SOLAR WIND - MAGNETOSPHERE - IONOSPHERE COUPLING

LECTURE 5

1. SUBSTORMS

AND

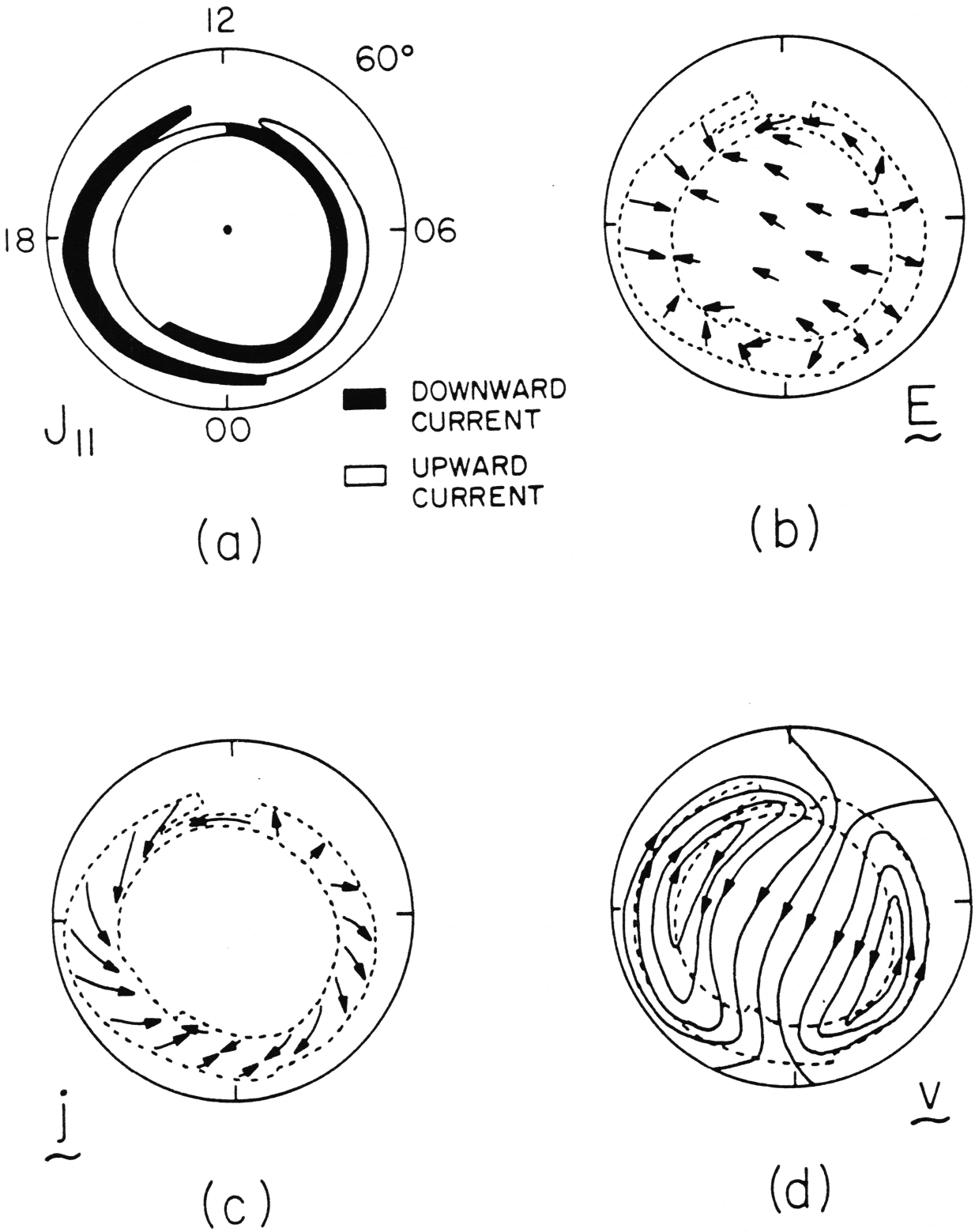
2. SOLAR WIND - MAGNETOSPHERE - IONOSPHERE COUPLING

EXPECT THE UNEXPECTED

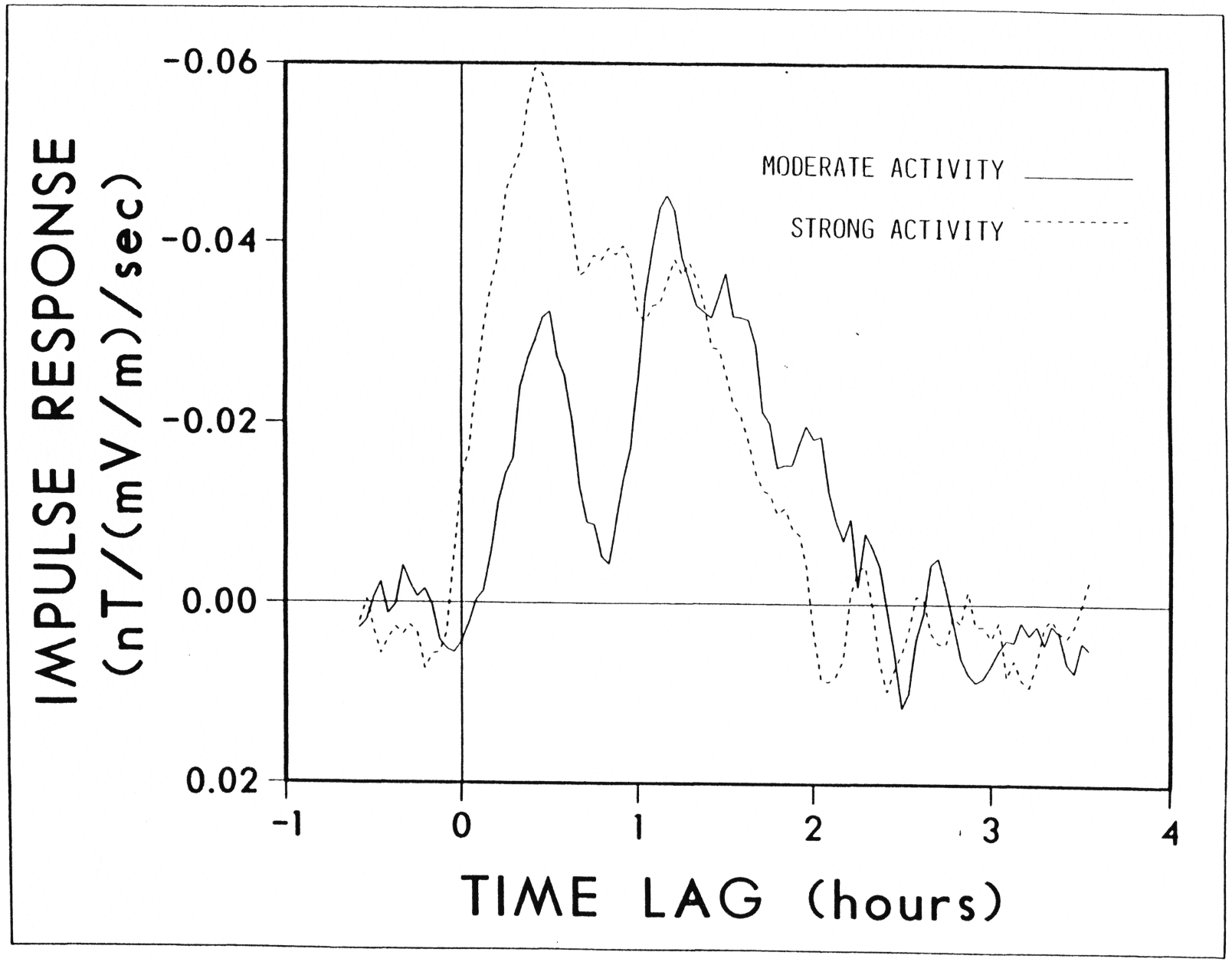
There are more things in heaven and
earth, Horatio,
