ONSITE ANALYSIS OF DATA FROM THE DYNAMICS EXPLORER (DE) SPACECRAFT

28 February 1992

Final Report Prepared Under Contract NAS5-31207 For

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

By:

Shing F. Fung
Robert M. Candey
Josephine N. Humphreys
ARC Professional Services Group, Inc.
8201 Corporate Drive, Suite 350
Landover, Maryland 20785

ONSITE ANALYSIS OF DATA FROM THE DYNAMICS EXPLORER (DE) SPACECRAFT

15 February 1992

Annual Report Prepared Under Contract NAS5-31207

For

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

By

Shing F. Fung
Robert M. Candey
Josephine N. Humphreys

ARC Professional Services Group, Inc.
8201 Corporate Drive, Suite 350
Landover, Maryland 20785

1 INTRODUCTION

The tasks performed by ARC Professional Services Group, Inc. (ARC) in the period from 1 February 1991 to 31 January 1992, under Contract NAS5-31207, are described in the following pages. The work fell into five parts: Section 2 describes Dynamics Explorer (DE) data analysis and modeling, Section 3 describes DE project support, Section 4 describes chemical release observations support, Section 5 describes VLF emissions and plasma instability studies, and Section 6 describes modeling of planetary radio emissions. In Section 7, we provide some recommendations for future considerations.

2 DYNAMICS EXPLORER DATA ANALYSIS AND MODELING (Task Assignment 1)

A major objective of the Dynamics Explorer (DE) Project is to use the DE 1 and 2 spacecraft to study the electrodynamic coupling between the Earth's ionosphere and magnetosphere. It is, therefore, important to study the mechanisms for the energization of the auroral particles, their interactions with the plasma medium, and the associated electrodynamics. In working toward an understanding of these auroral plasma phenomena, ARC conducted a number of studies by using the data obtained by the DE satellites.

ARC explored the possibility of locating the lower boundary of the auroral acceleration zone by considering (1) the consistency and the altitudinal variation of the auroral secondary electron spectra upon correction for the contaminating atmospheric photoelectron fluxes; and (2) the "survival" of the photoelectron spectrum in inverted-V events observed at high altitudes with weak secondary fluxes. No evidence of substantial auroral parallel electric field was found at altitudes below 1000 km. In so doing, ARC also investigated the effects of parallel electric fields on the spectra of low energy auroral electrons. Results from this study were used to develop a technique for detecting weak electric fields along auroral magnetic field lines. Moreover, the differences between the uncontaminated and contaminated dayside inverted-V events were studied. The primary analysis technique involves examining numerous scatter plots of various combinations of spectral index ratio, altitude, magnetic local time, solar elevation, secondary flux, primary beam energy, invariant latitude, and time for different pitch angles and corrected/uncorrected (for photoelectron contamination) events.

Results from the above studies were reported in a paper, "A search for parallel electric fields by observing secondary electrons and photoelectrons in the low altitude auroral zone", published in the *Journal of Geophysical Research (JGR)* in March 1991.

ARC modeled the magnetic field pattern sampled by a satellite traversing a finite field-aligned current (FAC) slab. Iso-current density plots were generated from model calculations. These were used to assess the applicability of the infinite current sheet approximation in the auroral zone. Sample plots from the model calculations are included in Appendix B.

The perturbation magnetic fields near the ends of finite field-aligned currents were quantitatively analyzed to obtain a measure of the satellite impact parameter through the field-aligned current region. Field-aligned current regions with uneven or unbalanced current elements were also considered. The technique of minimum

variance for the determination of the principal axes of an infinite current sheet was reviewed. Its applicability to recovering the satellite penetration angles through the field-aligned current region was investigated and implemented. The paper on finite geometry effects of field-aligned currents has been accepted for publication in the *Journal of Geophysical Research (JGR).*

In order to facilitate future studies of inverted-V events, ARC reprocessed the inverted-V database, including marking the width of the events. We continued selecting additional events for the inverted-V database.

ARC investigated the generalized auroral current-voltage relationship of the form $J \sim V^{\alpha}$. Based on a simple linear relationship between the peak energy and the thermal spread of the primary inverted-V electron precipitation, we obtained from a set of inverted-V events observed by the DE 2 satellite a value of $\alpha < 1$. The physical implications of $\alpha < 1$ were considered. Results have been summarized in a draft of a paper to be submitted to the *Geophysical Research Letters.*

ARC worked in collaboration with Dr. C. P. Escoubet on the calibration of the LAPI detectors by using data obtained from DE 2 spinning passes. In addition, we investigated the identification of the auroral cusp/cleft boundary by using the average energies of the precipitating electron and ion populations. In addition, we also studied the electron injection signature in the dayside cusp region.

We also investigated the electron injection and "staircase" ion signatures in the dayside cusp region. A paper on this subject was presented at the 1991 Spring AGU meeting in Baltimore, MD. A written paper has been submitted to the *Geophysical Review Letters (GRL).* Possibility of local acceleration of electron bursts in the dayside cusp was also considered. In addition, ARC considered the fluctuating electric field signals observed within the "staircase" event in terms of propagating electromagnetic waves. This might lead to a re-interpretation of the convection pattern associated with this event studied earlier.

ARC started to investigate the generation of inverted-V structures by standing hydromagnetic wave structures near the magnetospheric equator at high altitudes. We reviewed the physics of MHD waves in a cold plasma and considered the energization of auroral electrons by the magnetic pumping and phase-mixing mechanisms.

Effective use and presentation of the data require the production of certain data products (e.g., databases, tables and plots) which consolidate the raw data into analyzable forms. To this end, ARC produced plots of magnetic and electric fields, associated particle precipitations, and the resultant currents. For statistical studies of the auroral electron precipitations, ARC produced several inverted-V databases and tables. To study the effects of photoelectrons on the observed inverted-V spectra, energy spectra of the precipitation events and the photoelectron background were produced separately. Some samples of the data products produced by ARC are shown in the Appendix B.

ARC, in collaboration with Dr. V. Troitskaia, investigated the correlation between the various types of auroral electron precipitation and geomagnetic micropulsations. A paper on the search for hydromagnetic wave signatures in the polar regions was presented at the 1991 IAGA Meeting in Vienna, Austria (see abstract in Appendix A).

ARC continued with the study of relationships of the Interplanetary Magnetic Fields (IMF) (with B_Z positive) with the Earth's magnetosphere and ionosphere in collaboration with Ms. K. Kawan. We assisted with the preparation of a poster presentation at the 1991 IAGA meeting by Dr. R. A. Hoffman, entitled "Hemispherical quiescence as a function of the IMF B_X direction during periods of B_Z positive." ARC matched times of IMP-J magnetic field data segments with the Spin-scan Auroral Imager (SAI) instrument instruction file.

In order to verify the empirical linear energy-temperature relationship of inverted-V events, ARC considered the effects of the particle detector response on the measured fluxes. We investigated mathematical procedures for deconvolving the instrument response (as a function of energy) from the telemetered data from the LAPI particle instrument. ARC updated the model for simulating particle distribution functions. We fit the inverted-V primary beams with a Gaussian function and calculated the current carried by just the beam. We updated the model for simulating particle distribution functions; in particular, by fitting the inverted-V primary beams with a Maxwellian distribution to determine the temperature of the generation region.

3 DE PROJECT SUPPORT (Task Assignment 2)

General support was provided to the DE Project, particularly in assistance to the project investigators. This support consisted primarily of the production of graphics for the display of results of individual scientific analyses and studies concerning the DE Science Team as a whole. ARC supported the DE Science Team meetings and prepared materials for presentations.

ARC also performed many specialized computer tasks, such as transferring word processing files between computers and producing data files in various formats for DE collaborators.

Due to the multi-instrument and the two-spacecraft nature of the DE Project, summary plot microfiche were produced to summarize the DE data; providing easy, comprehensive searching for physical events at a glance, and also providing a way to monitor the health of the spacecraft and instruments. Therefore, good quality summary plots are essential. ARC continued monitoring the DE Summary Plot microfiche data and production quality. The microfiche were screened for quality and data integrity that meet the requirements determined by the Technical Officer. All problems and defects were documented on the DE SPP Data and Telemetry Inspection Forms, designed by ARC in 1985. Problems involving production quality were relayed to the micrographics staff, where the microfiche are generated.

ARC examined 566 DE-1 and 134 DE-2 summary plot microfiche (primarily for telemetry segments that have been recently recovered) for production and data quality and most were marked for poor production quality or data problems. The four microfiche sets were catalogued and missing fiche were replaced in the complete sets. We prepared the extra sets of the DE summary plot microfiche for shipping to other institutions.

We thoroughly checked the decompression algorithm for the HAPI/LAPI telemetered counts and the formula for computing the pitch angles. We also reviewed the files on the Sigma-9 and secured the orbit-attitude software before the Sigma-9 computer is decommissioned. We also reviewed the previous programs for computing currents from the LAPI data and wrote a new, faster, and more accurate routine. This current program was first used to compute currents at the centers of the events in the old inverted-V database and plotted versus peak energy. Several routines were developed in IDL for use in our analyses, including routines to draw a line of vector arrows, put legends on plots, plot with even scales for the X and Y axes, and to read the DE Orbit Attitude database.

4 CHEMICAL RELEASE OBSERVATIONS SUPPORT (Task Assignment 3)

ARC returned in February to the Cerro Tololo InterAmerican Observatory in Chile to complete the Combined Release and Radiation Effects Satellite (CRRES) experiments begun in January. The following equipment was moved from the warehouse to Pencoya (the old director's house) on the side of the mountain below the telescopes and setup and tested:

2 Nikon cameras with motorized film backs
2 K-46 reconnaissance cameras
Automax movie camera with a Night Invader intensifier
Scanco intensified video camera and 2 video recorders
Photometrics CCD camera system with a Night Invader intensifier

The following experiments were observed:

G2 Ba	1991 Jan 13 02:17 UT for about 40 min
G7 Li	1991 Jan 13 07:05 UT for about 20 min
G3 Ba	1991 Jan 15 04:11 UT for about 35 min
G4 Ba	1991 Jan 16 06:25 UT for about 60 min
G5 Li	1991 Jan 18 05:20 UT for about 20 min
G10 Ba	1991 Jan 20 05:30 UT for about 90 min
G6 Li	1991 Feb 12 04:15 UT for about 20 min
G8 Ba	1991 Feb 17 03:30 UT for about 80 min

After returning from Chile, ARC prepared for the next CRRES expedition in July. We also visited Grand Turk in the British West Indies to investigate an additional possible site for the July CRRES campaign.

