

**SOLAR WIND - MAGNETOSPHERE - IONOSPHERE
COUPLING**

LECTURE 5

1. SUBSTORMS

AND

**2. SOLAR WIND - MAGNETOSPHERE - IONOSPHERE
COUPLING**

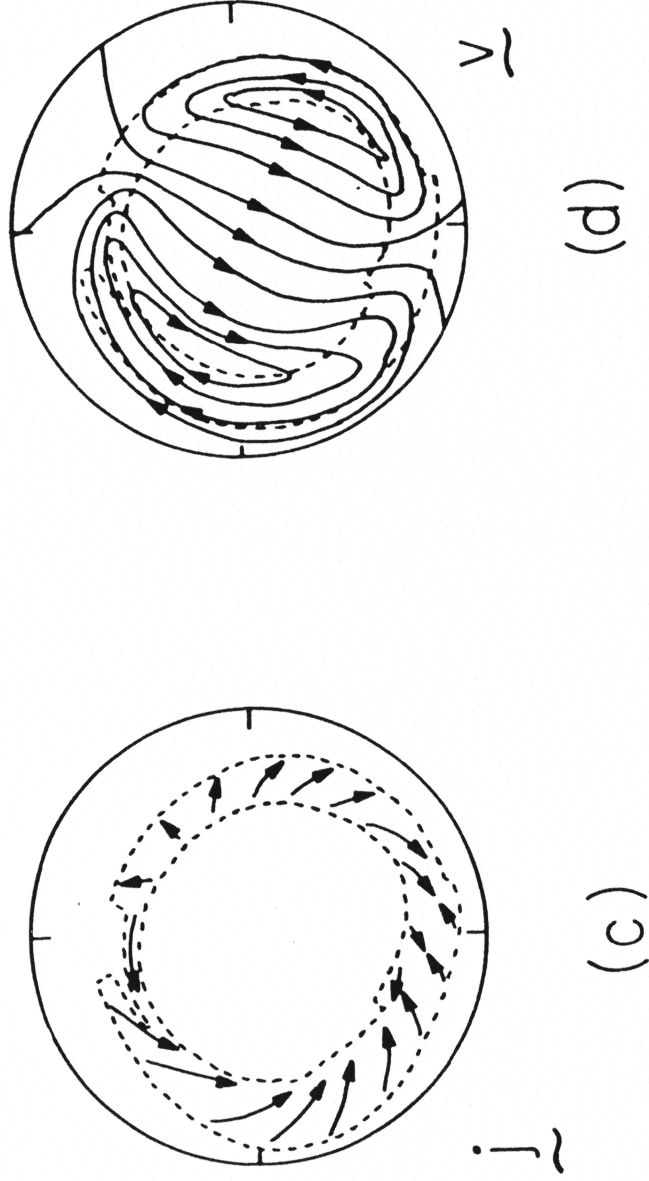
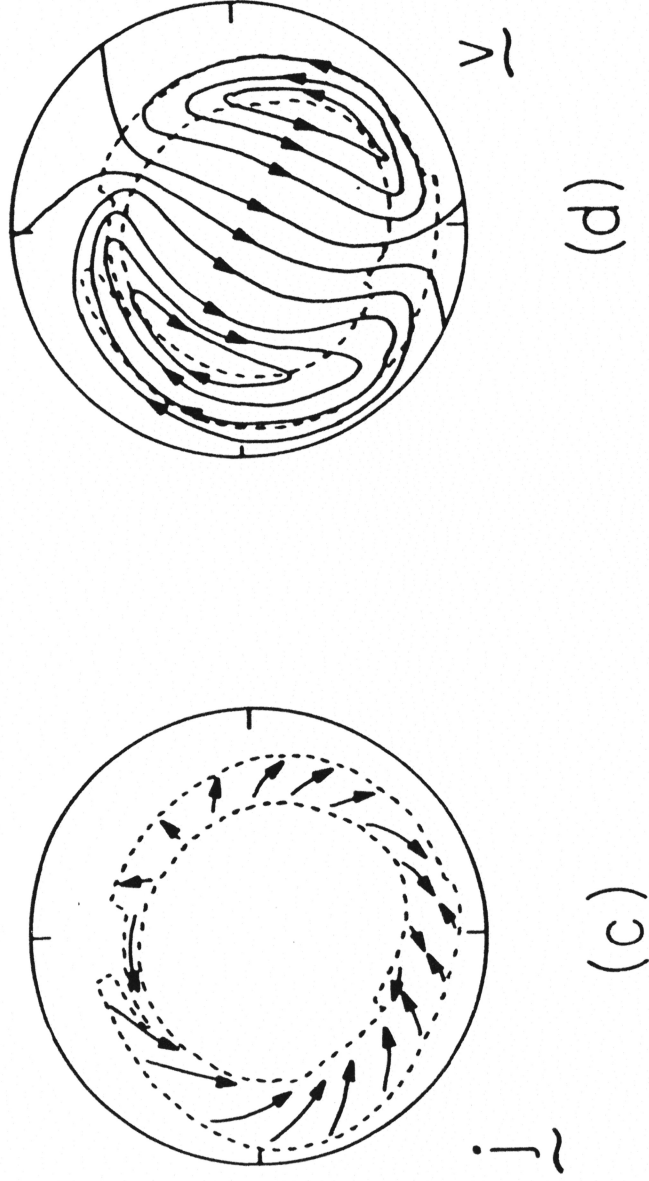
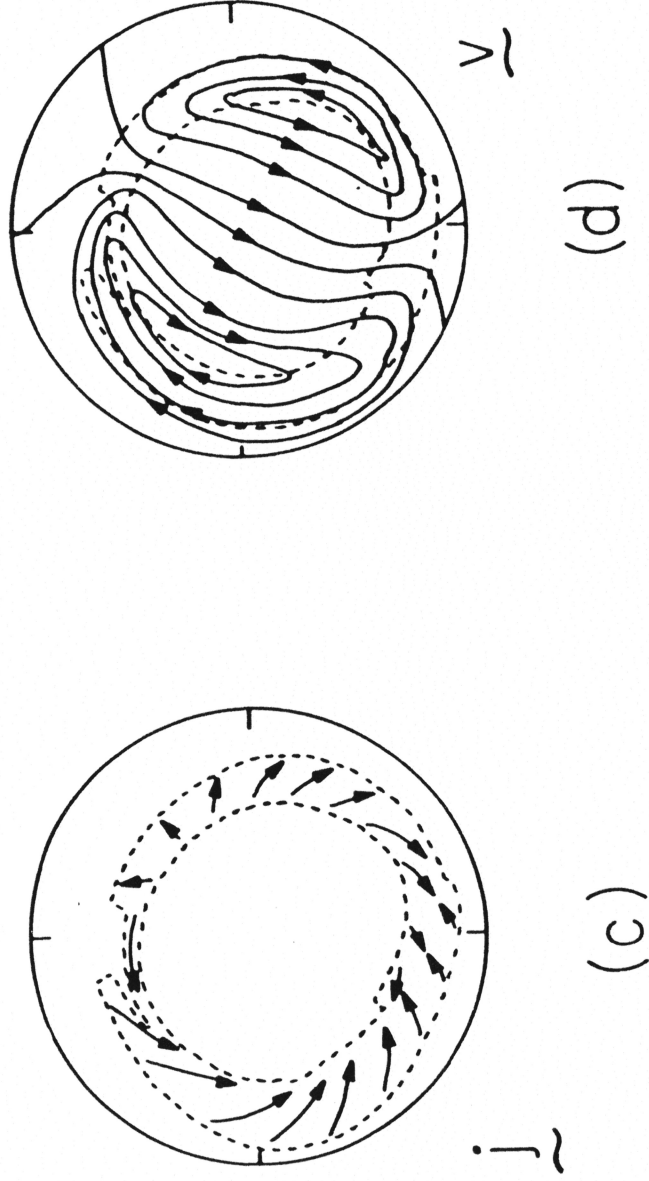
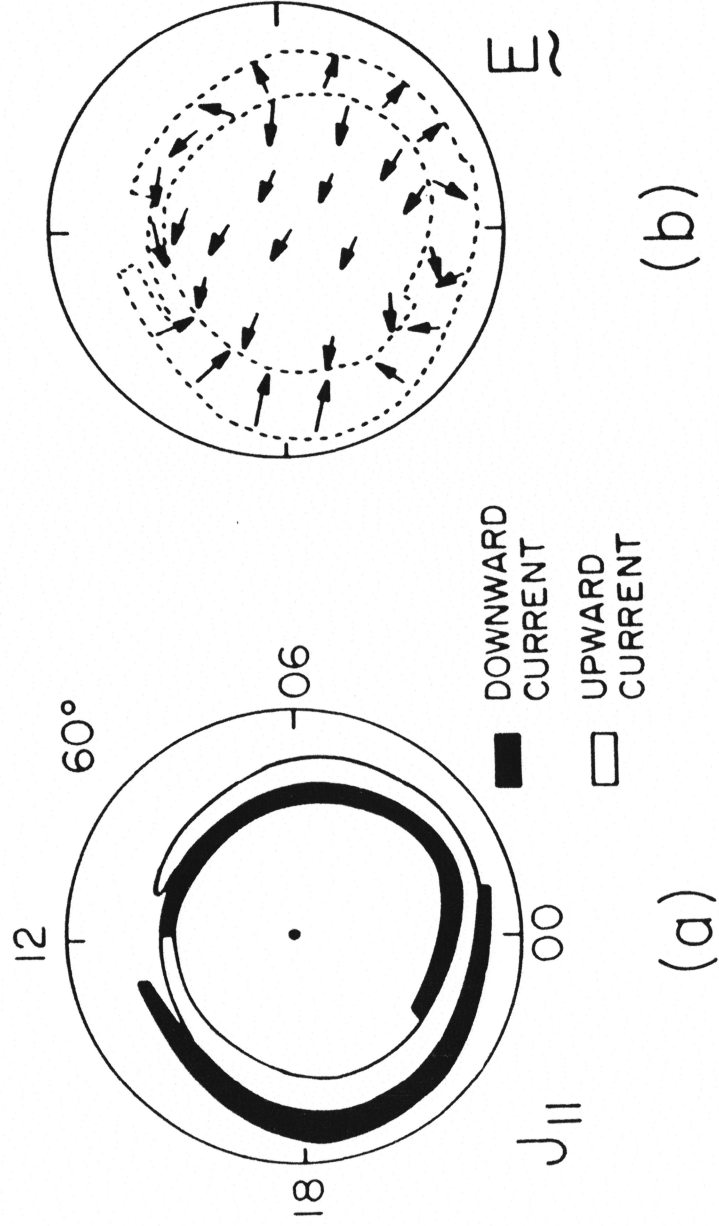
EXPECT THE UNEXPECTED