Than are dreamt of in your philosophy.
Shakespeare - Hamlet, ca. 1600

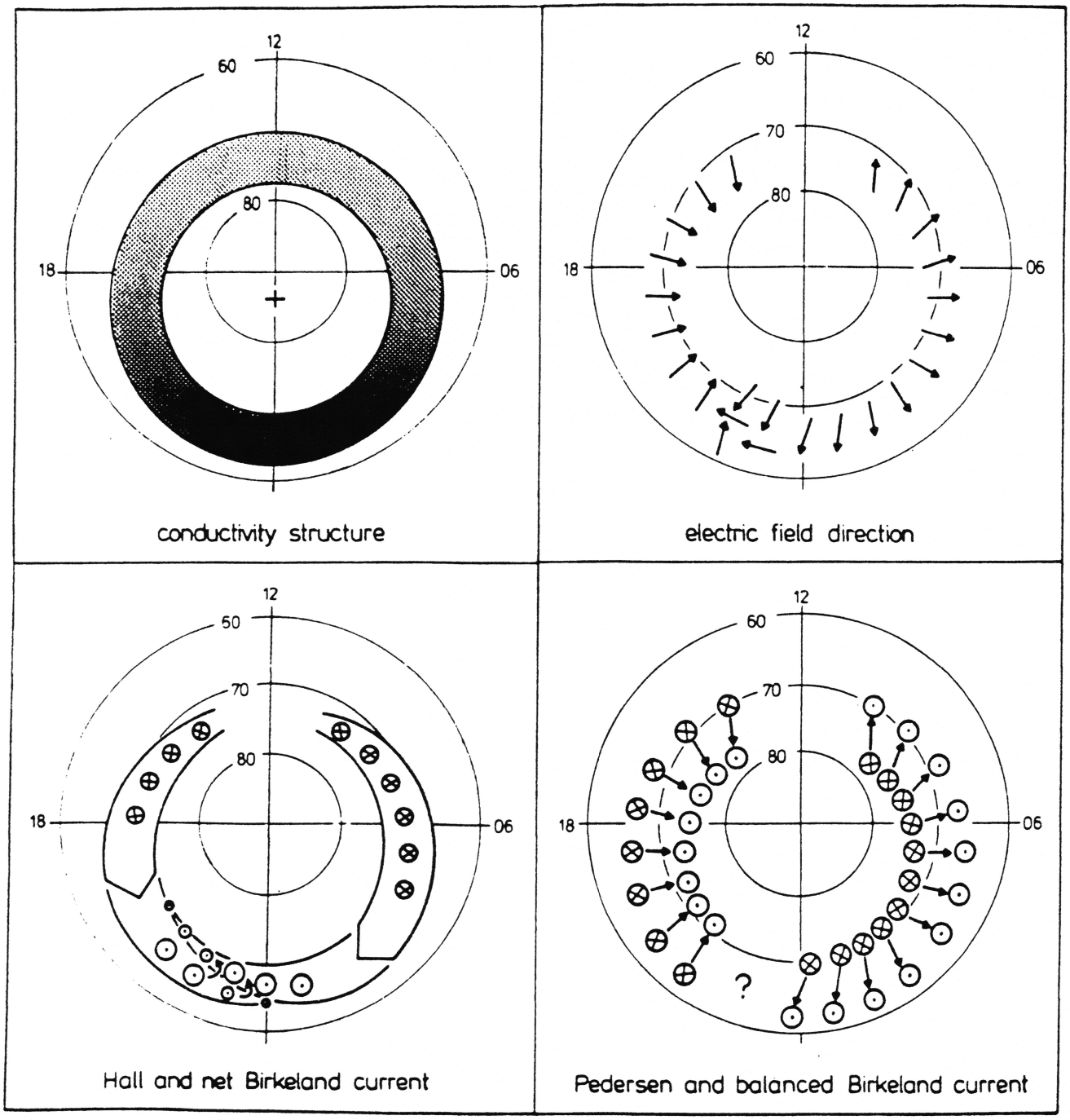
Our age is retrospective. ... The foregoing
generations beheld God and nature face to face;
we through their eyes. Why should not we also
enjoy an original relation to the universe?
Emerson - Nature, 1836