ARC setup and operated an observing station as part of the low altitude Combined Release and Radiation Effects Satellite (CRRES) Program near Porto Alegre, Brazil with the help of Mr. Michael Black of STx, Inc. The observing station was at the Estação Experimental Agronômica of the Universidade Federal do Rio Grande do Sul (UFRGS). The assistance of Prof. Jorge Ducati of UFRGS was invaluable for site arrangements and shipping the equipment in and out of Brazil. A shed was constructed to hold the cameras and other observing equipment. The experiments on July 13, 19, 22, and 25 were tracked but no Barium was detected due to weather and insufficient travel of the ions along the magnetic field lines. Communications were difficult due to the radio phone at the station and the cold weather. We repaired the CCD tape drive and a short in the Nikon power cable, and arranged for shipping of the equipment back from Brazil.

5 VLF EMISSIONS AND PLASMA INSTABILITY STUDIES (Task Assignment 4)

ARC collaborated with Dr. K. Maeda in studying the VLF ion cyclotron harmonic emissions and absorption bands associated with saucer emissions observed in the nightside polar magnetosphere/ionosphere. The frequency dependence and the asymmetry of the band features with respect to the center of the saucer emissions were modeled in terms of Doppler shifts due to the spacecraft and plasma motions.

To facilitate the investigation of the terrestrial VLF generation, ARC formulated a versatile model particle distribution function containing beam, ring, temperature anisotropy and loss cone features to study various medium and low frequency plasma instabilities. We developed contour and surface plot routines to display the distribution function model.

6 MODELING OF PLANETARY RADIO EMISSION (Task Assignment 5)

ARC continued working with Dr. A. F. Vinas (Code 692) to develop the theory of the electron cyclotron maser with a modified loss-cone distribution due to the presence of a parallel potential drop. We explored an alternate algorithm of the computer code for the numerical calculations of the cyclotron maser instability growth rate. Analytical calculations were carried out to facilitate renormalization.

ARC revised the algorithm for the numerical calculation of the electron cyclotron maser instability growth rate. Numerical results will be incorporated in a paper to be submitted to the JGR. The computer code is operational and running on both the NSSDC Vax 8650 and LEPVX2. Steps were made to optimize the code; however it remains so computationally intensive that full scale search in parameter space for instability is still laborious. Emission signatures generated by a loss-cone distribution and the effects of parallel potential drops on the loss-cone distribution were implemented. These will be compared to that excited by a DGH distribution.

ARC met weekly with Drs. J. Thieman and J. Green of Code 930 to analyze the data on Striated Spectral Activity (SSA)-like events observed by the Voyager and DE spacecraft. We investigated the fine structure features appearing in the radio spectra of planets in terms of the cyclotron maser and the nonlinear wave-wave interaction models. A ray-tracing program was adapted and modified in order to investigate the role of propagation effects in the generation of the fine structure characteristics. The radio wave tracings were plotted using interactive 3-dimensional techniques on a Silicon Graphics Personal Iris workstation, along with model magnetic field lines and plasma parameters surrounding the planet.

ARC continued working with Drs. J. Green and J. Thieman on the fine structure of the Jovian kilometric radiation (KOM) and the "lane events" in the hectometric radiation (HOM) observed by the Voyager spacecraft. We completed the paper, "Lane features in Jovian hectometric radio emissions," to be published in the *Proceedings of the 3rd Meeting on Planetary Radio Emissions*. We created a catalog of the Voyager 1,2 Planetary Radio Astronomy (PRA) 6 second data that is stored on the IBM 3081 computer system.

ARC continued studying the physics relevant to a magnetospheric sounder. A paper on the conceptual magnetospheric sounder is being prepared for submission to the *Journal of Geophysical Research*.

7 RECOMMENDATIONS

The following suggestions are included for future consideration.

- The DE 1 and 2 spacecraft provide unique opportunities to study the relationship between magnetospheric and ionospheric plasma phenomena occurring at different altitudes along common magnetic field lines. We should continue to explore possible correlations observed by the two satellites near magnetic conjunctions. Furthermore, due to different orbital configurations and spatial coverages of the DE and ISEE spacecraft, the magnetic conjunction study should be extended to include the ISEE spacecraft.

- In order to lend confidence in the velocity-space distribution function graphics in development, ARC recommends that the problems associated with the cross-calibration of the LAPI detectors by looking at the photoelectron background during spinning passes be investigated and resolved.

- ARC recommends that the inverted-V database be continually updated and expanded. This will eventually evolve to a catalog of inverted-V events for future analyses.

- In anticipation of large scale computations associated with theoretical modeling, ARC recommends that possible access to high-speed supercomputers be explored.

Appendix A

Abstracts

Staircase Ion Signature in the Polar Cusp: A Case Study

C P Escoubet*, M F Smith, S F Fung** and R A Hoffman (Laboratory for Extraterrestrial Physics, NASA/Goddard Space Flight Center, Code 696, Greenbelt,MD 20771)
Ewa Basinska (Boston University, Center for Space Physics, 725 Commonwealth Avenue, Boston, MA 02215)
J M Bosqued (Centre d'Etude Spatiale des Rayonnements, CNRS/UPS B. P. 4346, 31029 Toulouse Cedex, France)

Observations of ion energy dispersion are a common feature of the polar cusp. Occasionally ion precipitation does not show a continuous decrease in energy but rather several steps of different energy, similar to a staircase profile. On 15 October 1981, Dynamics Explorer 2 crossed the polar cusp at 1015 MLT and observed three distinct ion populations of different energies. These three populations with energies of 3 keV, 1 keV and 0.3 keV were detected successively as the spacecraft moved poleward. The width in latitude of each population was approximately 50 km. The center of each ion population was associated with a westward convection while the boundaries were associated with an eastward convection. At the time of observation, both the IMF Bz and By components were negative. Implications of these results for multiple sources of solar wind particles will be discussed.

* supported by CNES (France)

** Atlantic Research Corp., 8201 Corporate Dr., Landover, Maryland 20785

1. 1991 Spring Meeting
2. 010647393
3. (a) C. P. Escoubet
   NASA/GSFC
   Code 696
   Greenbelt, MD 20771
   (b) 301-286-6301
4. SM(Magnetospheric Physics)
5. (a) SM02 GEM
   (b) 2724 Magnetopause, cusp, and boundary layer
   2760 Plasma convection
   (c)
6. Oral
7. 0%
8. (a) Code 690
   NASA/GSFC
   Greenbelt, MD 20771
   (b) S- -D, Call #
9. C
10. None
11. NA

SEARCH FOR HYDROMAGNETIC WAVE SIGNATURES IN SATELLITE MEASUREMENTS NEAR THE POLAR REGIONS

V. A. Troitskaya, S. P. McCarthy, T. L. Aggson, S. F. Fung, W. R. Hoegy, M. C. Liebrecht, Laboratory for Extraterrestrial Physics, NASA GSFC

Two types of short period irregular ULF-waves (Pi1c and Pi1b) are commonly observed on the ground in regions magnetically connected to the polar cusp and auroral zones. We attempt here to relate these ground observations to in-situ field measurements of $\vec{E}$ and $\vec{B}$ onboard the Dynamics Explorer (DE) 2 spacecraft in the lower ionosphere. Assuming that the wave signals are coherent within the satellite traversal of the region where the pulsations are observed, the perturbation magnetic and electric field data are filtered for the frequency range typical for these pulsations. We will discuss the observed correlations between the ground-based magnetometer and the satellite particle and field measurements. Results from a study of these field fluctuations in the ionosphere as a function of the scale size and energy of the current carrier of the associated field-aligned currents as well as their relation to the electron density fluctuations will also be presented.

TROITSKAYA, Valeria Alexeevna, (1) Laboratory for Extra-terrestrial Physics, NASA Goddard Space Flight Center, Code 696, Greenbelt, MD 20771, USA, FAX: 301-286-9240, TEL: 301-286-2452; *(2) Permanent Address: Physics Department, La Trobe University, Bundoora, Victoria, Australia 3083.

Symposium GAM 3.1 - "ULF-MHD Waves: Transport and Excitation"

Presentation - Oral

Slide and Overhead Projectors

Lane Features in Jovian Hectometric Radio Emission

J. R. Thieman, J. L. Green
Code 930, NASA/GSFC/NSSDC
Greenbelt, MD 20771

L. Aist-Sagara
ST Systems
Lanham, MD 20706

S. F Fung & R. M. Candey
Atlantic Research Corporation
Landover, MD 20785

Observations of hectometric radio emission (HOM) by the Planetary Radio Astronomy experiment (PRA) aboard the Voyager spacecraft near the encounters of Jupiter show persistent structural features which had not been previously studied. HOM is modulated by the rotation of the planet such that very little is observed when the central meridian longitude is near the longitude of the Northern magnetic dipole, but occurrence probability approaches 100% at other longitudes. The features of interest appear as decreases in the emission intensity within the HOM, as displayed in the spectrograms of frequency versus System III longitude. The features often appear as "lanes" of decreased intensity having well-defined, sloping, linear borders in spectrograms of frequency vs. longitude, and are relatively consistent in their location.

To study the phenomena more closely and enhance the persistent features, calculations of emission occurrence in one-half degree longitude bins were combined for more than 20 rotations before and after the encounters of Voyagers 1 and 2. Emission was determined to have occurred if the intensity at a given longitude and frequency exceeded a calculated background threshold. This technique demonstrates the stability of the lane features. The features may be intrinsic to the source or a phenomenon produced by the media between source and observer. Ray tracing techniques and theoretical approaches are used to determine the feasibility of various explanations.

On the Variation of Field Line Conductance and the Auroral Current-voltage Relationship

Shing F Fung* and R A Hoffman (Laboratory for Extraterrestrial Physics, NASA/Goddard Space Flight Center, Code 696, Greenbelt, MD 20771; (301) 286-6301; SPAN: DE696::ORSFF)

Quasistatic electric potential drops have larg ly been invoked to model the acceleration of charged particles observed along auroral magnetic field lines. Moreover, the magnitudes of these potential drops Φ are generally believed to vary linearly with the associated upward field-aligned current densities J. The proportionality constant K, defined as the field line conductance, also known as the Lyons-Evans-Lundin parameter, is given by $K = J/\Phi$. Kinetic calculations have given a functional dependence of K on the electron plasma density n_s and temperature T_s at the top of the potential structure, $K \propto n_s T_s^{-1/2}$. Thus, K should vary with the changing magnetospheric plasma conditions. Since the auroral potential structure should depend on its upper and lower boundary plasma conditions, K may have at least an implicit Φ dependence. Using 100 inverted-V events observed by the Dynamics Explorer 2 satellite, we determine the Φ dependence of K by fitting a power law through a plot of J_i/Φ_i $(= K_i)$ as a function of Φ_i of all the events. A new empirical auroral field-aligned current-voltage relationship of the form $J = \Sigma\Phi^{\alpha}$ with constants Σ and α can then be formulated, showing a net Φ dependence of J. This generalized relationship is compatible with both the linear relationship $J = K\Phi$, which tends to hold across an auroral arc, and the observed arc-to-arc variation of the field line conductance K. In addition, it is easily shown that the auroral potential drop varies with the magnetospheric plasma parameters, $\Phi^{(1-\alpha)} \propto T_s^{1/2} n_s^{-1}$. This suggests that the latitudinal distribution of the primary beam energies of inverted-V events may reflect the latitudinal plasma density and temperature profiles in the high altitude boundary plasma sheet.

