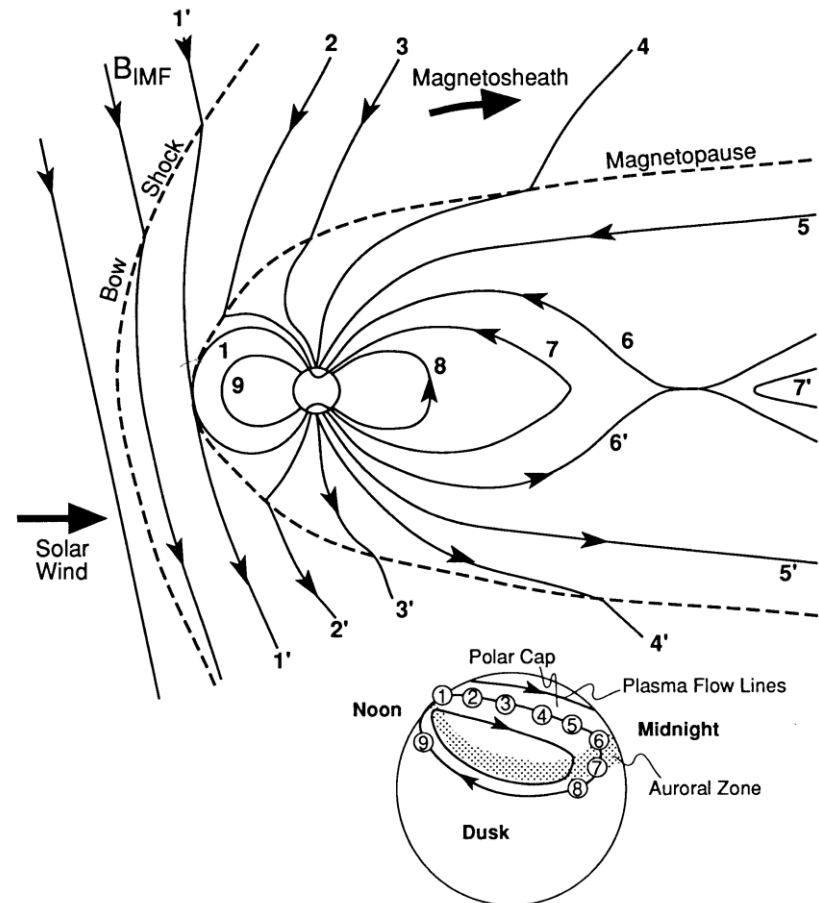
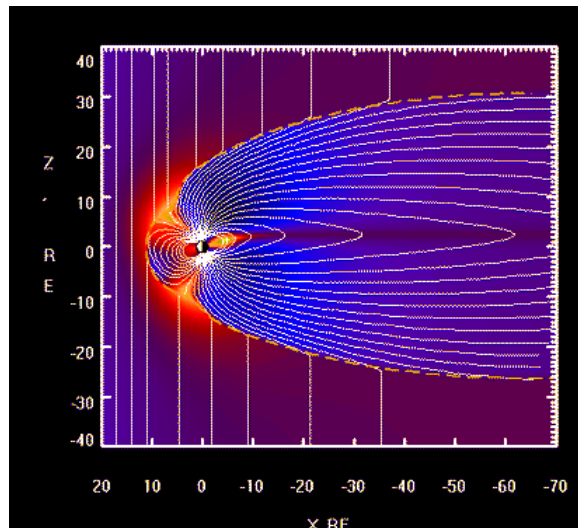
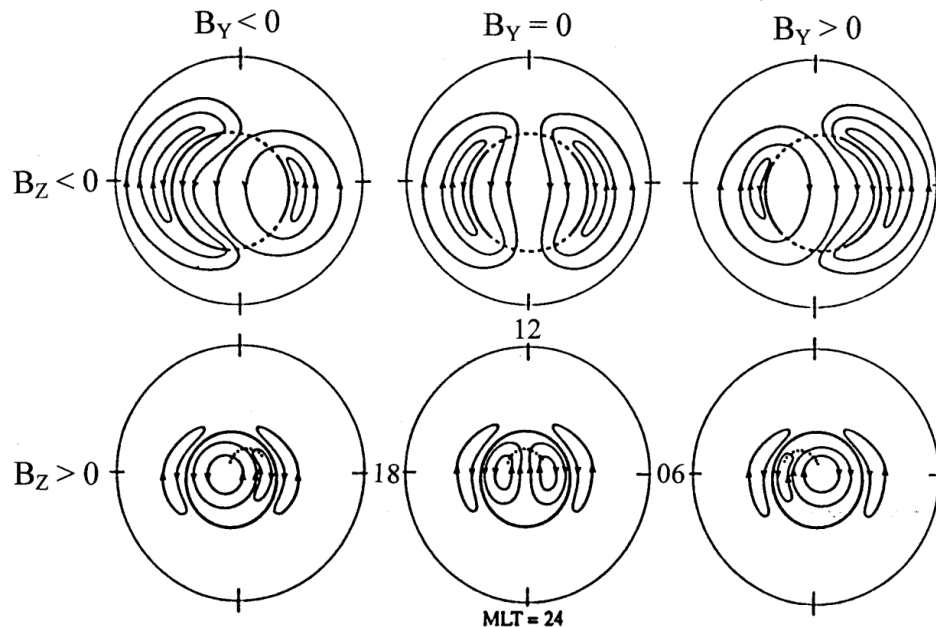