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

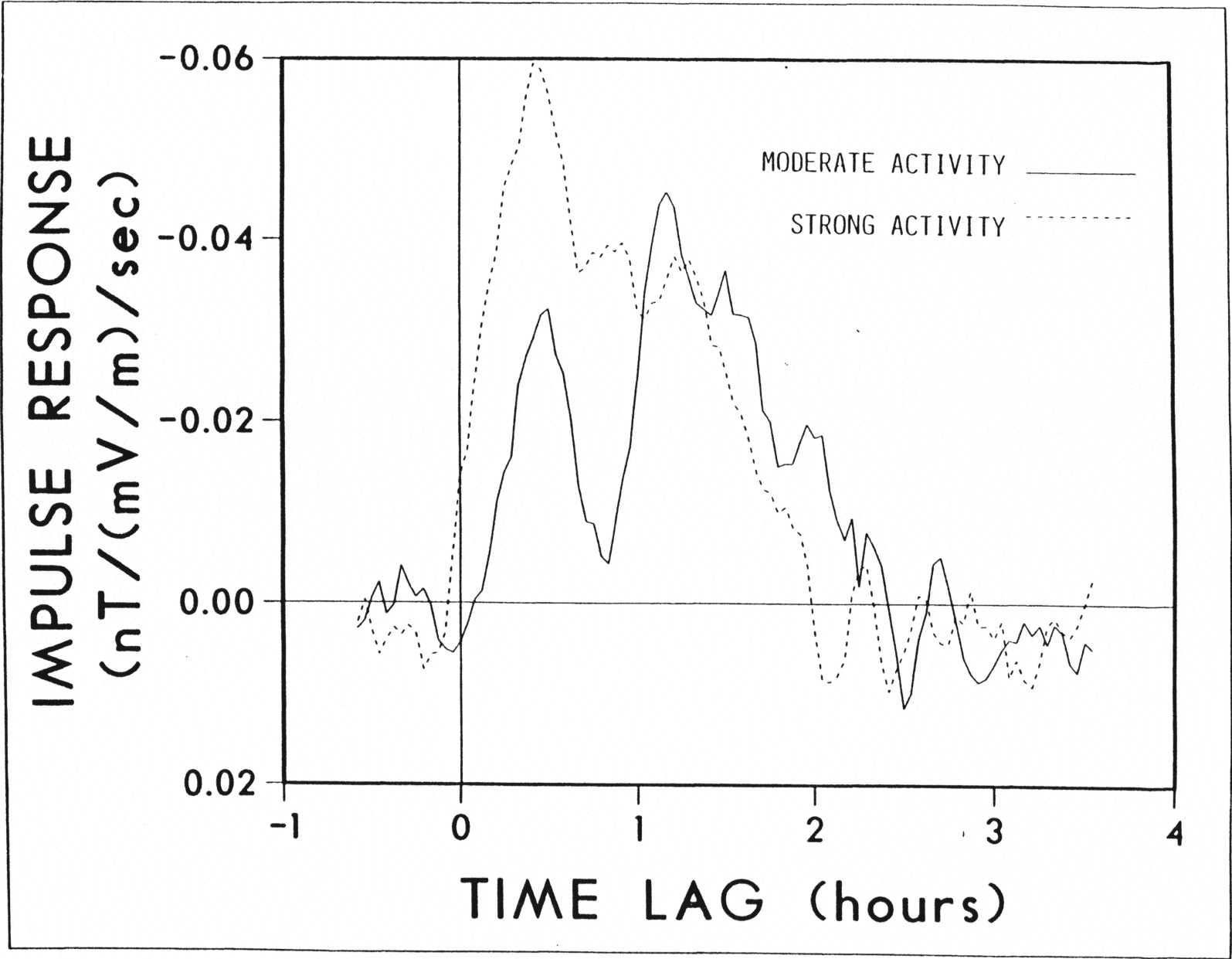
**Our age is retrospective. ... The foregoing
generations beheld God and nature face to face;
we through their eyes. Why should not we also
enjoy an original relation to the universe?
Emerson - Nature, 1836**