* Atlantic Research Corp., 8201 Corporate Dr., Landover, MD 20785

1. Chapman Conference on Auroral Plasma Dynamics, 1991

2. P or O

3. (a) S. F. Fung
NASA/GSFC
Code 696
Greenbelt, MD 20771

(b) 301-286-6301

UNSI
1/7-11/92
U-Q Colorado
Boulder, CO.

PROBING THE MAGNETOSPHERE BY RADIO SOUNDING TECHNIQUES

James L. Green, Shing F. Fung, and James R. Thieman
National Space Science Data Center
Goddard Space Flight Center
Greenbelt, MD 20771

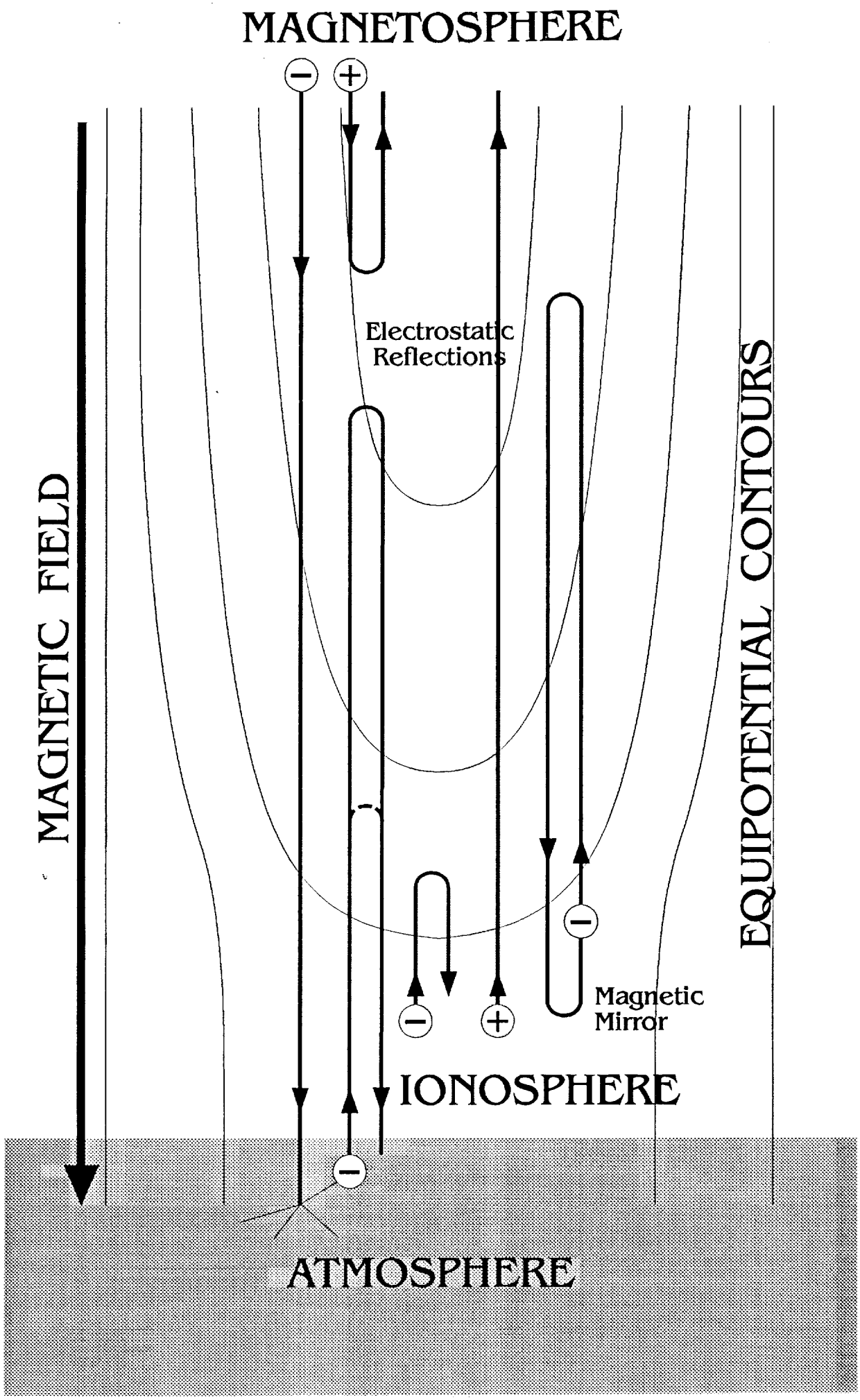
The concept that will be discussed is the viability of a space-based active radio transmitter and receiver, stationed on the moon, which will "sound out" remote magnetospheric plasma regions. It will be assumed that the lunar-based radio frequency transmitters would be designed to generate steerable narrow beams of emissions over a wide frequency range (from 9 kHz to 1 MHz) with R-X and L-O mode "free space" wave polarizations. These signals would be reflected and refracted off magnetospheric structures such as the plasmapause, plasmasheet, magnetopause, and the high and low latitude boundary layer. The frequency range of the sounder will depend on the local lunar ionospheric conditions and the region of the magnetosphere that is targeted to be probed.

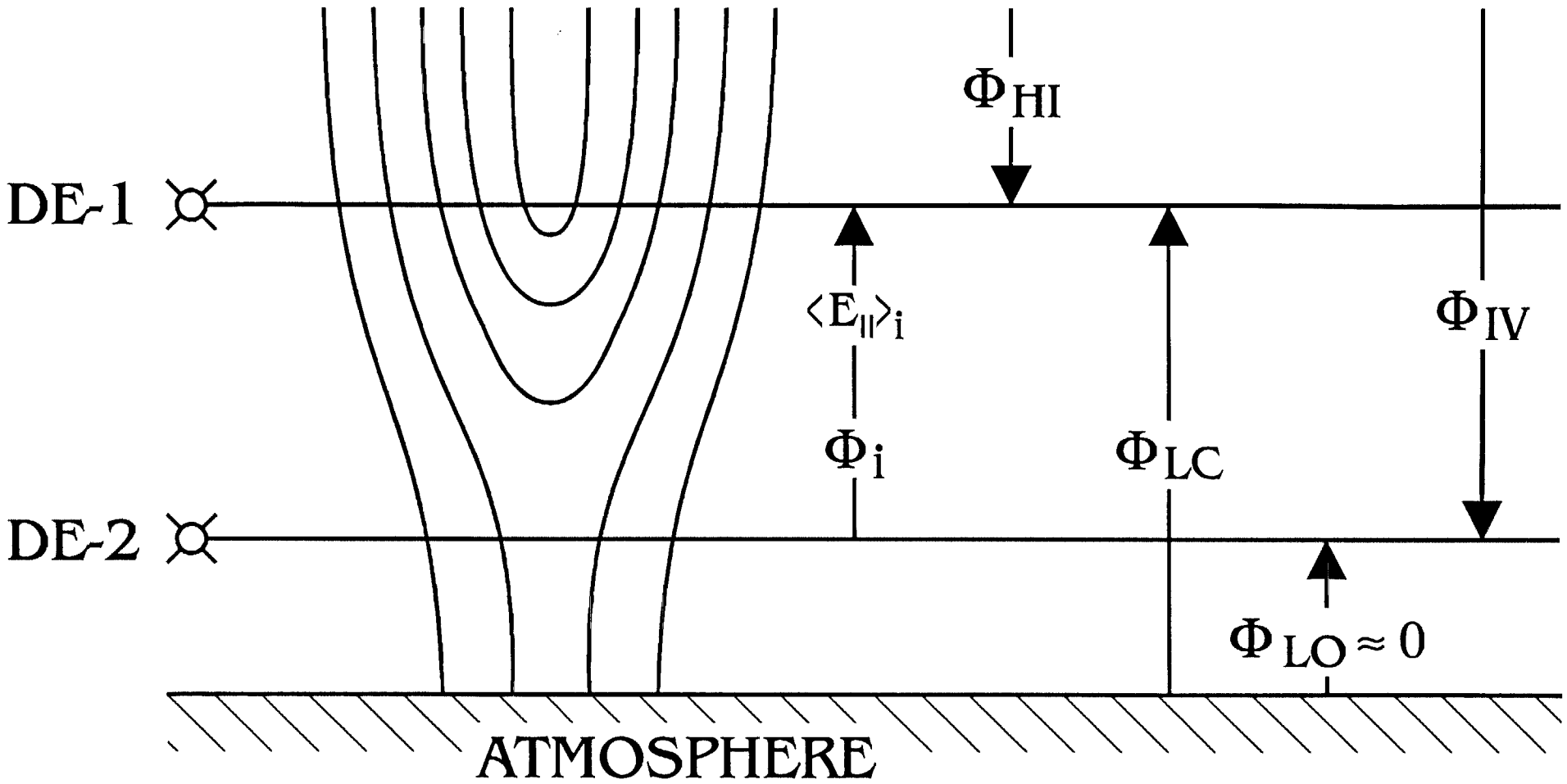
It will be shown, through ray tracing calculations, that several of the magnetospheric plasma regimes can be remotely sensed by using a range of selected discrete frequencies; this technique could then produce a nearly instantaneous picture of the global magnetosphere. In addition, at times when the active radio experiment is in the solar wind, information can be obtained on the density and speed of streams of particles coming toward the Earth.

By way of example, particular emphasis will be placed on the application of the proposed sounding technique to understanding plasmasphere dynamics. By using the lunar-sounder, it is believed that the filling rate, the plasmapause position, the formation and motion of a detached region, and the intensity of local current systems very near the plasmasphere could be accomplished within a few frequency sweeps of the instrument.