Nature sometimes creates a phenomenon that
is far beyond our imagination. Sato - Formation
of Field-Twisting Flux Tubes on the Magnetopause, 1986



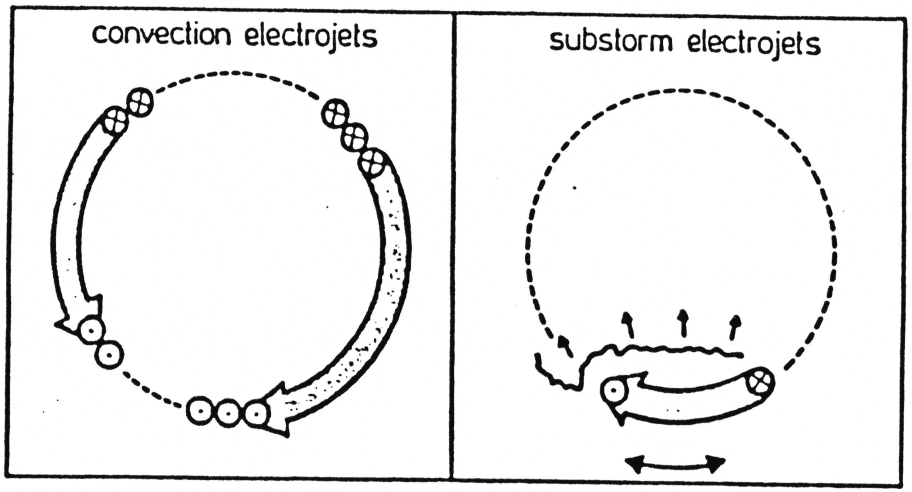
Sketch of the typical patterns of (a) Birkeland current (Iijima and Potemra, 1978), (b) electric fields, (c) horizontal ionospheric current, and (d) $\vec{E}x\vec{B}$-drift velocity. Polar cap currents are not shown.

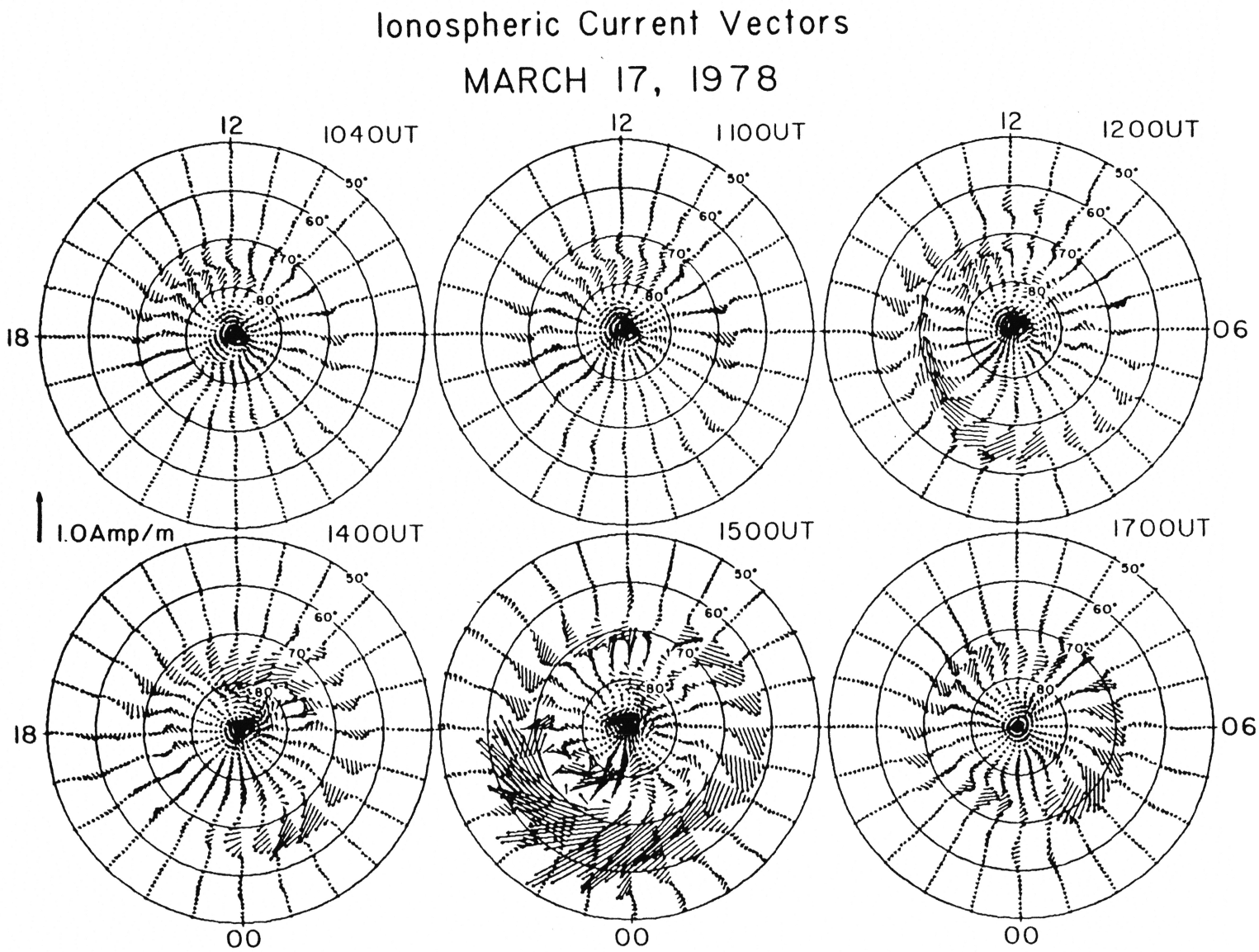

IMPULSE RESPONSE
(nT/(mV/m)/sec)
-0.06
-0.04
-0.02
0.00
0.02
-1
0
1
2
3
4
TIME LAG (hours)
MODERATE ACTIVITY
STRONG ACTIVITY



Schematic diagram of conductivity structure, electric field direction and current flow associated with the auroral electrojet system. Coordinates are invariant latitude and magnetic local time.