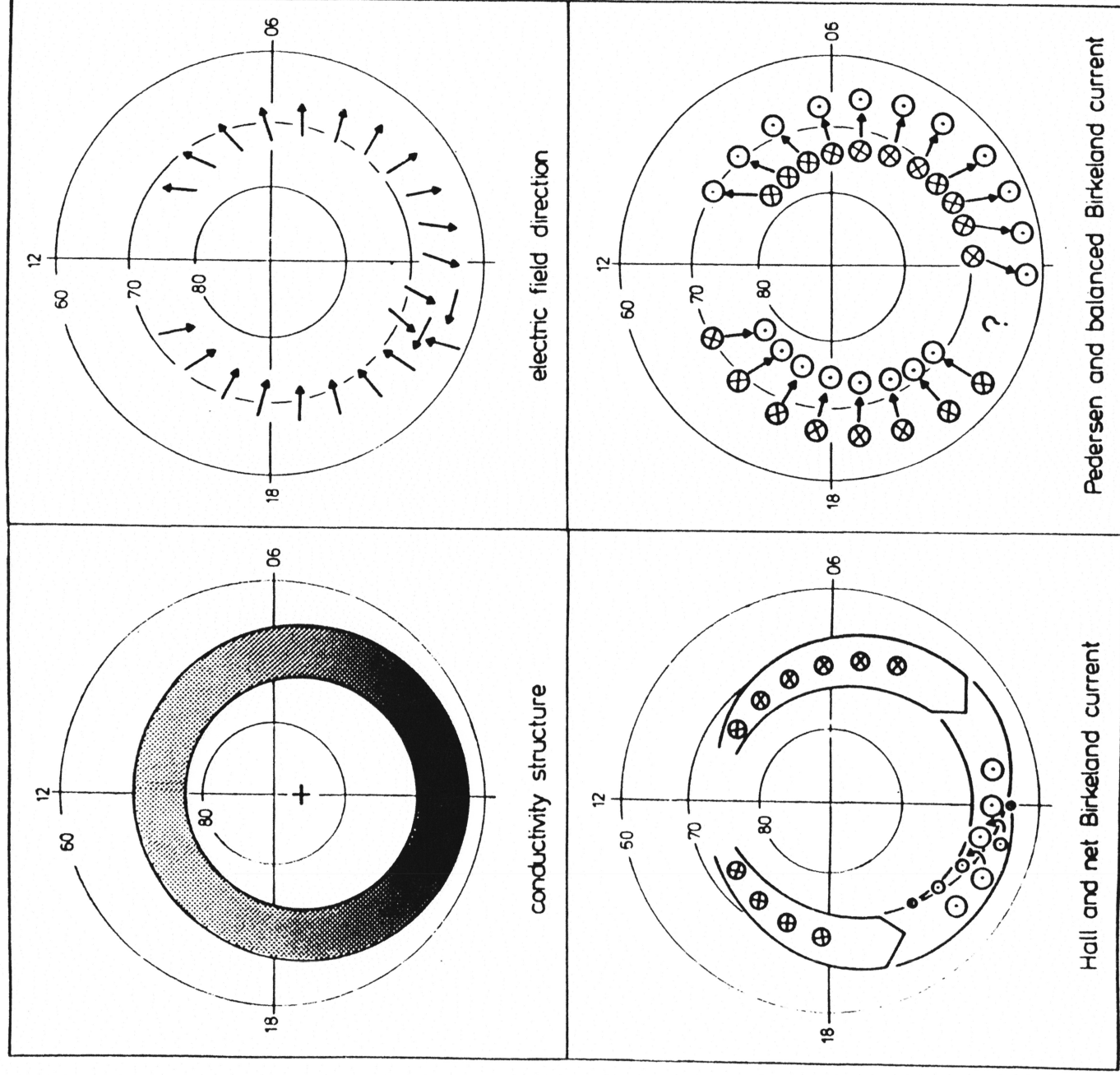
**Nature sometimes creates a phenomenon that
is far beyond our imagination. Sato - Formation
of Field-Twisting Flux Tubes on the Magnetopause, 1986**