Appendix B

Illustrations


MAGNETOSPHERE
MAGNETIC FIELD
Electrostatic
Reflections
EQUIPOTENTIAL CONTOURS
Magnetic
Mirror
IONOSPHERE
ATMOSPHERE

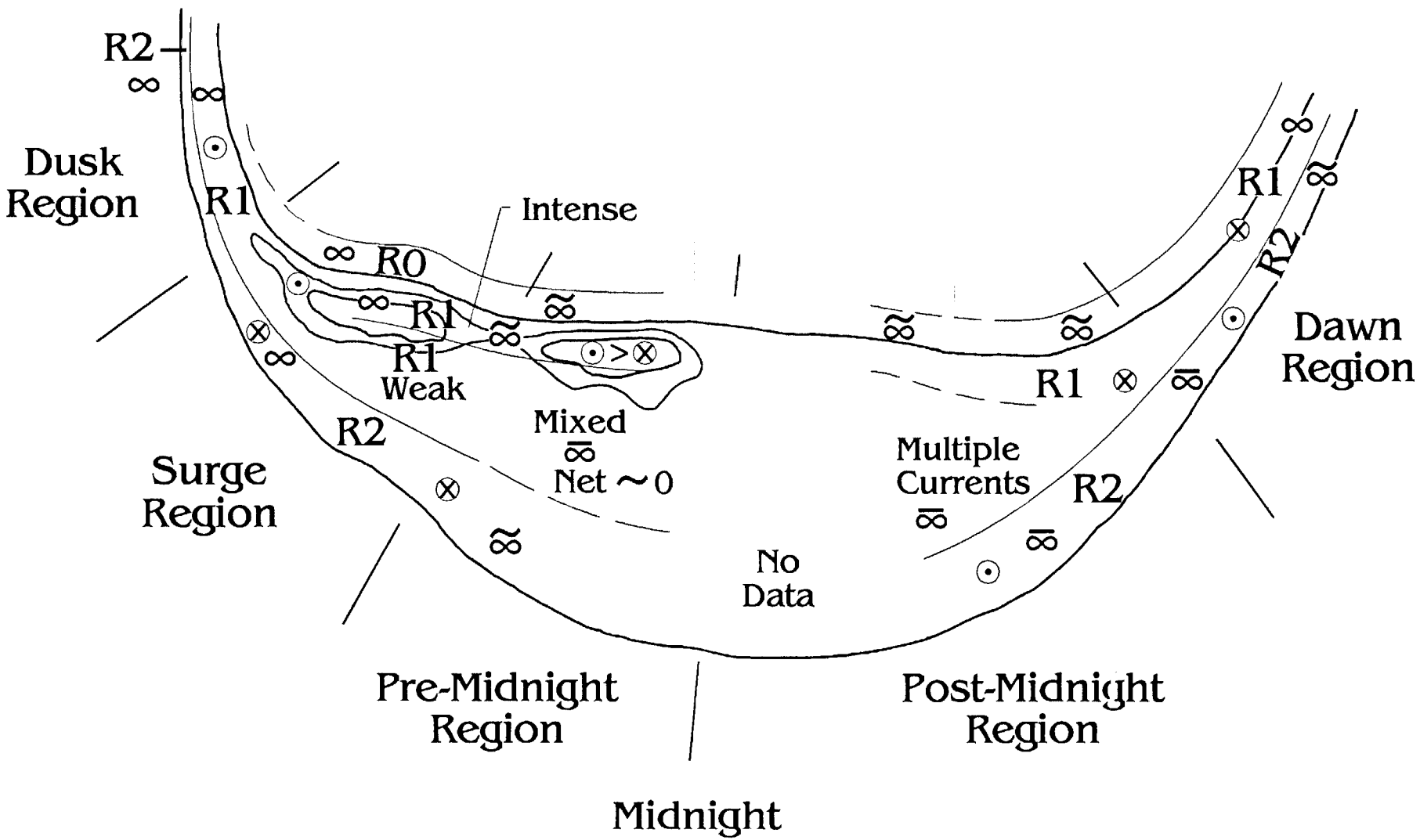

DE-1
DE-2
Φ_{HI}
$\langle E_{II} \rangle_i$
Φ_i
Φ_{LC}
Φ_{IV}
$\Phi_{LO} \approx 0$
ATMOSPHERE

FIELD-ALIGNED CURRENTS

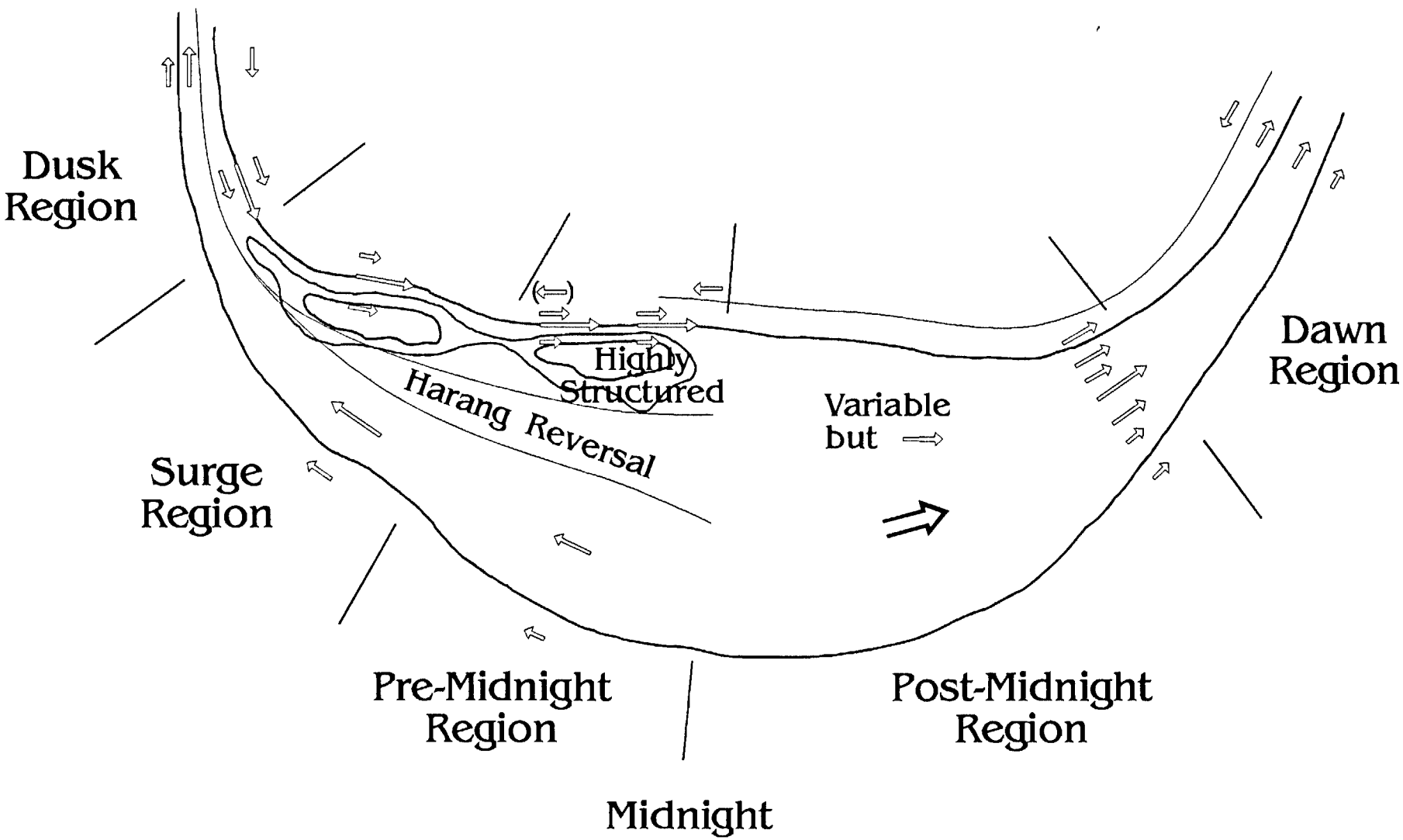
∞ "Infinite" current sheets

≅ Indications of non-infinite sheets

≋ NOT sheet currents--filamentary



CONVECTION


Dusk
Region
Dawn
Region
Highly
Structured
Harang Reversal
Variable
but
Surge
Region
Pre-Midnight
Region
Post-Midnight
Region
Midnight