# Solar wind driven ionospheric convection





# IMF controlled convection patterns



Up to the 1980s the main information about flow patterns was from low-altitude polar orbiting satellites –

Resulted in **10-15 min averages** of the polar cap flow potential

**Reiff and Burch, JGR, 1985**



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# Excitation and decay of solar wind-driven flows in the magnetosphere-ionosphere system

by

Cowley and Lockwood, Ann.  
Geophys., 1992.



# Cowley-Lockwood time dependent model of excitation of large scale flows

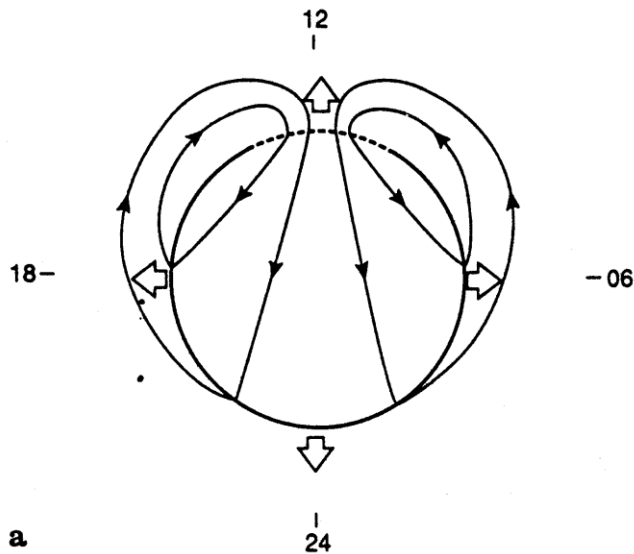
The **two component** flow model:

- The flow is driven by **dayside reconnection** and by **nightside reconnection**
- Unbalanced dayside reconnection expands the polar cap.
- Unbalanced nightside reconnection contracts the polar cap.