CONNECTION BETWEEN THE MAGNETOSPHERE AND IONOSPHERE



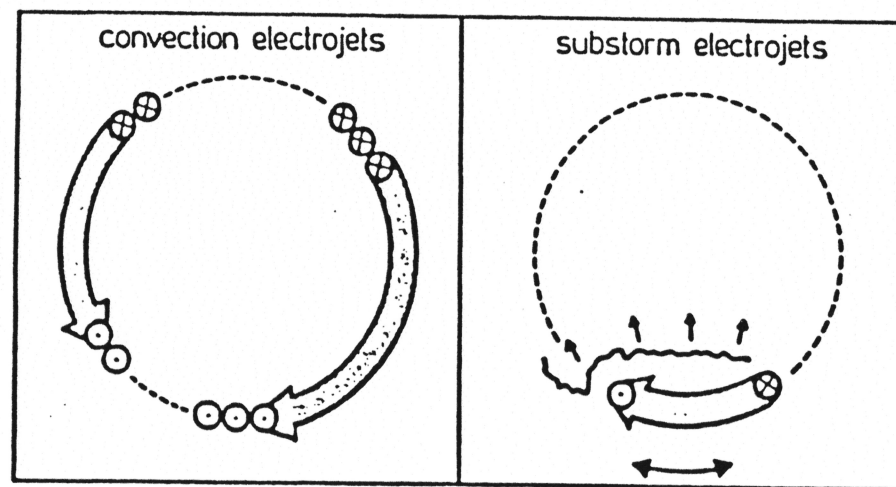
Sketch of the typical patterns of (a) Birkeland current (Iijima and Potemra, 1978), (b) electric fields, (c) horizontal ionospheric current, and (d) $\vec{E} \times \vec{B}$ -drift velocity. Polar cap currents are not shown.



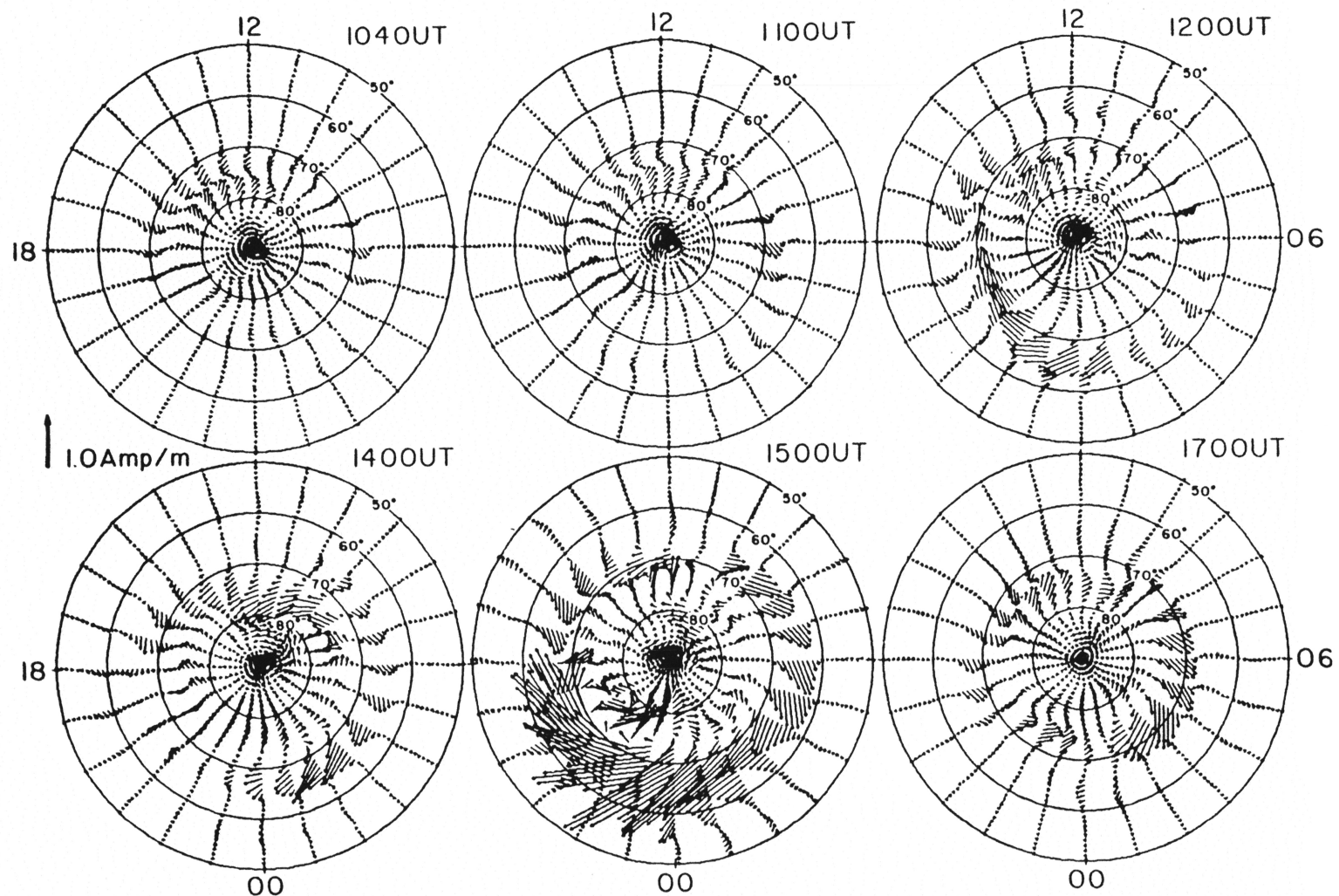


Schematic diagram of conductivity structure, electric field direction and current flow associated with the auroral electrojet system. Coordinates are invariant latitude and magnetic local time.