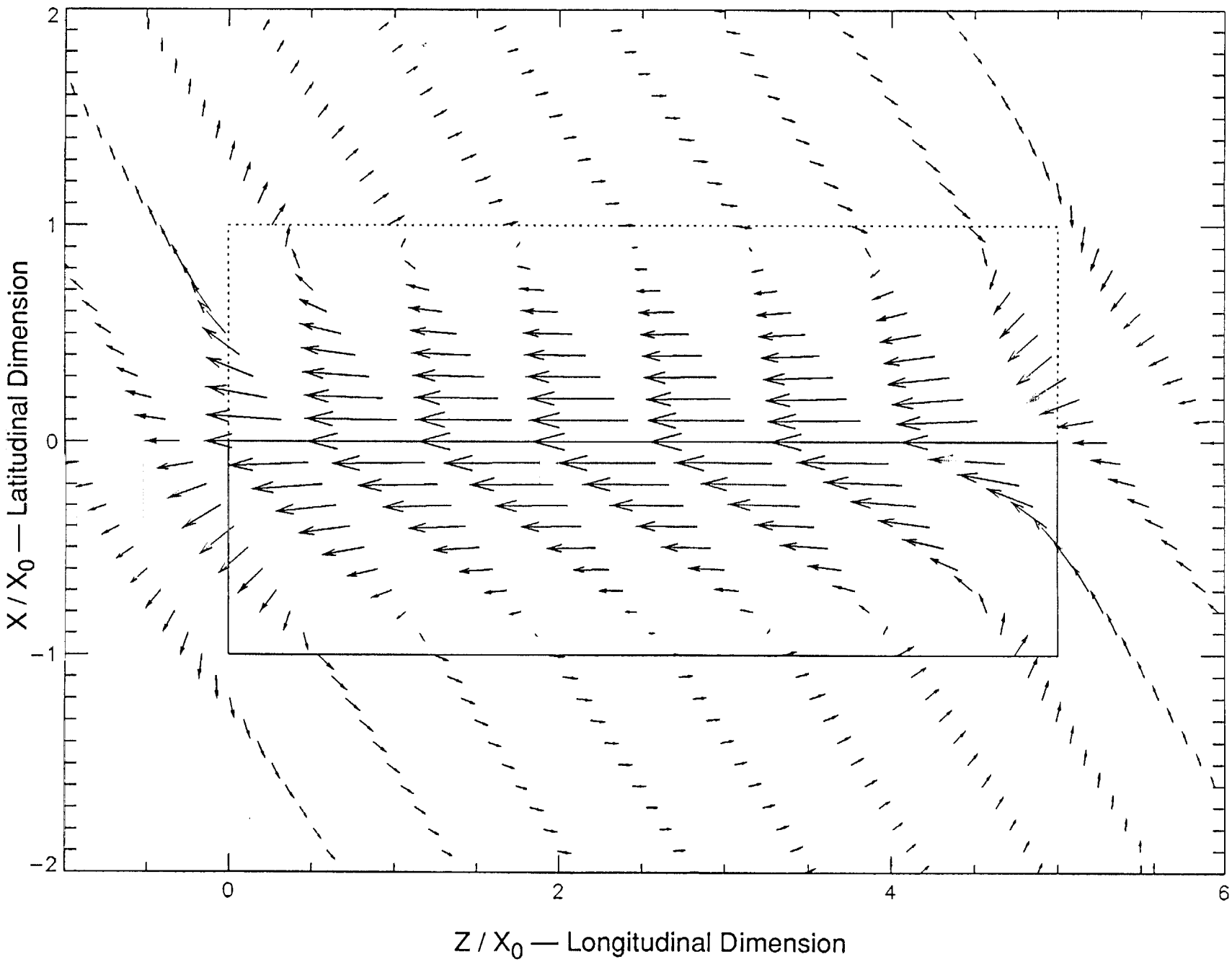
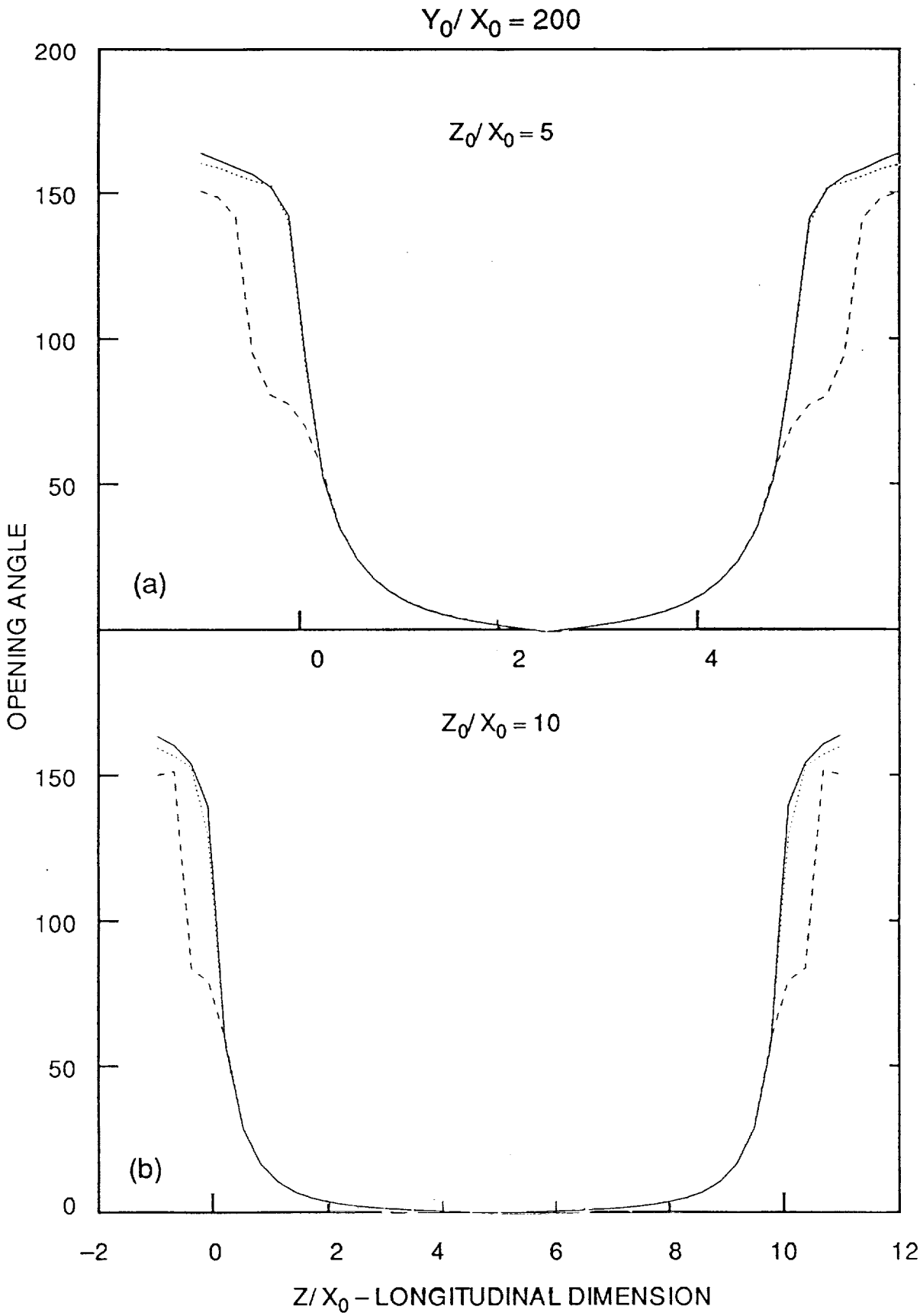
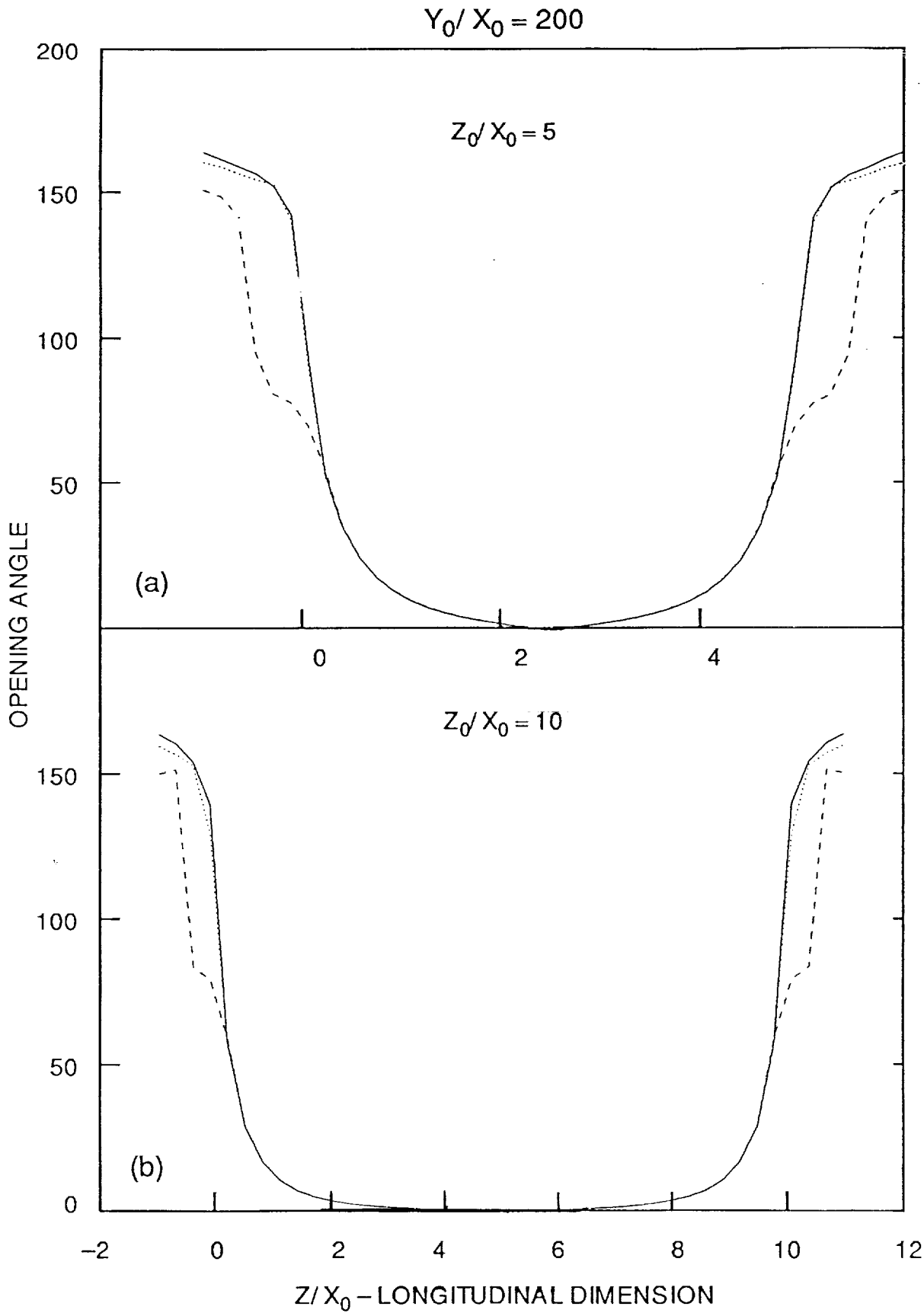

$Z_0 / X_0 = 5$ $Y_0 / X_0 = 200$ $\eta = 40$
X / X_0 — Latitudinal Dimension
Z / X_0 — Longitudinal Dimension
2
1
0
−1
−2
0
2
4
6

Fig 3


$Y_0/X_0 = 200$
$Z_0/X_0 = 5$
(a)
$Z_0/X_0 = 10$
(b)
OPENING ANGLE
200
150
100
50
0
−2
0
2
4
6
8
10
12
Z/X_0 – LONGITUDINAL DIMENSION


$Y_0/X_0 = 200$
$Z_0/X_0 = 5$
(a)
$Z_0/X_0 = 10$
(b)
OPENING ANGLE
200
150
100
50
0
−2
0
2
4
6
8
10
12
Z/X_0 – LONGITUDINAL DIMENSION