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# Magnetopause reconnection



**Polar Cap Boundary or (PCB)**

**Open-Closed-Boundary (OCB):**

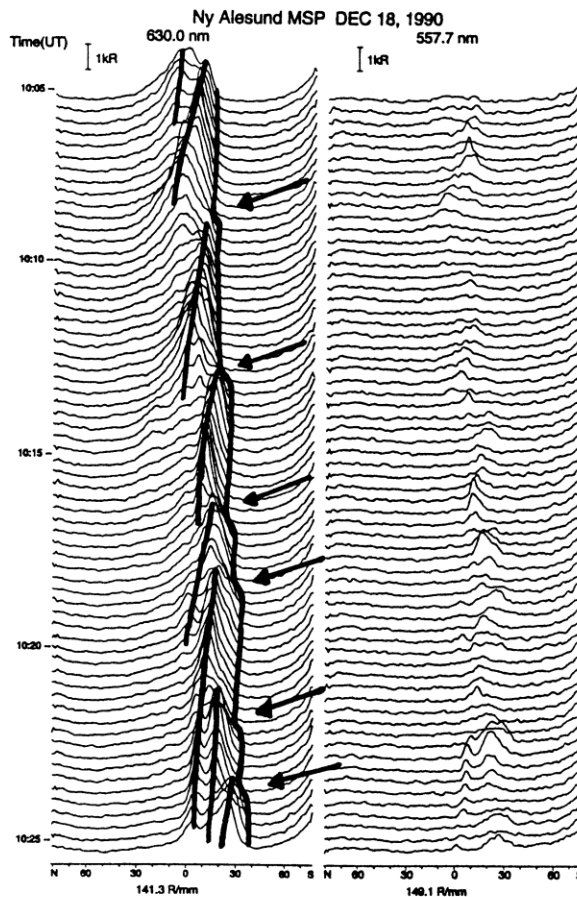
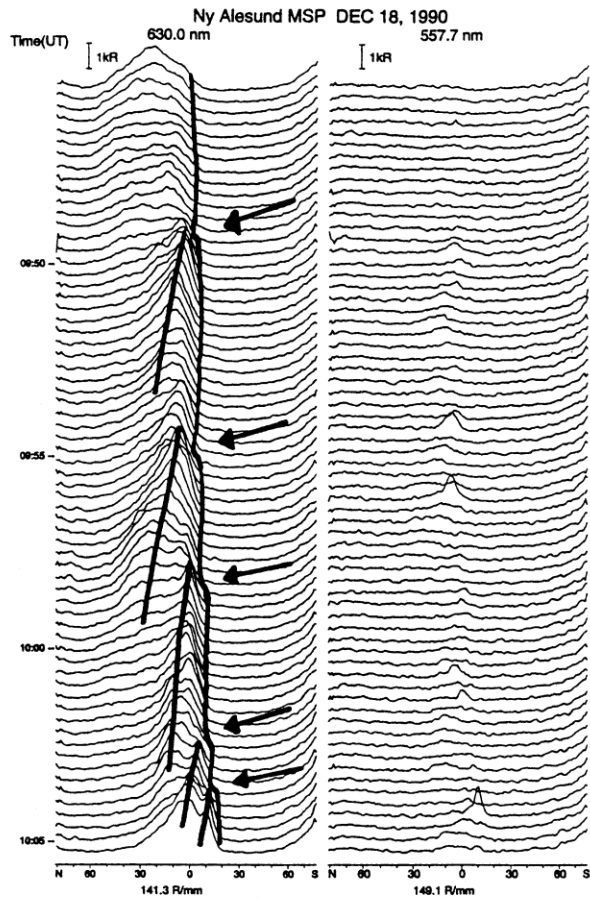
**Dashed line** = reconnection boundary – plasma flow across this boundary during episodes of reconnection

**Full line** = adiabatic boundary – this boundary is frozen into the plasma movement



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# Flux Transfer Events – Pulsed reconnection