Wolfgang Baumjohann

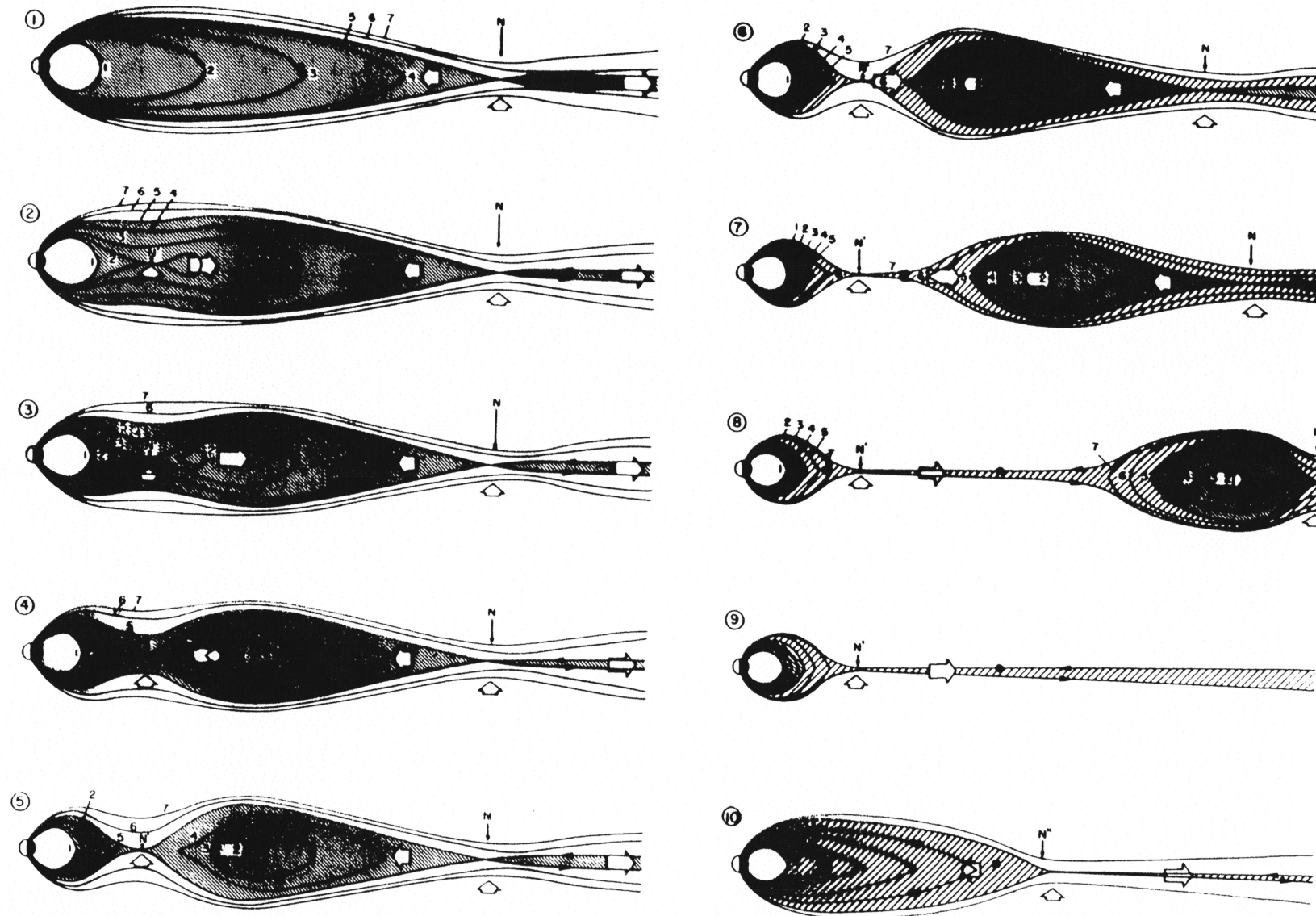


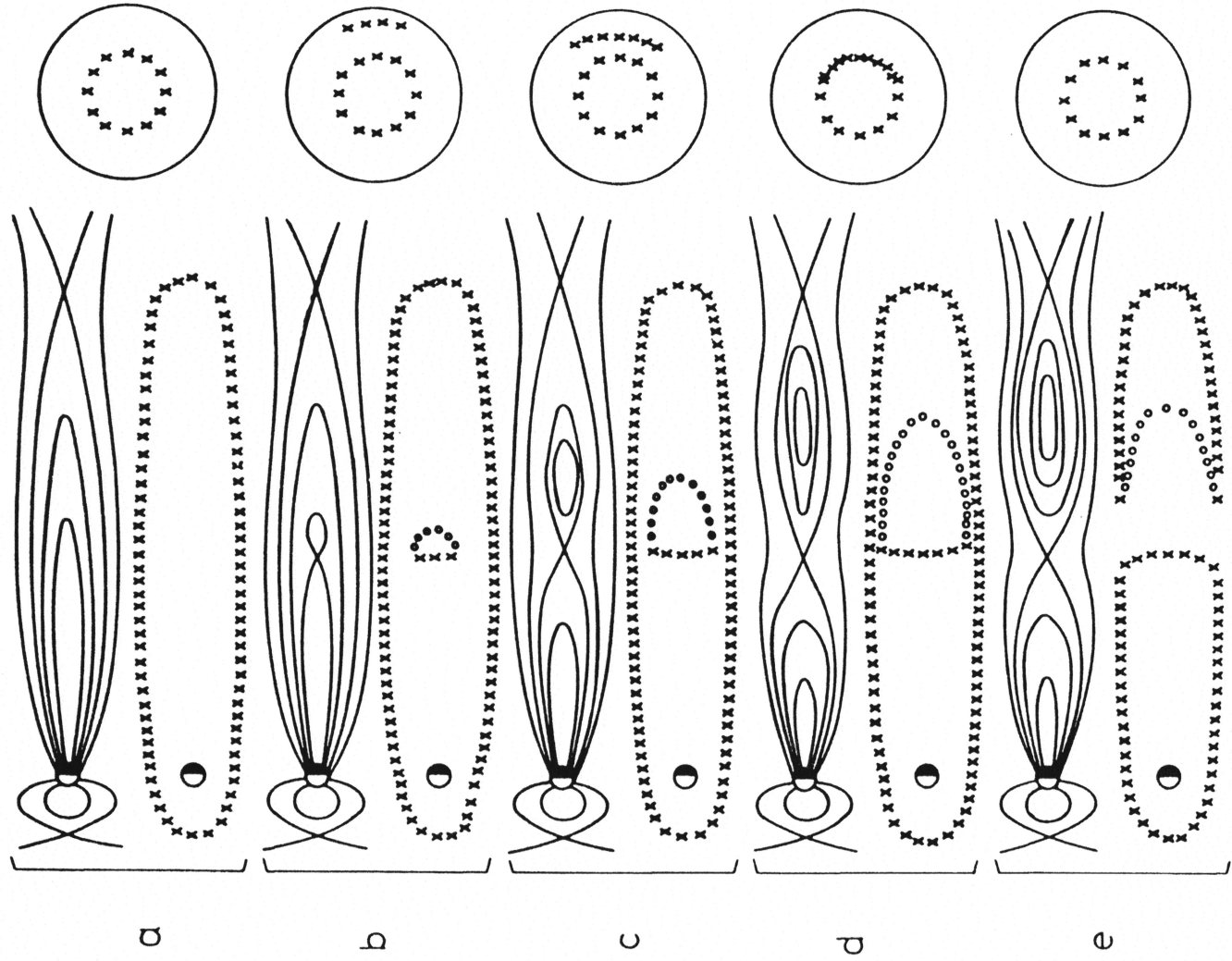
Ionospheric Current Vectors MARCH 17, 1978



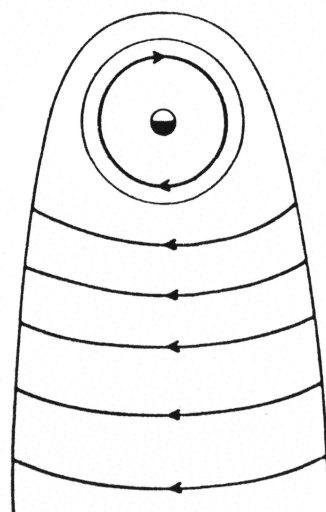
The distributions of calculated ionospheric current vectors at 1040, 1100, 1200, 1400, 1500, and 1700 UT on March 17, 1978.

