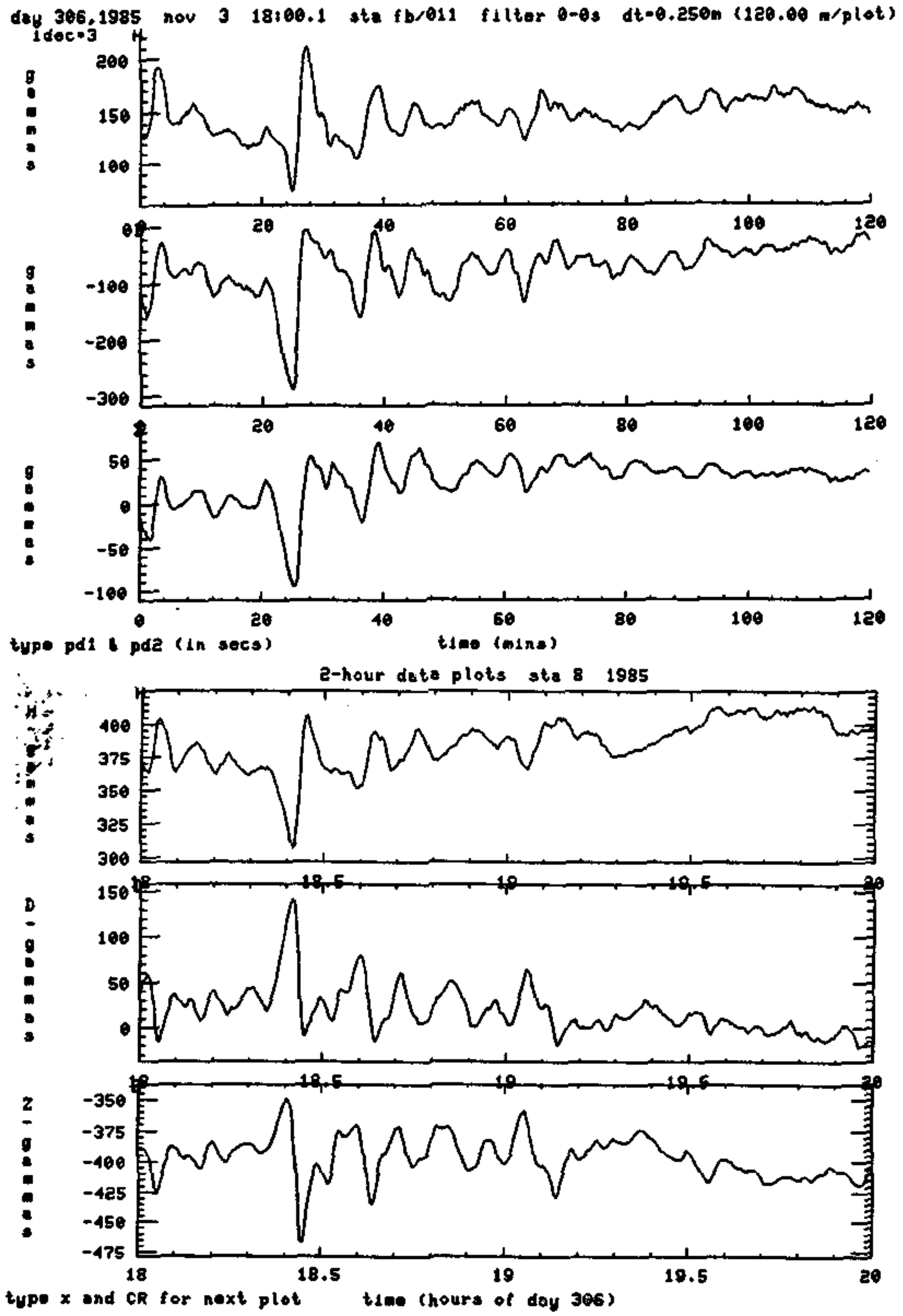
day 306,1985 nov 3 18:00.1 sta fb/011 filter 0-0s dt=0.250m (120.00 m/plot)
idec=3
type pd1 & pd2 (in secs)
time (mins)
2-hour data plots sta 8 1985
type x and CR for next plot
time (hours of day 306)

Fig. 5