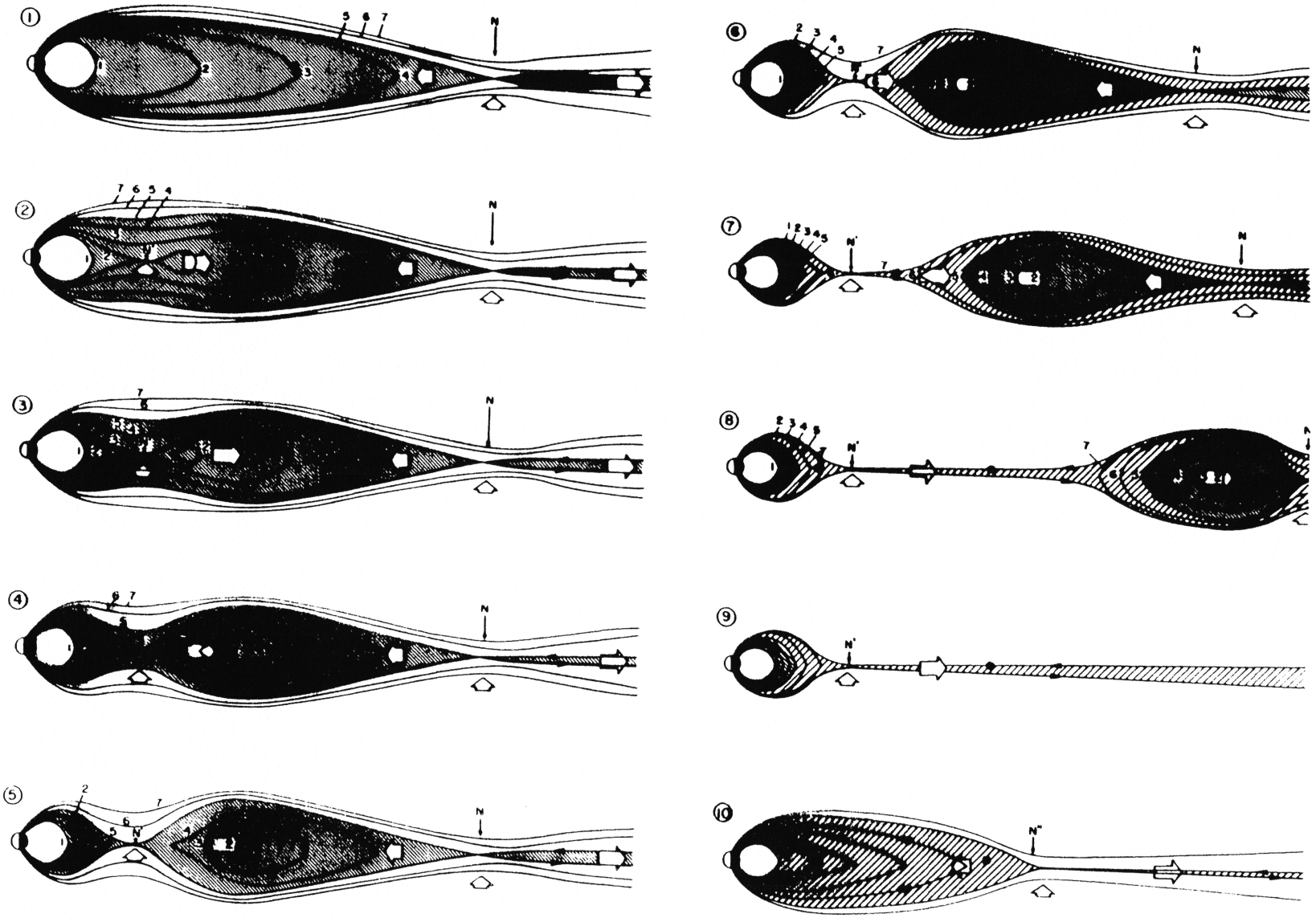
Wolfgang Baumjohann

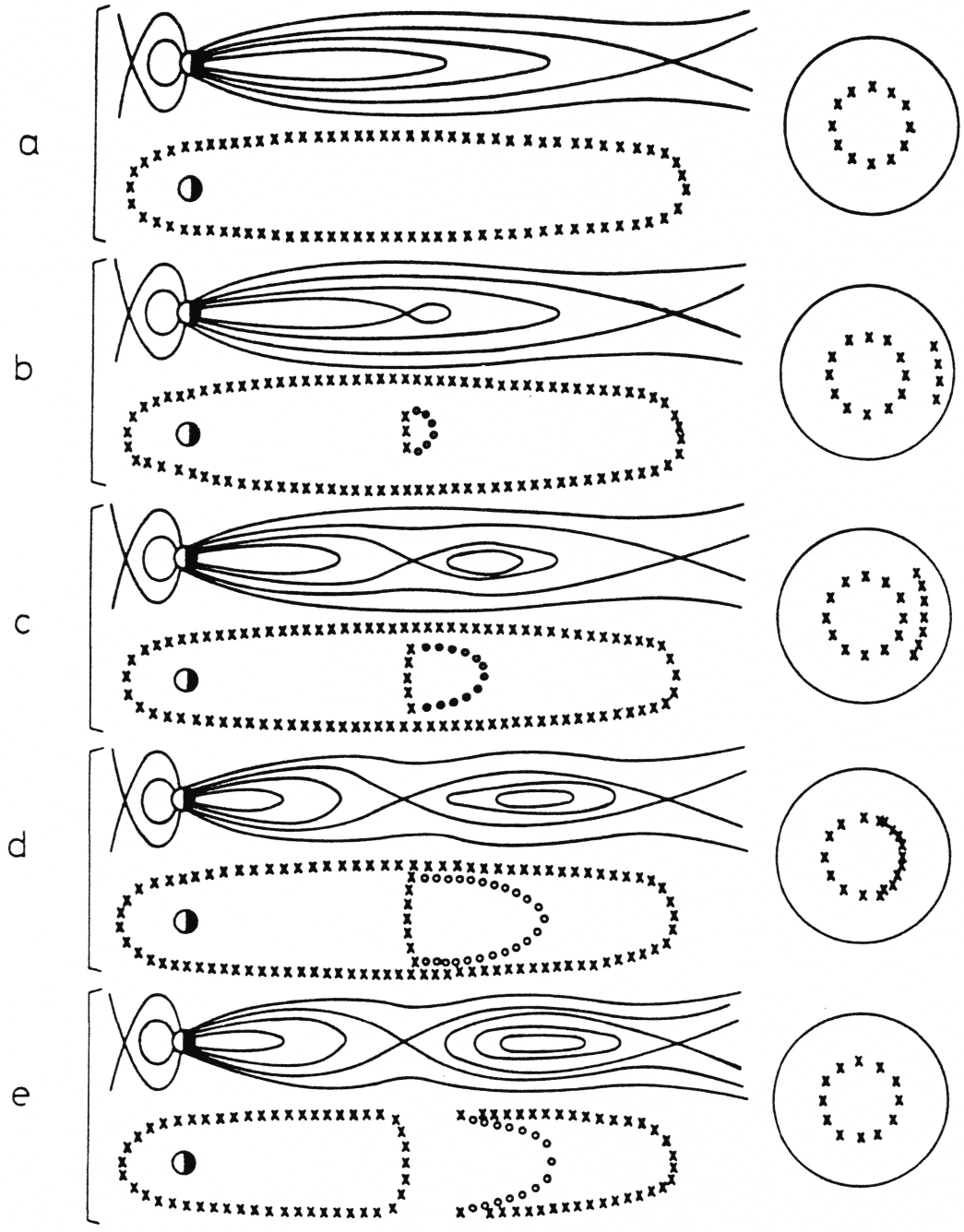

convection electrojets
substorm electrojets



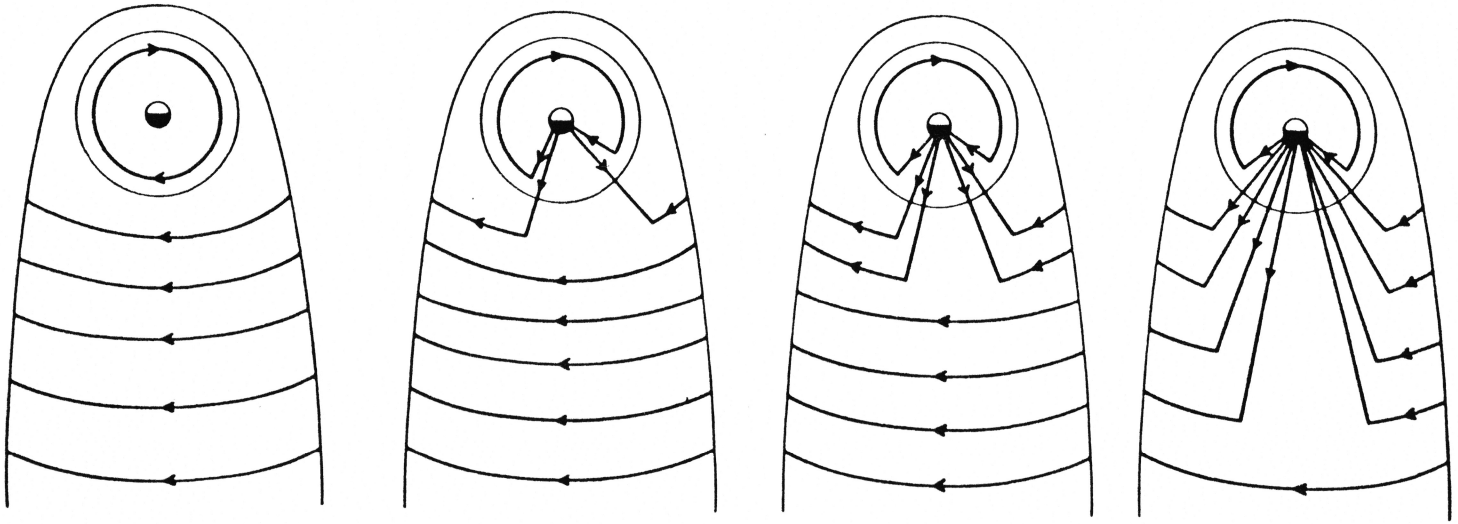
The distributions of calculated ionospheric current vectors at 1040, 1100, 1200, 1400, 1500, and 1700 UT on March 17, 1978.