PLASMA SHEET CONFIGURATION CHANGES DURING A SUBSTORM

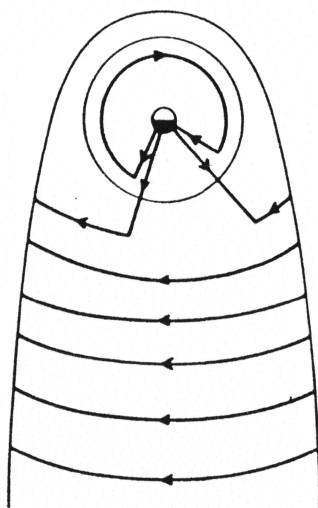




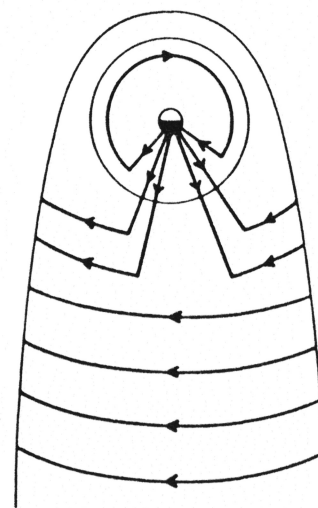
Vasyliunas.



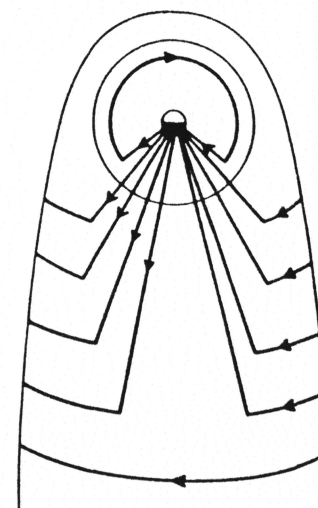
Quiet Time



$T = +5 \text{ min}$

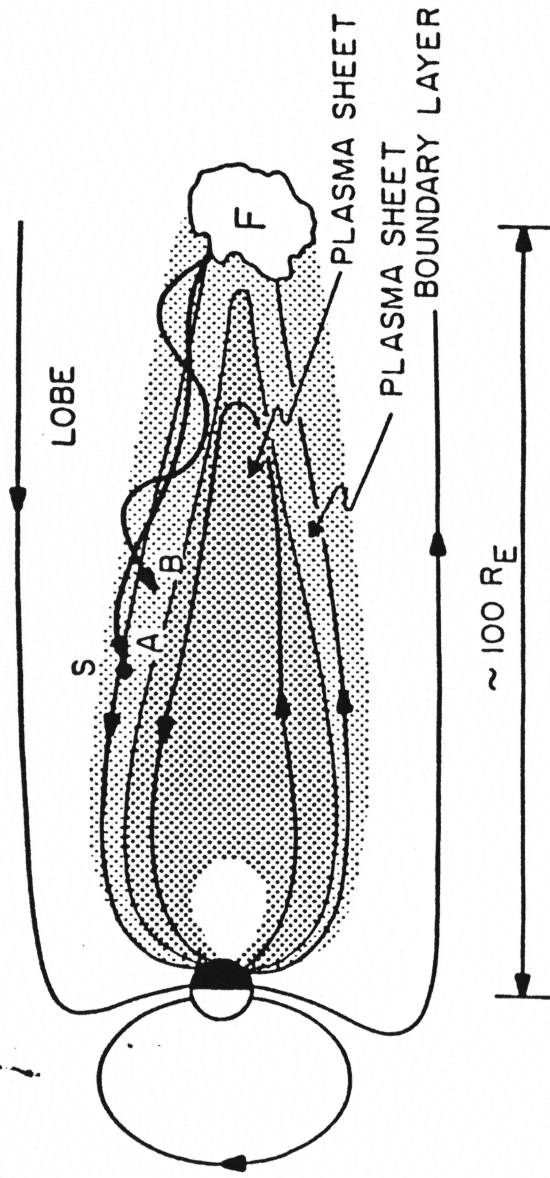


$T = +30 \text{ min}$



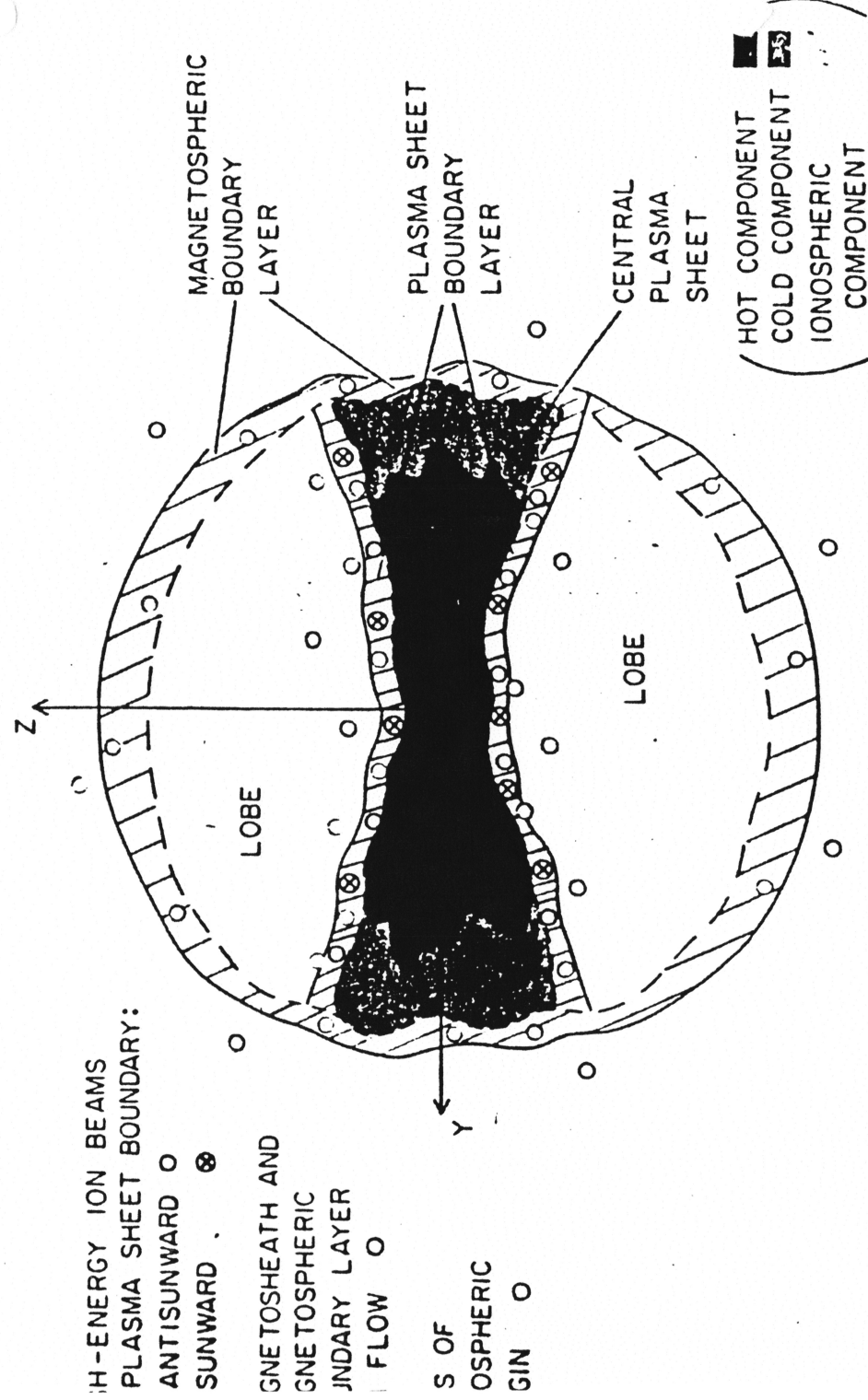
$T = +1 \text{ hr}$

Akasofu