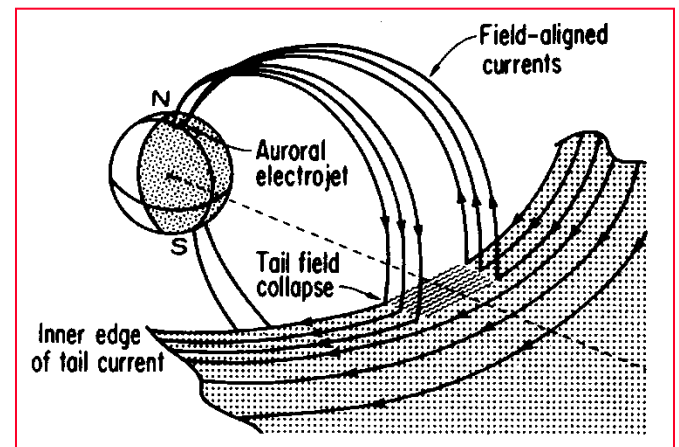
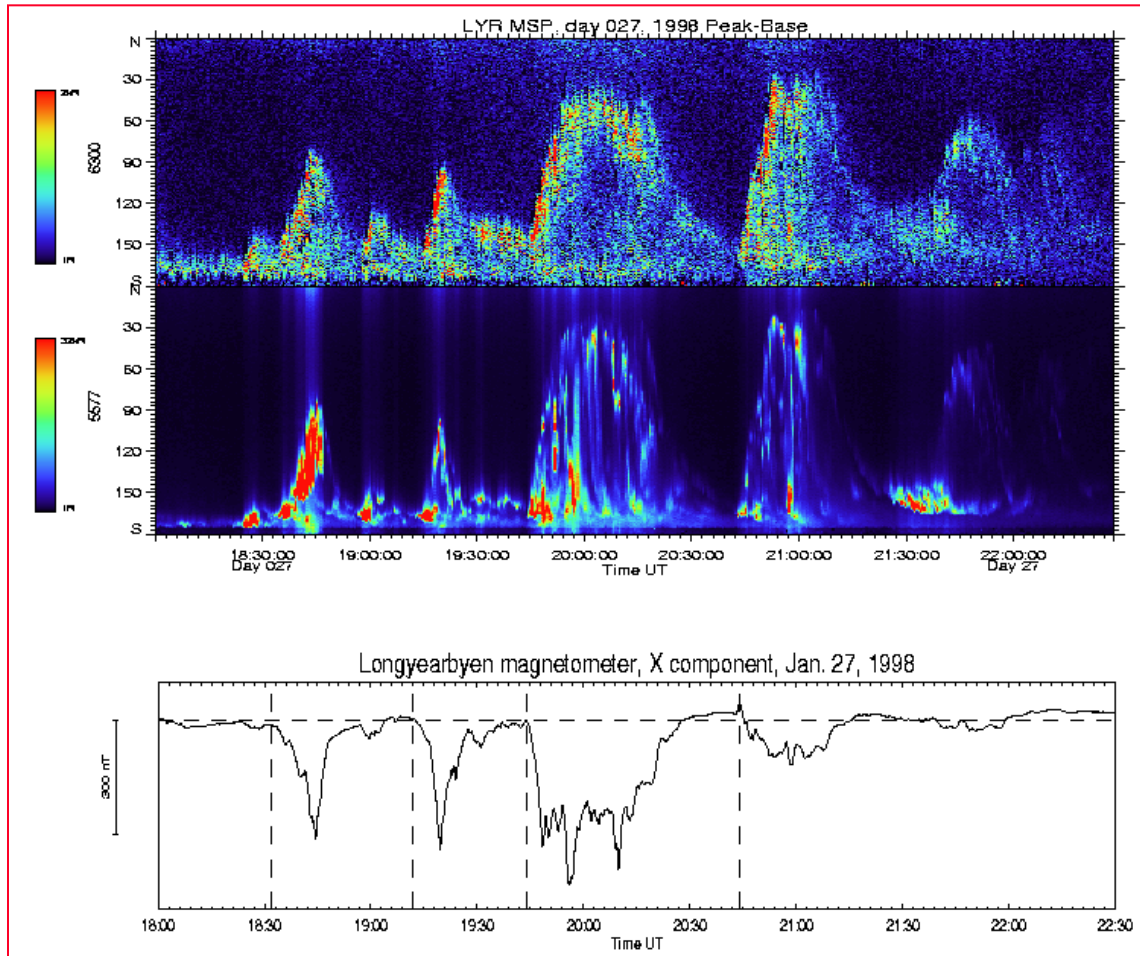