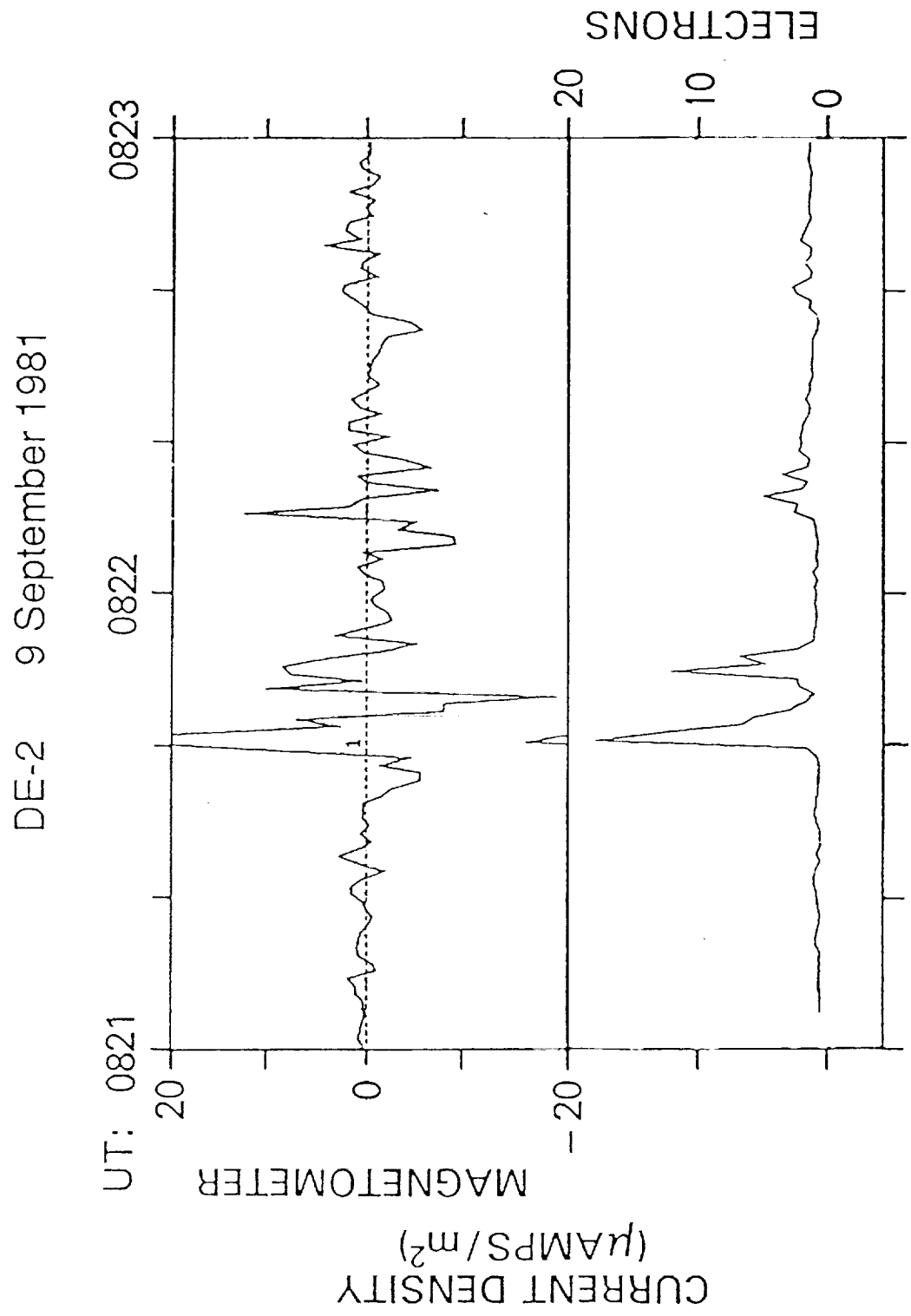

DE-2 9 September 1981
UT: 0821
0822
0823
20
0
−20
MAGNETOMETER
CURRENT DENSITY
(μAMPS/m²)
ELECTRONS
20
10
0

Fig. 1

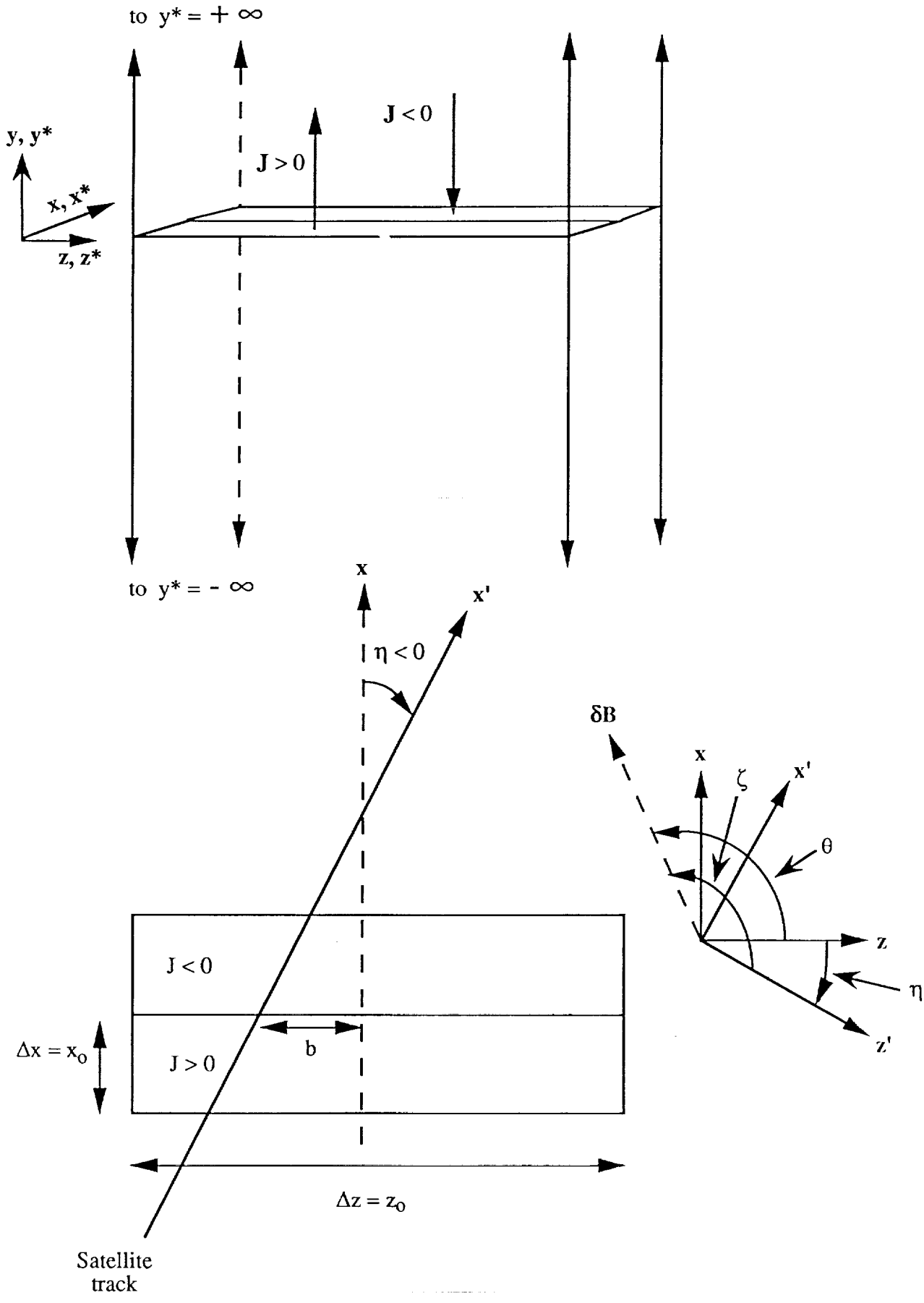
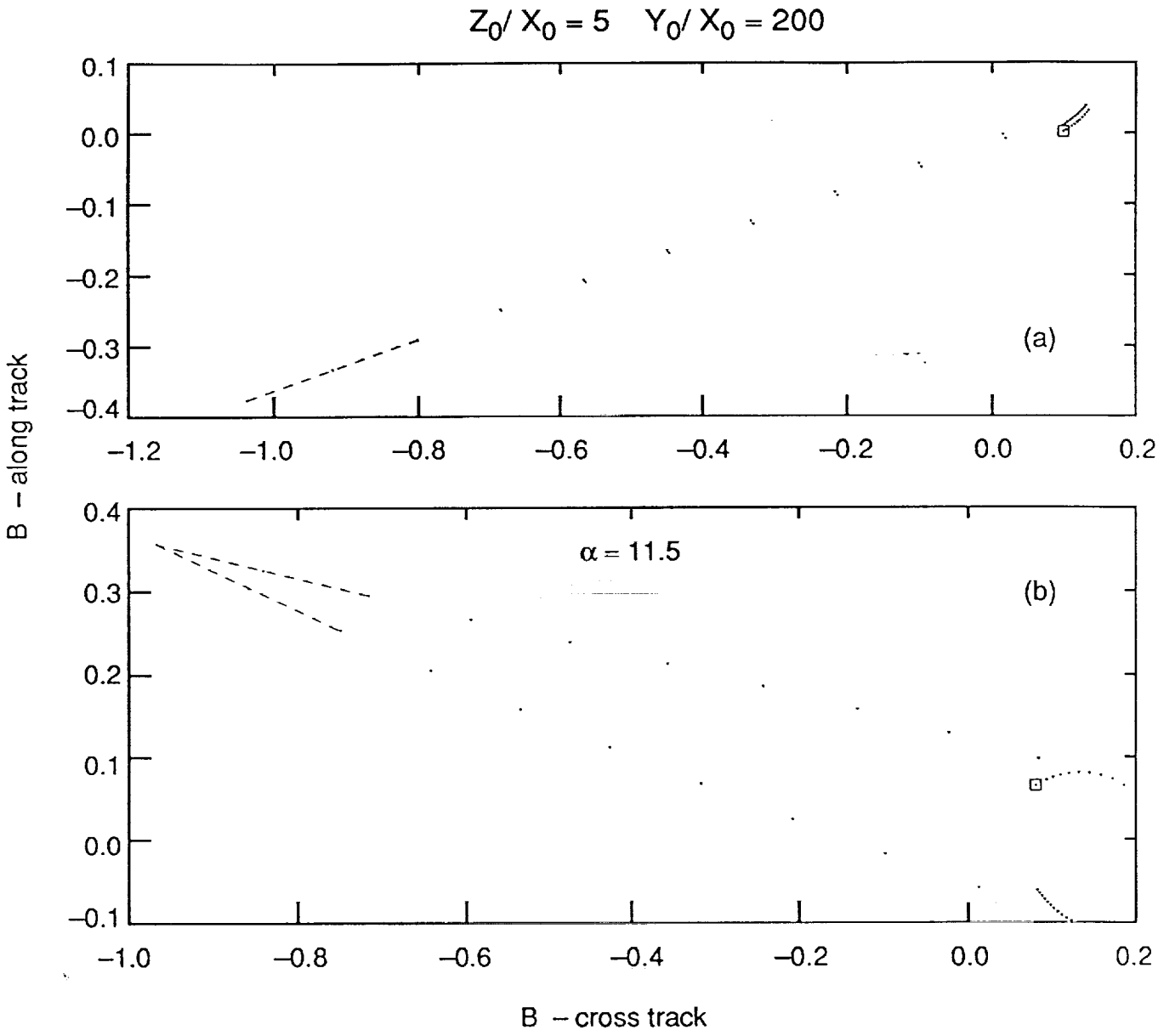
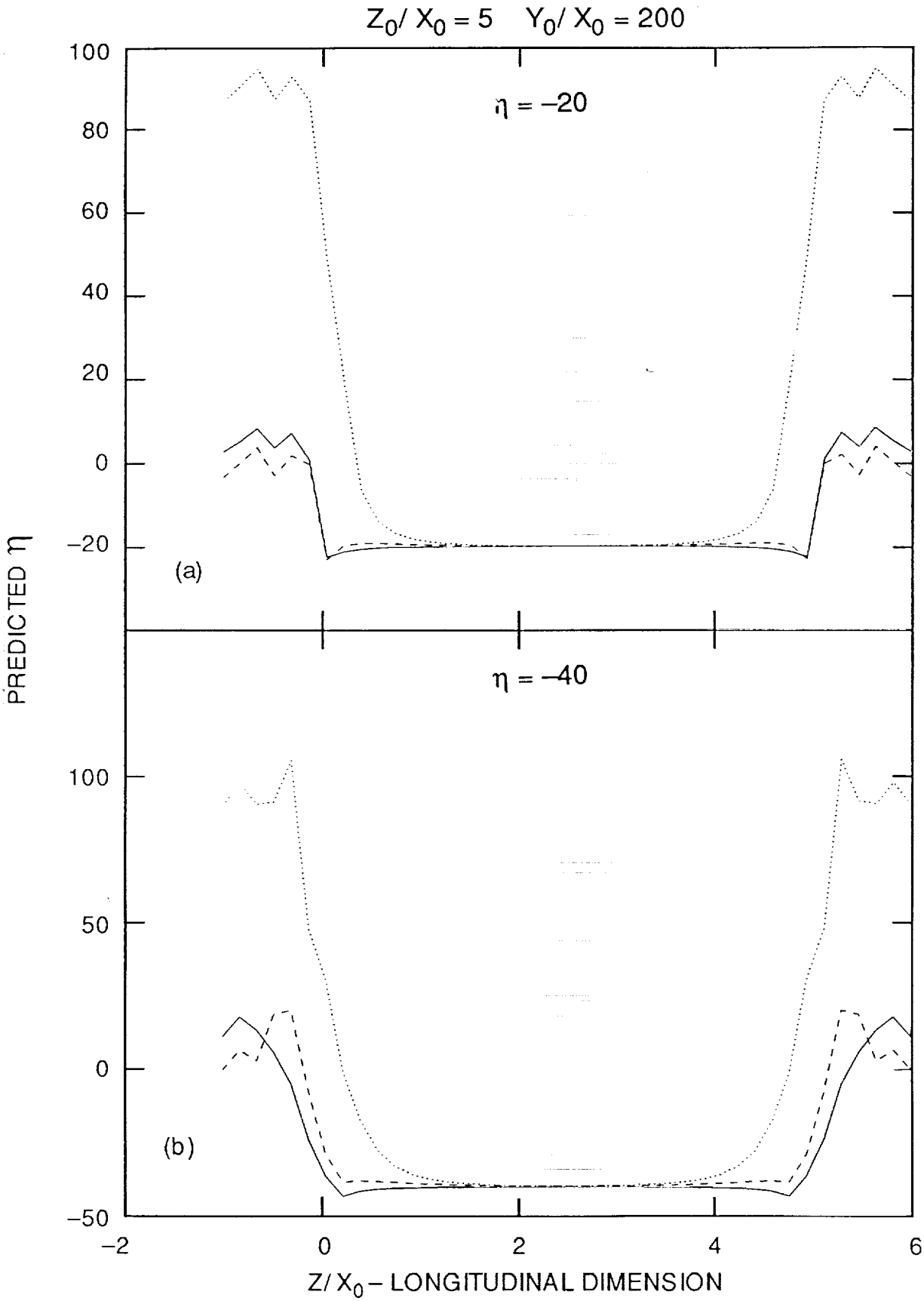