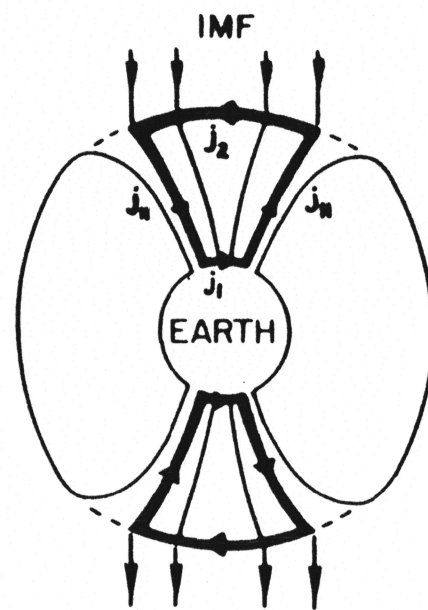


FRANK 1985

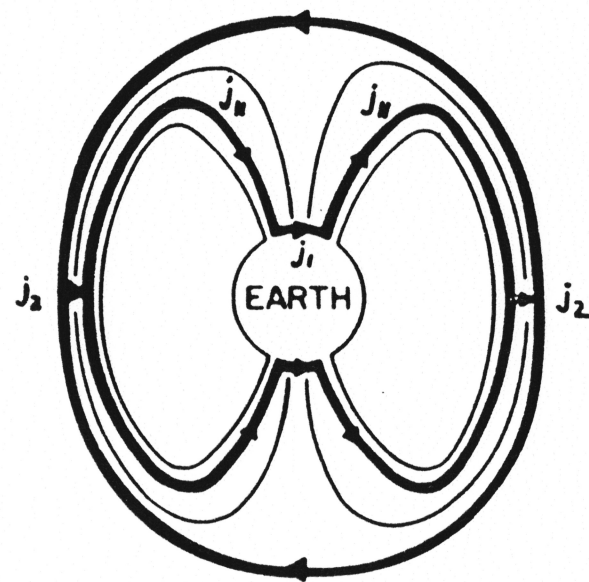
MAGNETOTAIL CROSS-SECTION INCLUDING THE TRANSPORT REGIONS



EASTMAN & FRANK 1984



A



B

SOURCES OF PARALLEL CURRENTS

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



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

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

SOURCE TERMS = INERTIAL + PRESSURE + VISCOUS