**IMF Bz  
south**

**5-10 min  
recurrence  
time**

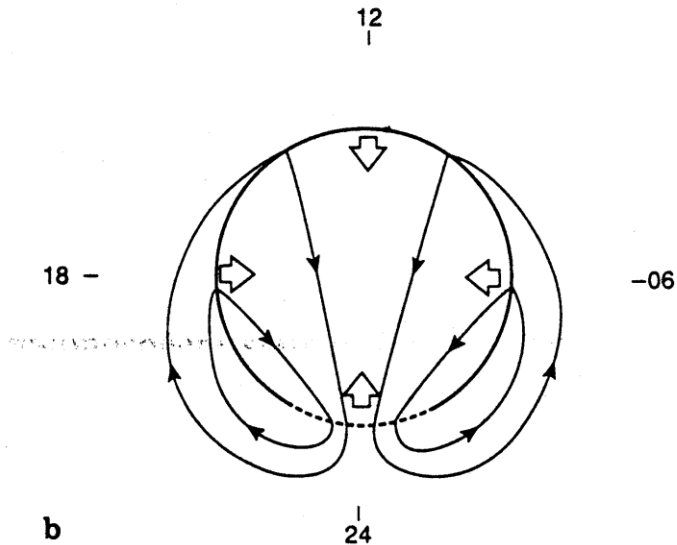


# Auroral and magnetic signatures of tail reconnection





# Tail reconnection



**Polar Cap Boundary or (PCB)**

**Open-Closed-Boundary (OCB):**

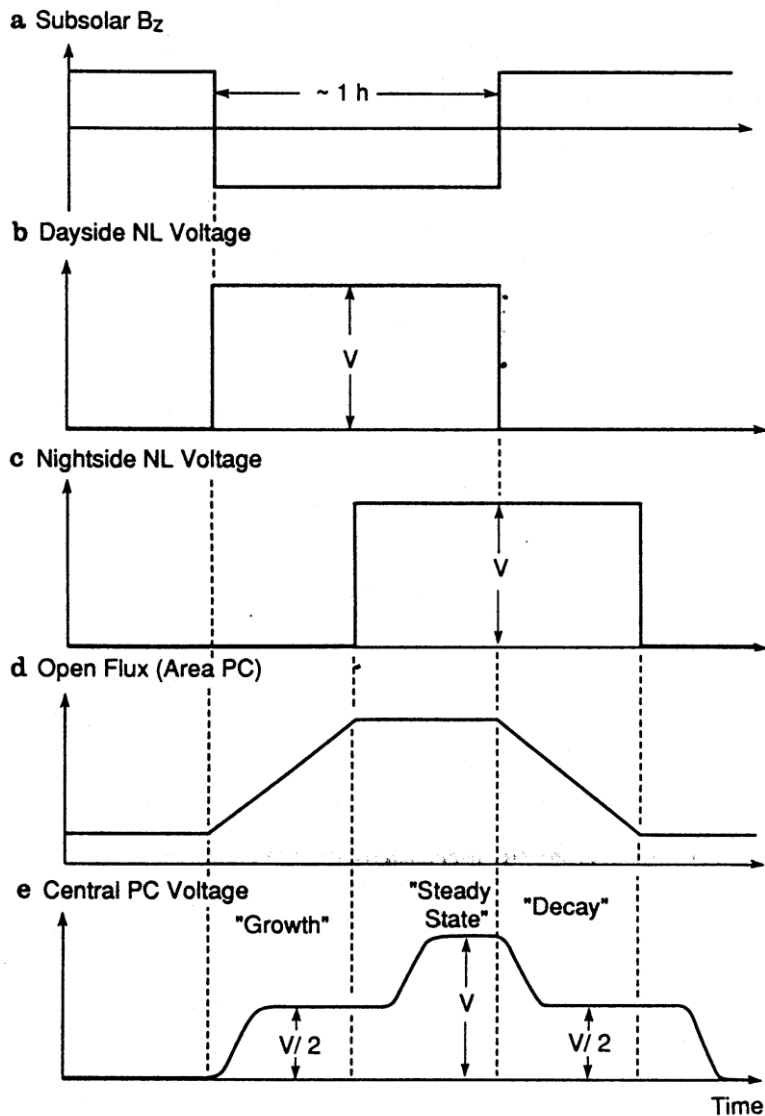
**Dashed line** = reconnection boundary – plasma flow across this boundary during episodes of reconnection