to y* = + ∞
y, y*
x, x*
z, z*
J > 0
J < 0
to y* = - ∞
x
x'
η < 0
δB
x
ζ
x'
θ
z
η
z'
J < 0
J > 0
Δx = x_o
b
Δz = z_o
Satellite track

Fig 2




$Z_0/X_0 = 5$ $Y_0/X_0 = 200$
$\eta = -20$
(a)
$\eta = -40$
(b)
PREDICTED η
100
80
60
40
20
0
−20
100
50
0
−50
−2
0
2
4
6
Z/X_0 – LONGITUDINAL DIMENSION

F.5

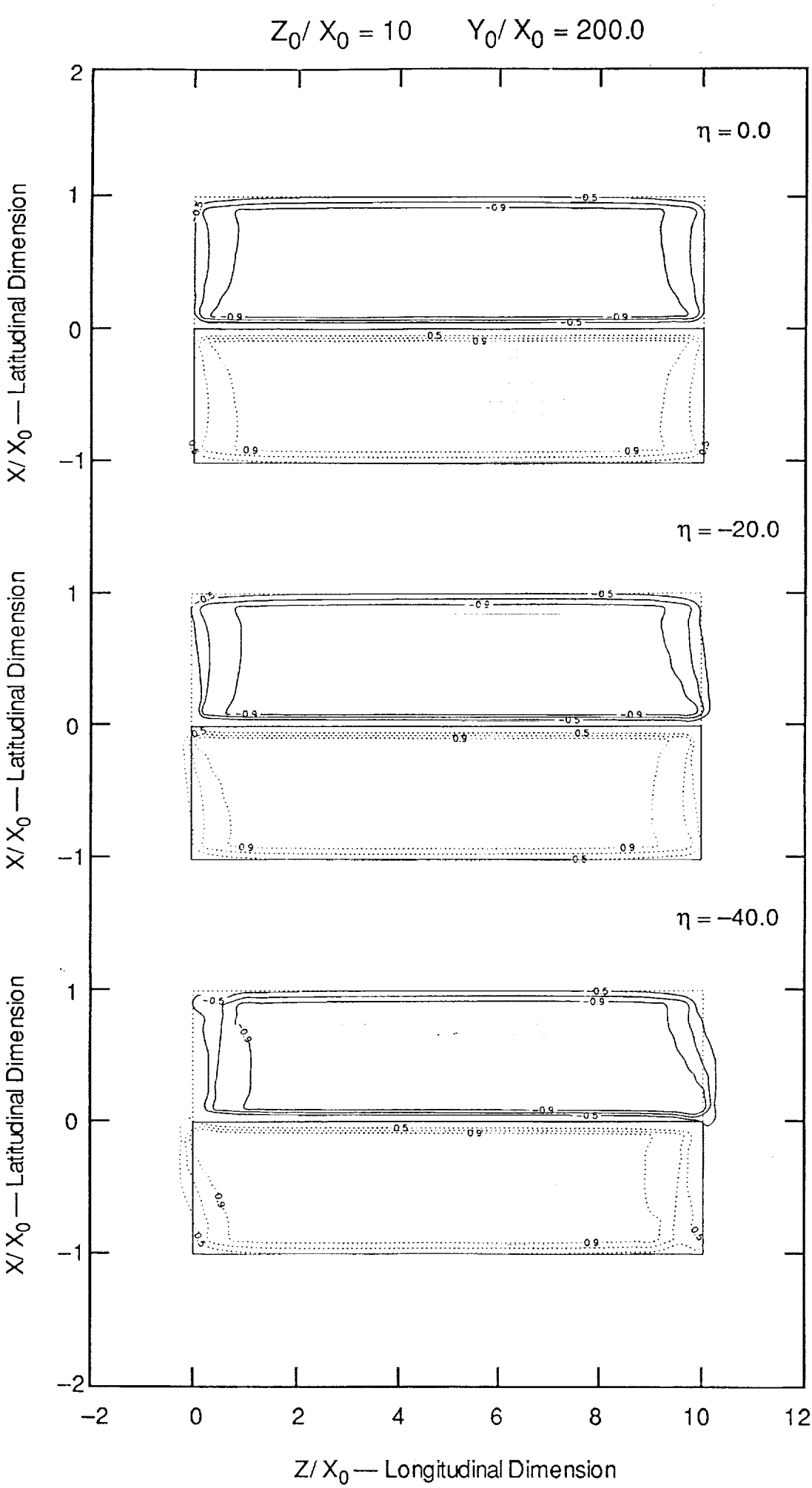
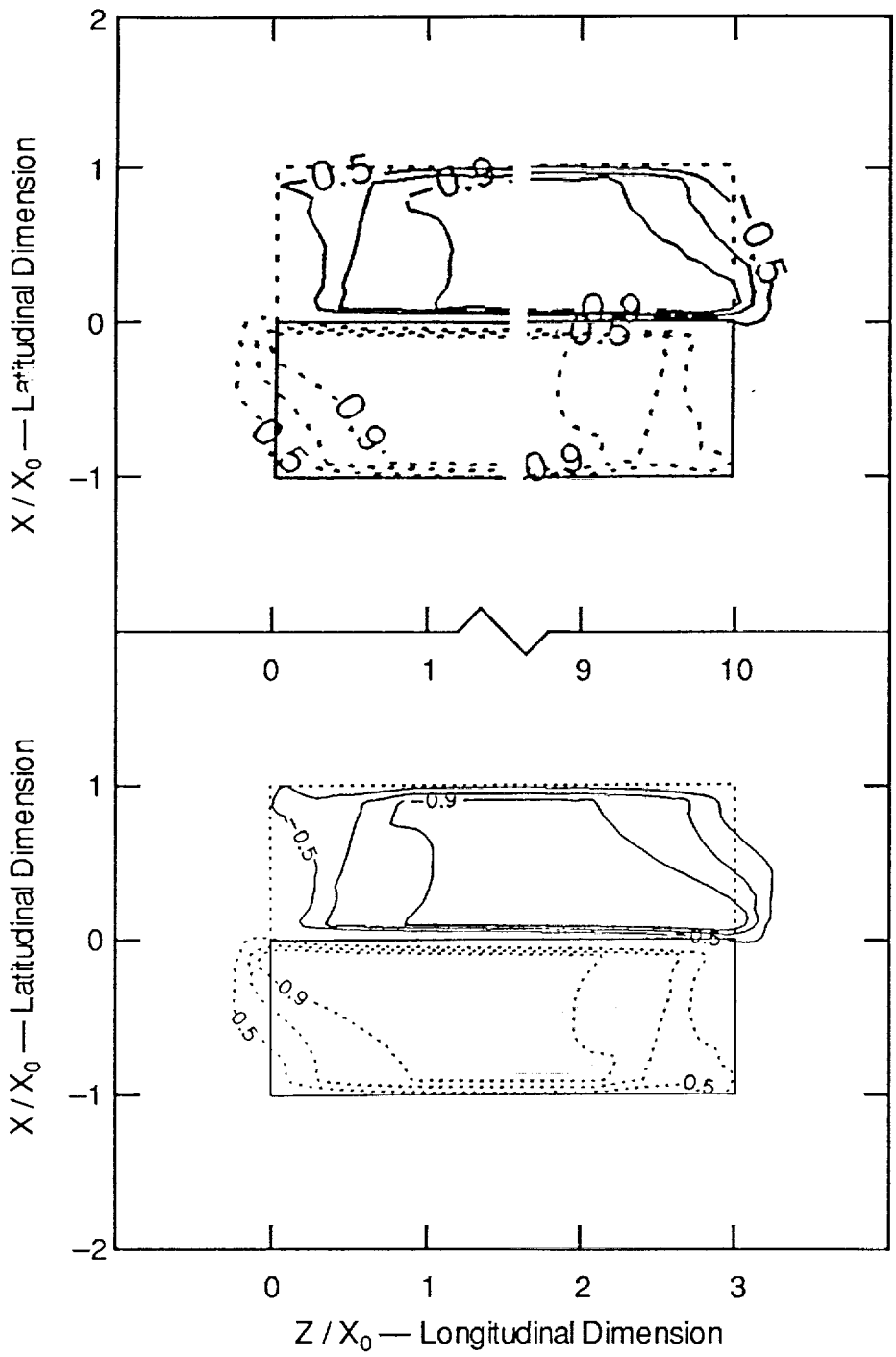