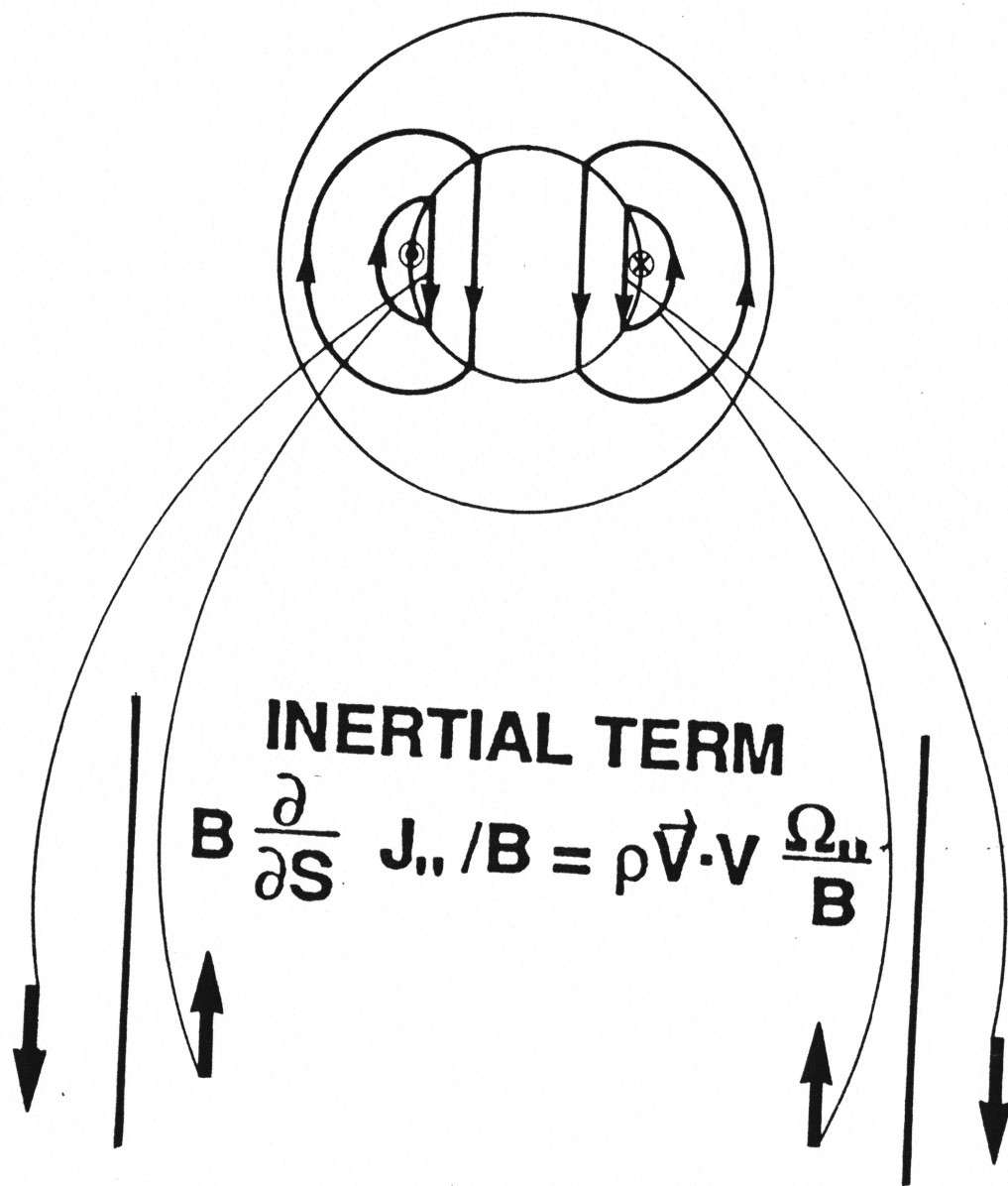
$$\text{VI. 1. } B \frac{\partial}{\partial S} \frac{J_u}{B}$$

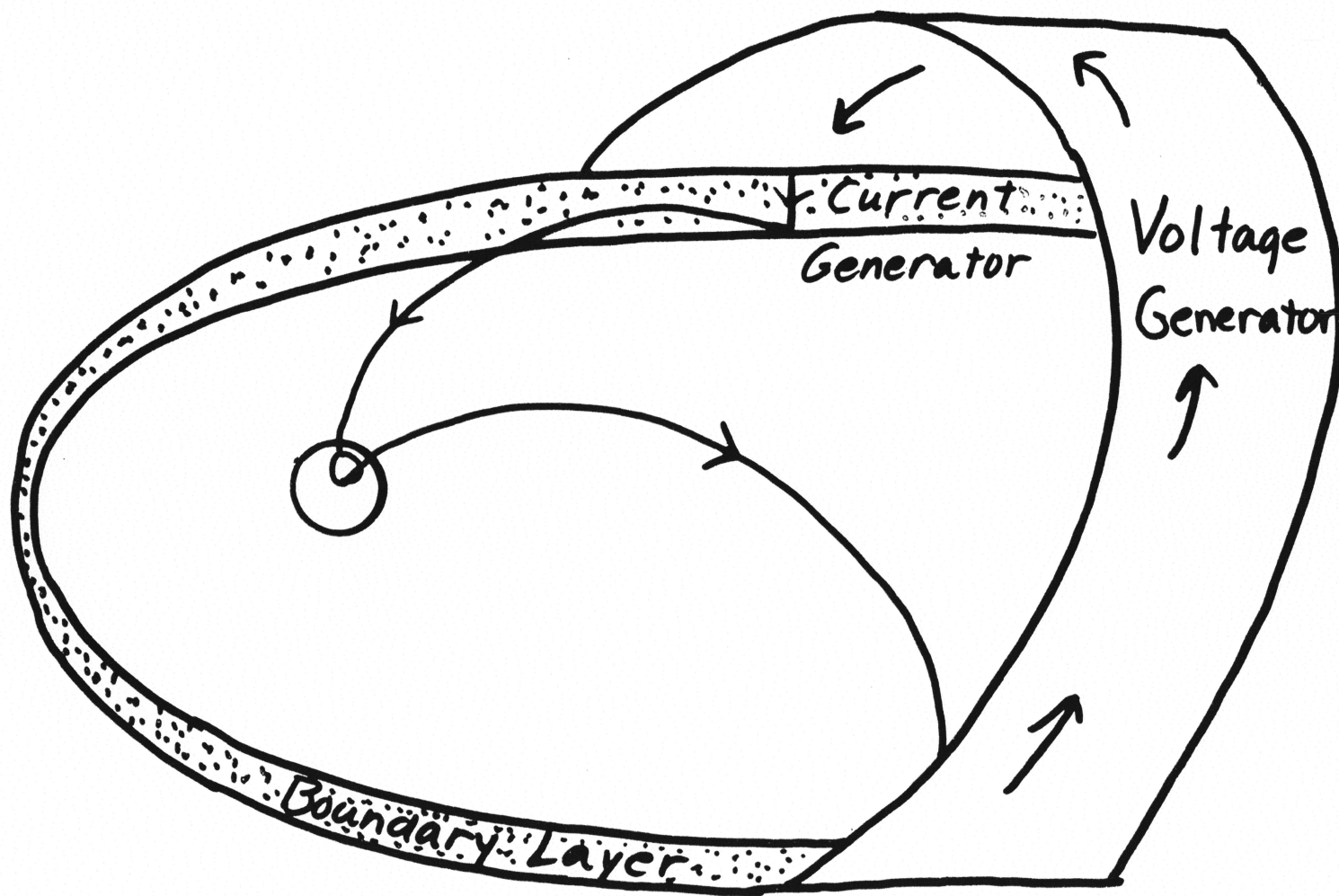
$$= 2 \frac{\vec{B}}{B^3} \cdot (\nabla p \times \nabla B)$$

PRESSURE TERM

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

INERTIAL TERM





Interactively Coupled
Solar Wind - Magnetosphere - Ionosphere (Thermosphere)