**Full line** = adiabatic boundary – this boundary is frozen into the plasma movement





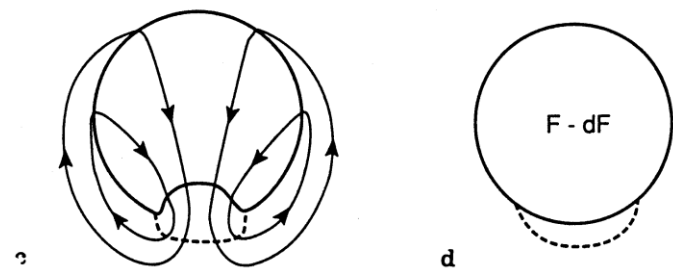
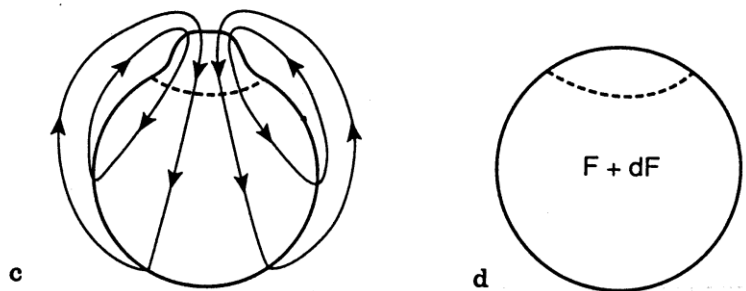
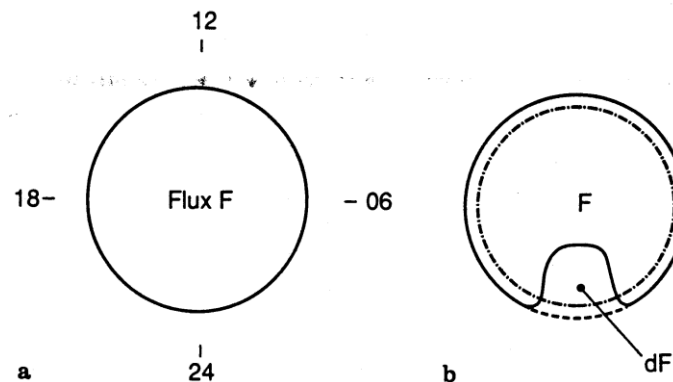
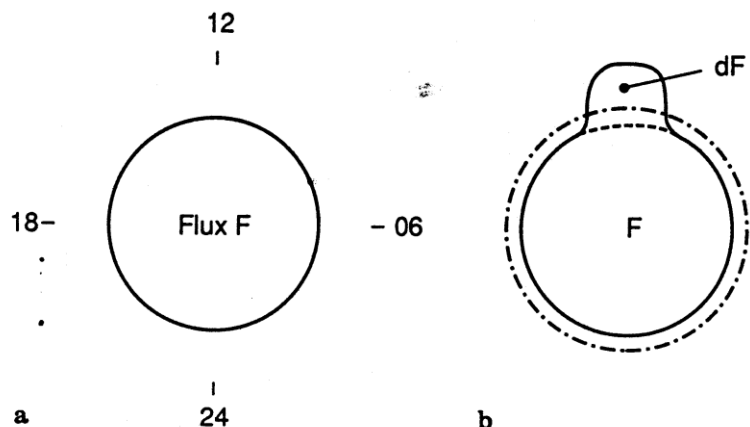
# Magnetosphere response to a 1 hour interval of southward IMF



- A simple case when the nightside reconnection voltage follows the dayside reconnection voltage but with a 30-min time delay.
- Note that the open flux area is constant during balanced magnetopause and tail reconnection.
- e) shows the central polar cap voltage assuming a circular expanding or contracting polar cap.