$Z_0/X_0 = 10$ $Y_0/X_0 = 200.0$
$\eta = 0.0$
$\eta = -20.0$
$\eta = -40.0$
X/X_0 — Latitudinal Dimension
Z/X_0 — Longitudinal Dimension
2
1
0
−1
−2
−2
0
2
4
6
8
10
12
0.5
0.9

Fig. 1


$Z_0/X_0 = 3.0$ $Y_0/X_0 = 200.0$ $\eta = -40.0$
X/X_0 — Latitudinal Dimension
Z/X_0 — Longitudinal Dimension
-0.5
-0.9
0.5
0.9

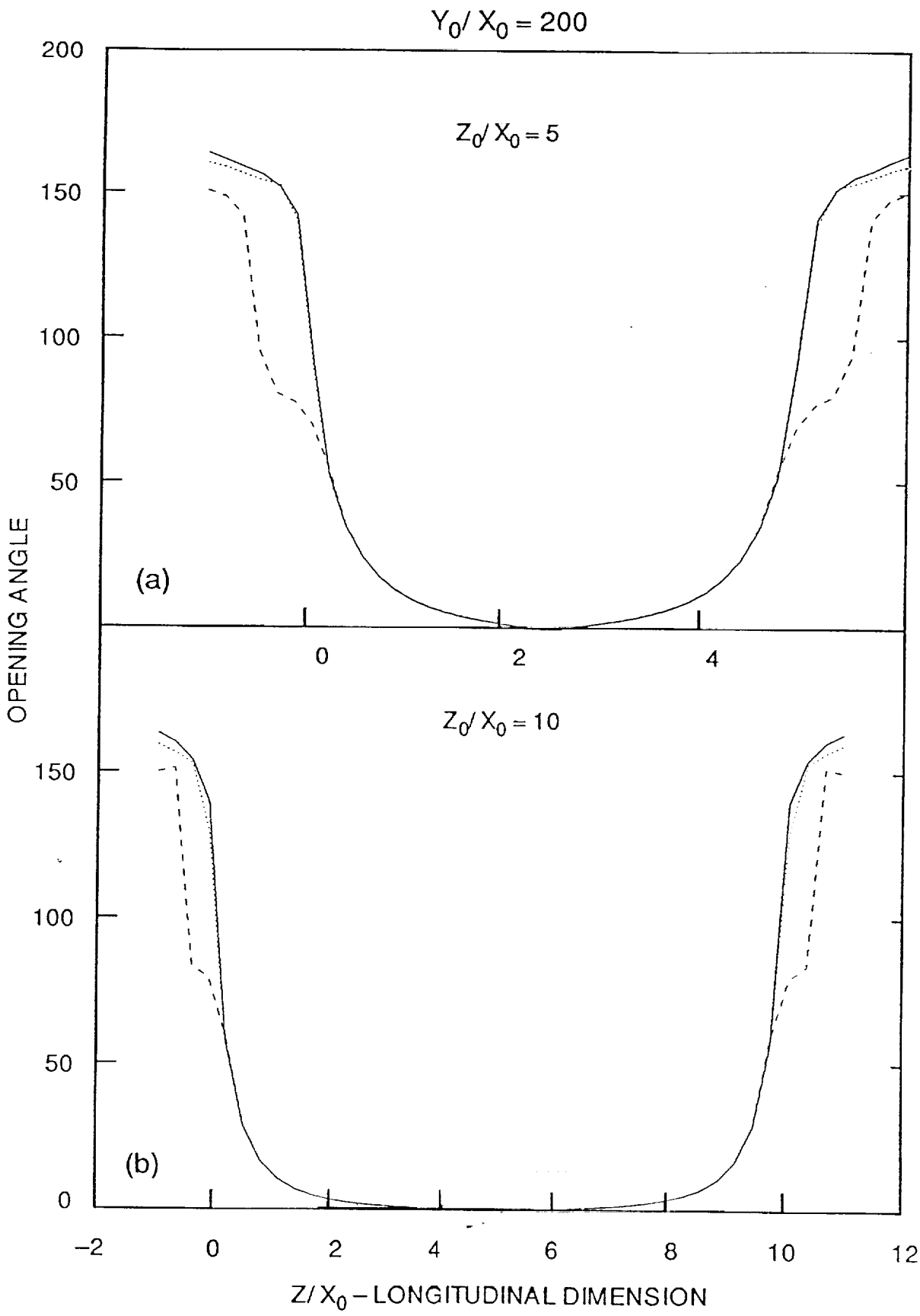
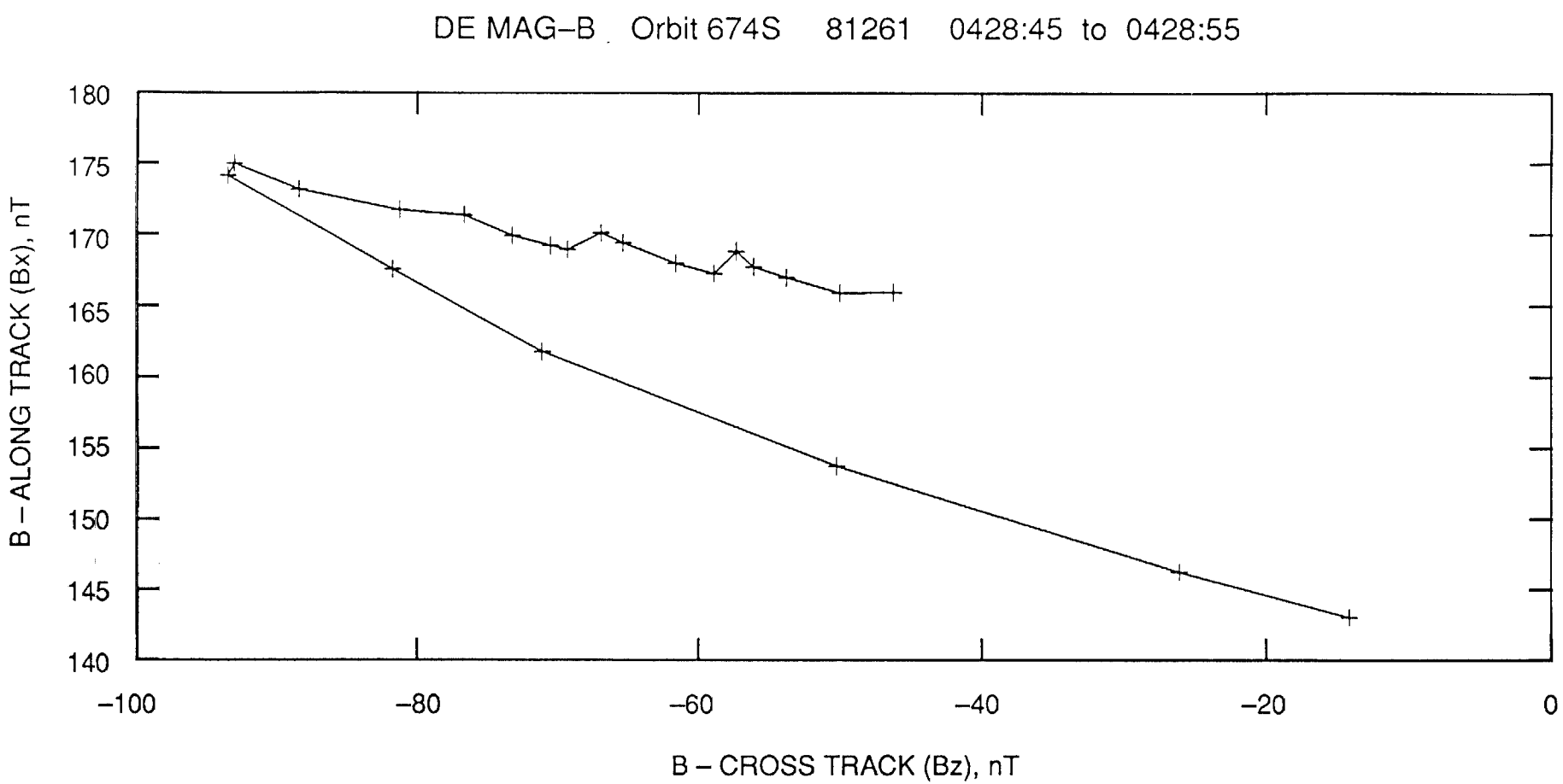

$Y_0/X_0 = 200$
$Z_0/X_0 = 5$
(a)
$Z_0/X_0 = 10$
(b)
OPENING ANGLE
200
150
100
50
0
−2
0
2
4
6
8
10
12
Z/X_0 – LONGITUDINAL DIMENSION

Fig 1


DE MAG–B Orbit 674S 81261 0428:45 to 0428:55
180
175
170
165
160
155
150
145
140
B – ALONG TRACK (Bx), nT
–100
–80
–60
–40
–20
0
B – CROSS TRACK (Bz), nT

Appendix C

Meetings Attended by ARC

DE Science Team Meeting at GSFC, Spring and Fall 1991.

AGU Spring Meeting in Baltimore, MD, May 1991.

1991 Chapman Conference on Auroral Plasma Dynamics in Minneapolis

Abstracts of papers presented at these meetings are included in Appendix A.