PLASMA SHEET CONFIGURATION CHANGES DURING A SUBSTORM

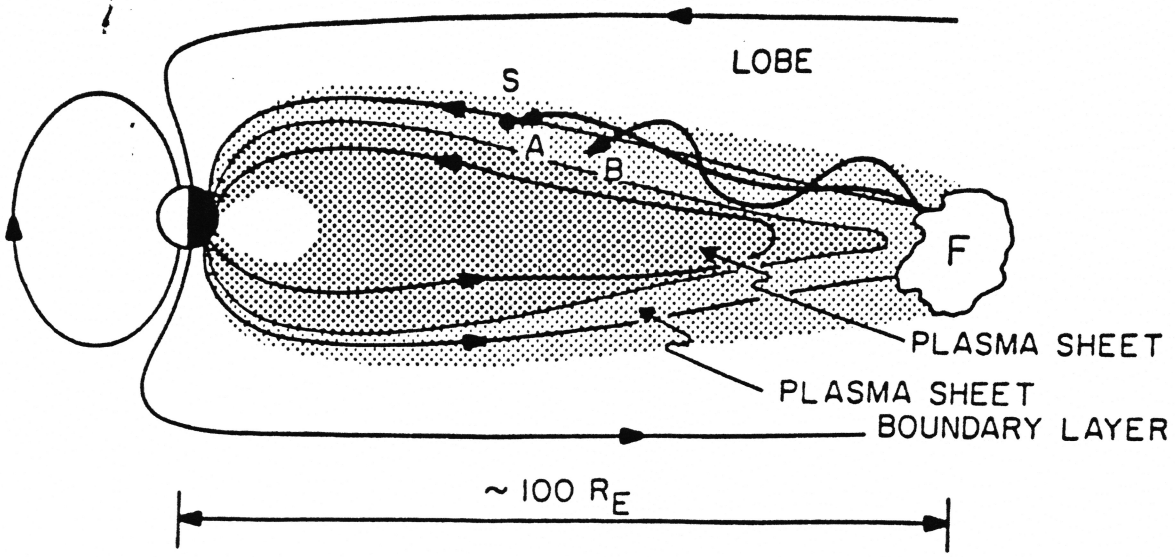




Vasyliunas.