# The principle of flow-free equilibrium



**The ionospheric response to an impulse of magnetopause reconnection**

**The ionospheric response to an impulse of tail reconnection**



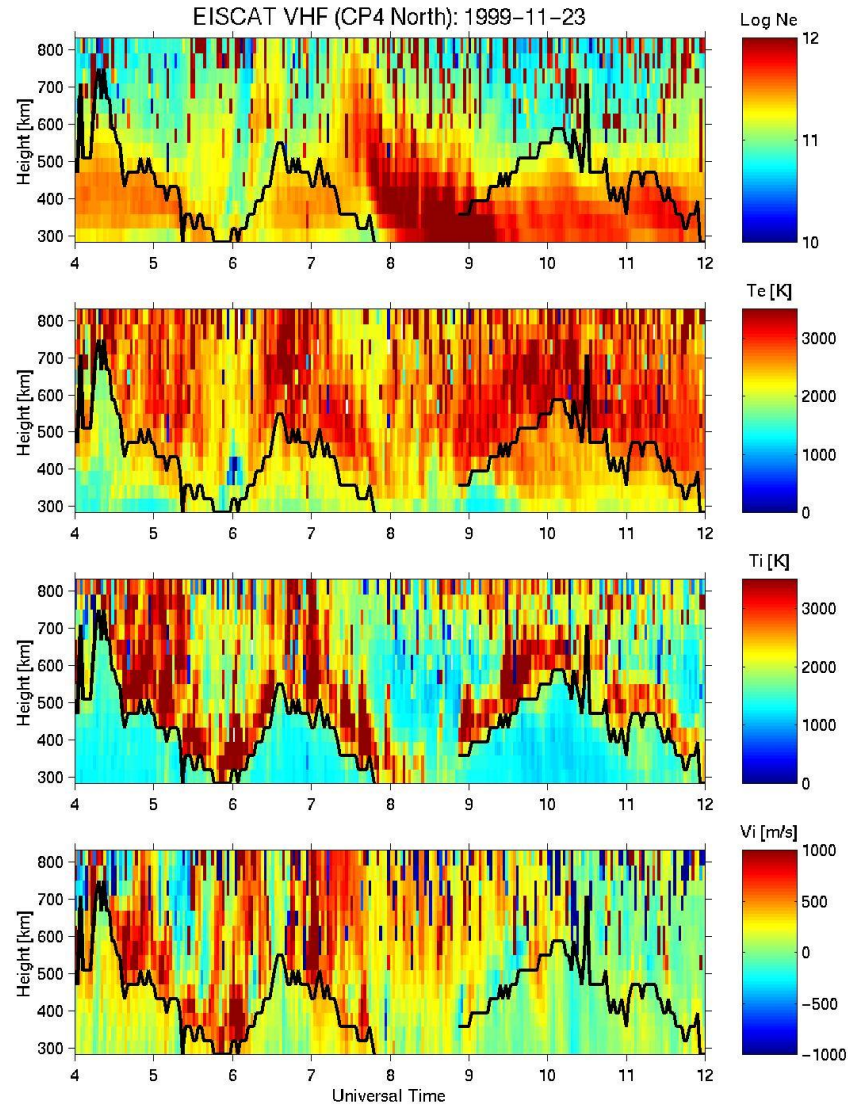
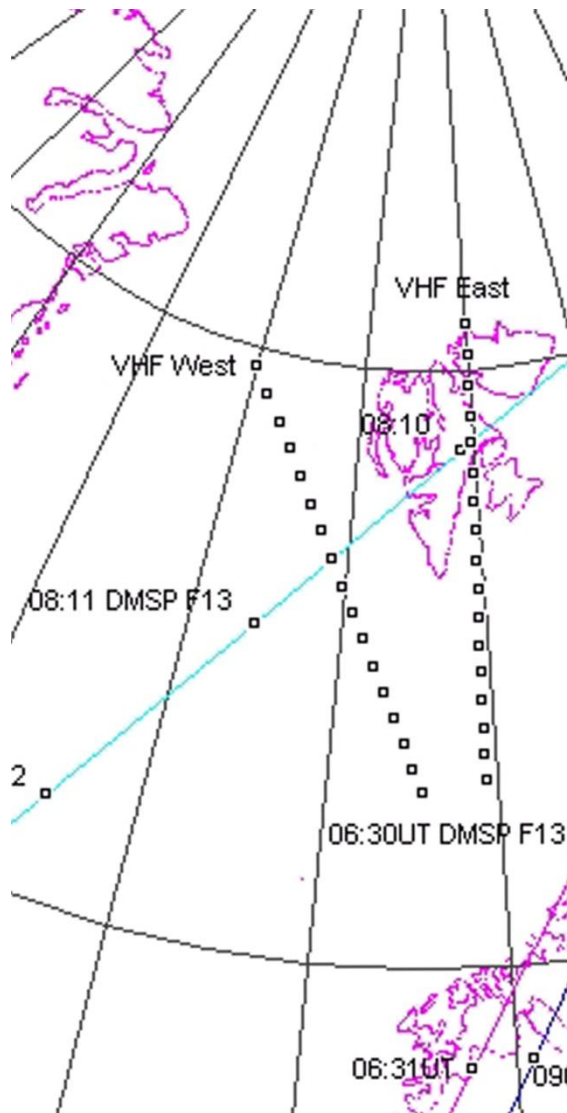
$$\frac{\Delta F}{\Delta t} = \text{Voltage}$$

$$[F] = [AB] = \text{Tm}^2 = \text{kg s}^{-1} \text{C}^{-1} \text{m}^2$$

$$\left[ \frac{\Delta F}{\Delta t} \right] = \frac{\text{kg m}^2}{\text{s}^2 \text{C}} = \frac{\text{J}}{\text{C}} = \text{V}$$