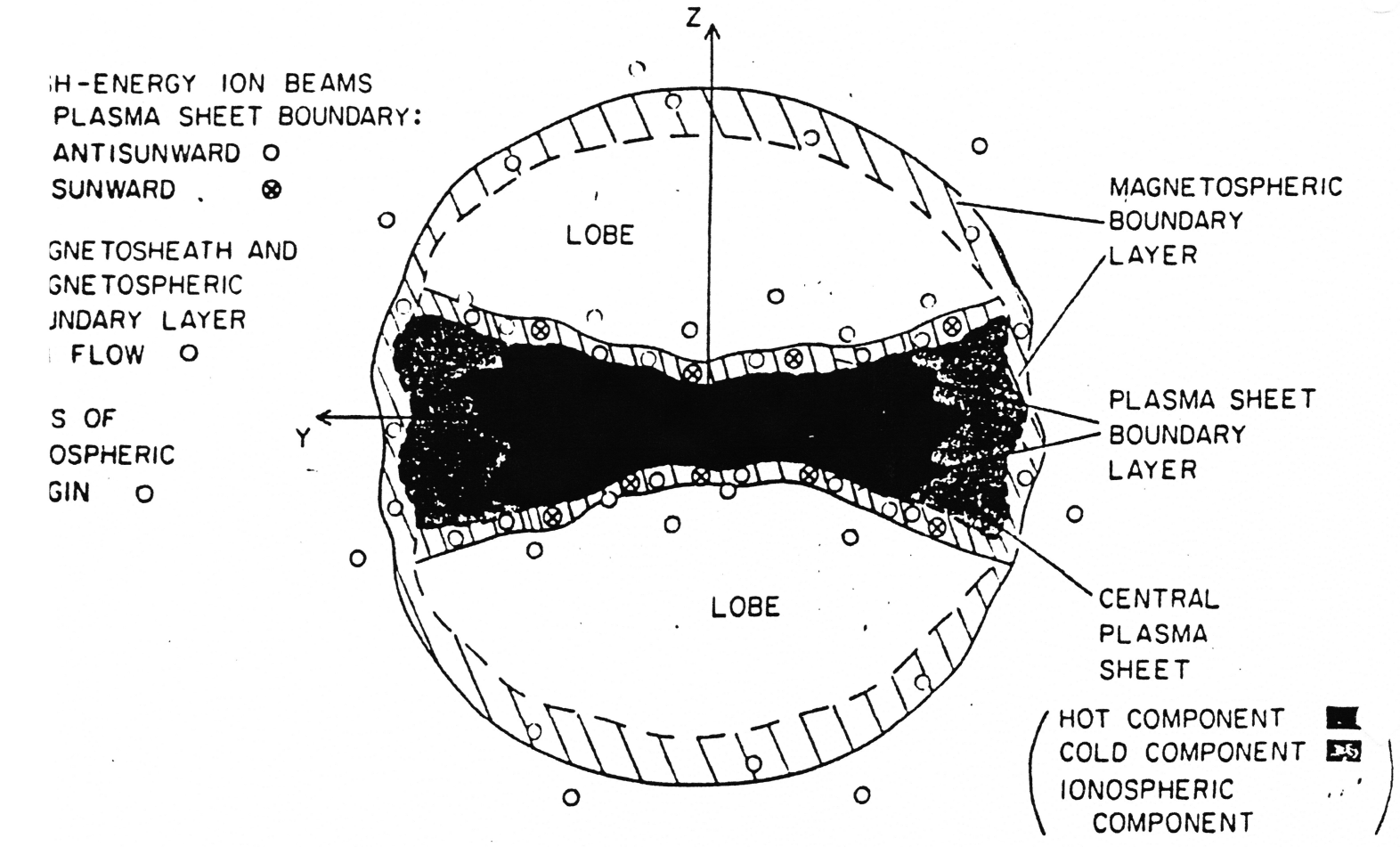


Akasofu

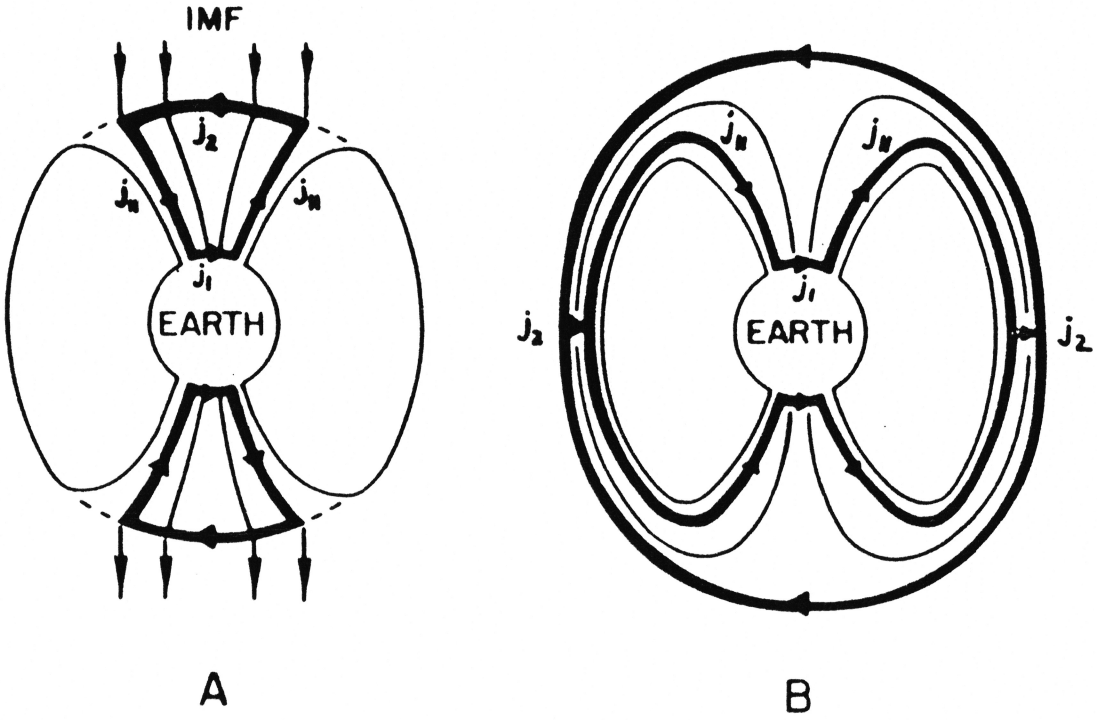


FRANK 1985

MAGNETOTAIL CROSS-SECTION INCLUDING THE TRANSPORT REGIONS

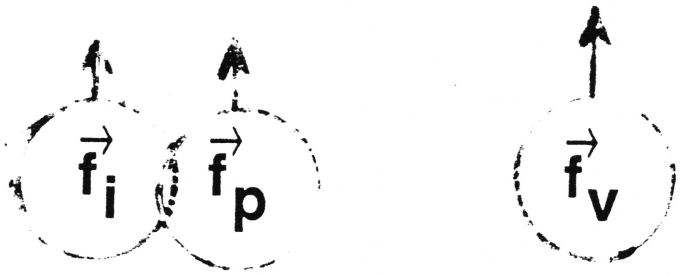


EASTMAN & FRANK 1984


IMF
j_2
j_N
j_N
j_1
EARTH
A
j_N
j_N
j_1
j_2
EARTH
j_2
B

SOURCES OF PARALLEL CURRENTS

$$\rho \frac{d\vec{v}}{dt} + \nabla p = \vec{J} \times \vec{B} + \eta \nabla^2 \vec{v}$$



$$\vec{J}_\perp = \frac{\vec{B}}{B^2} \times (\vec{f}_i + \vec{f}_p - \vec{f}_v)$$

$$B \frac{\partial J_\parallel / B}{\partial s} = - \nabla \cdot \vec{J}_\perp$$

SOURCE TERMS = INERTIAL + PRESSURE + VISCOUS

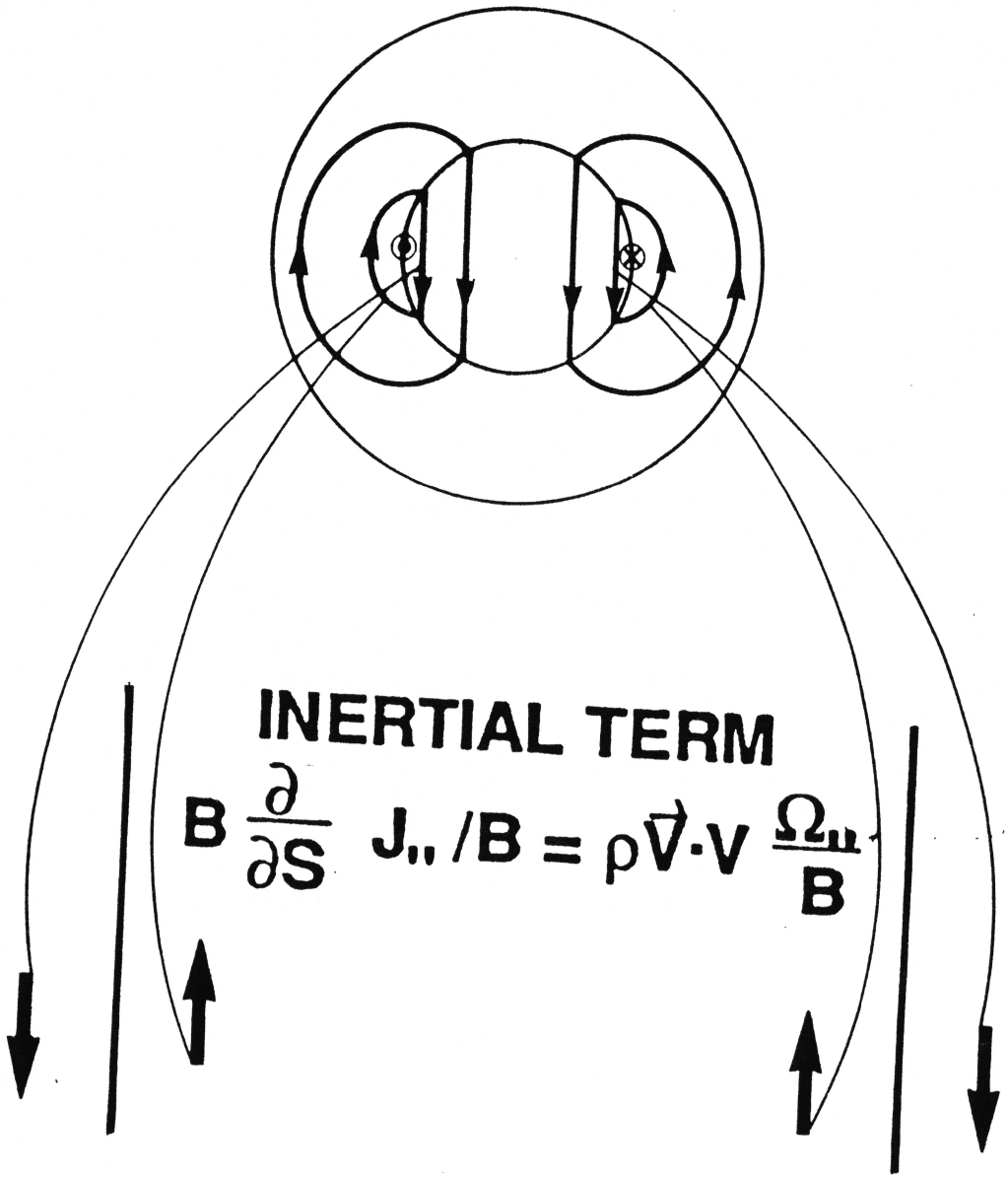
VI. 1. $B \frac{\partial}{\partial S} \frac{J_{\mu}}{B}$

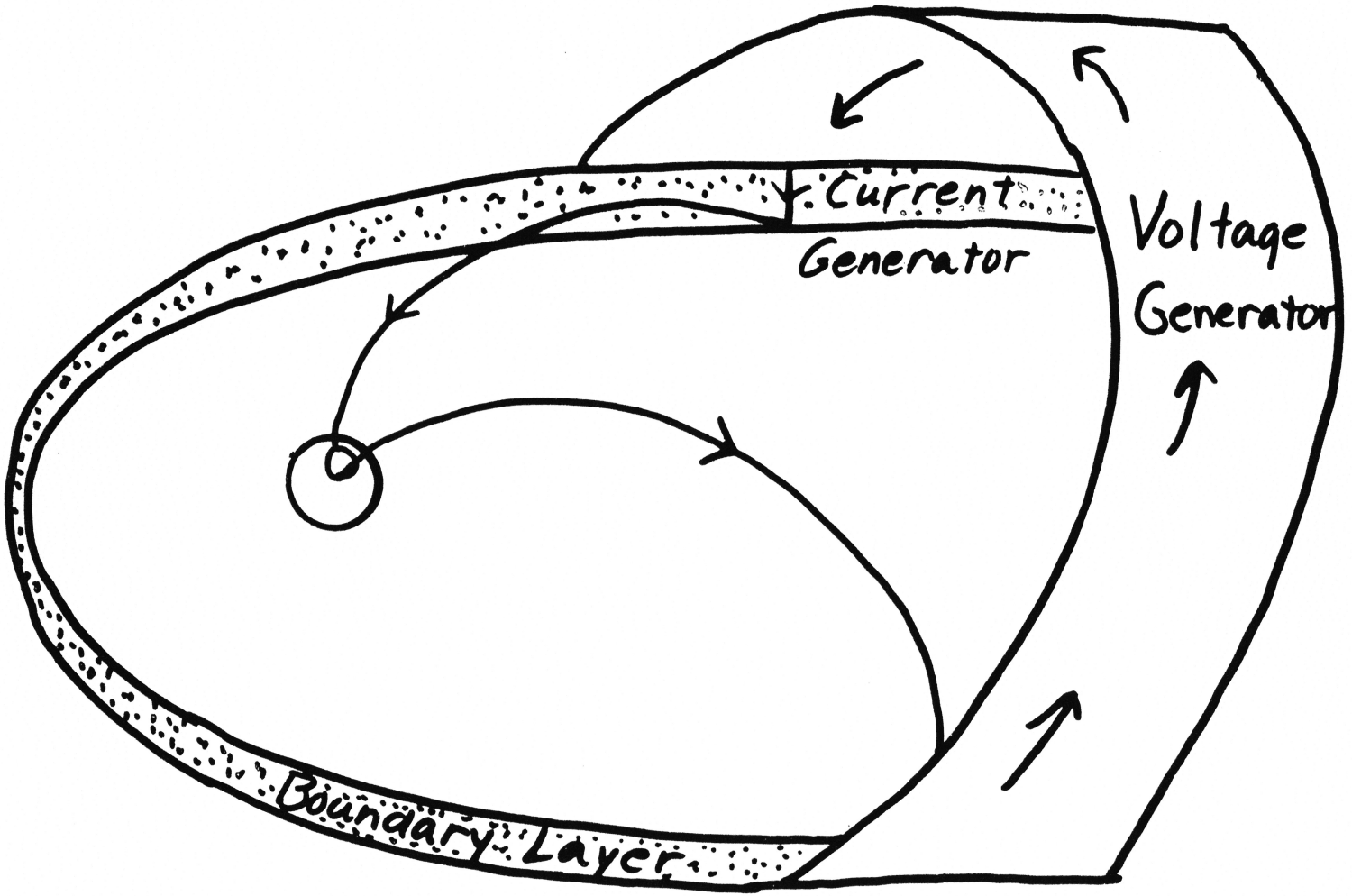
$$= 2 \frac{\vec{B}}{B^3} \cdot (\nabla p \times \nabla B)$$

PRESSURE TERM

$$+ \rho \vec{V} \cdot \nabla \frac{\Omega_{\mu}}{B}$$

INERTIAL TERM


INERTIAL TERM
$B \frac{\partial}{\partial S} J_{\parallel} / B = \rho \vec{V} \cdot V \frac{\Omega_{\parallel}}{B}$



Interactively Coupled
Solar Wind - Magnetosphere - Ionosphere (Thermosphere)