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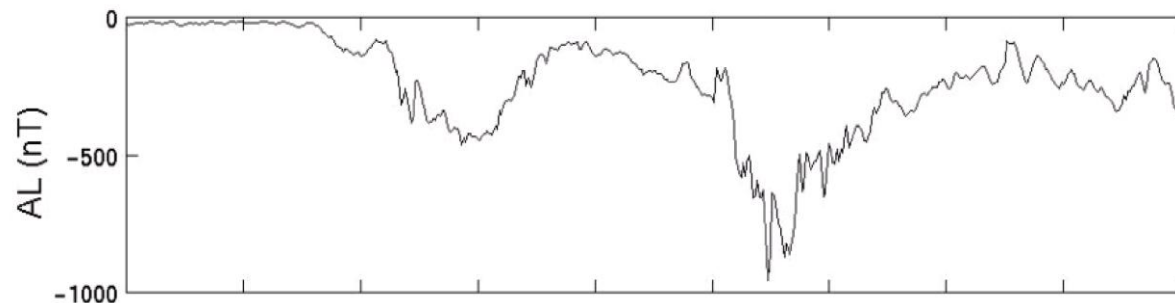
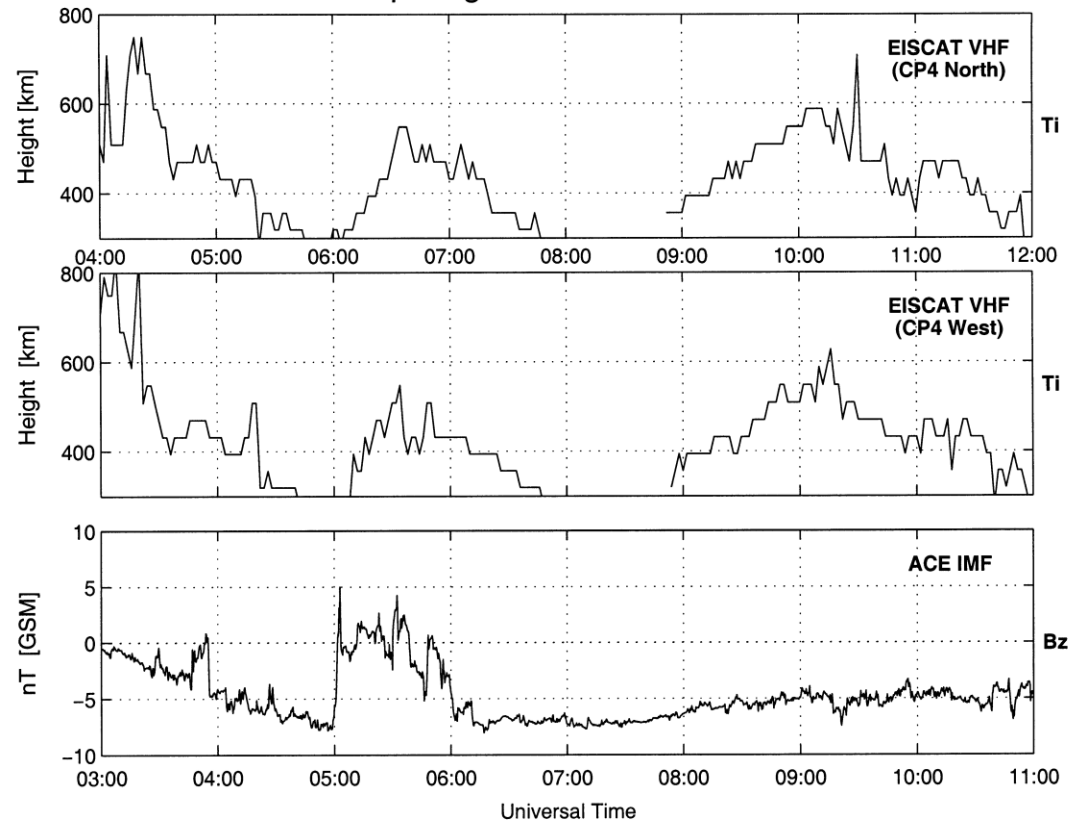




Evidence of Polar  
Cap Contraction  
during Bz south  
conditions –  
controlled by  
nightside tail  
reconnection

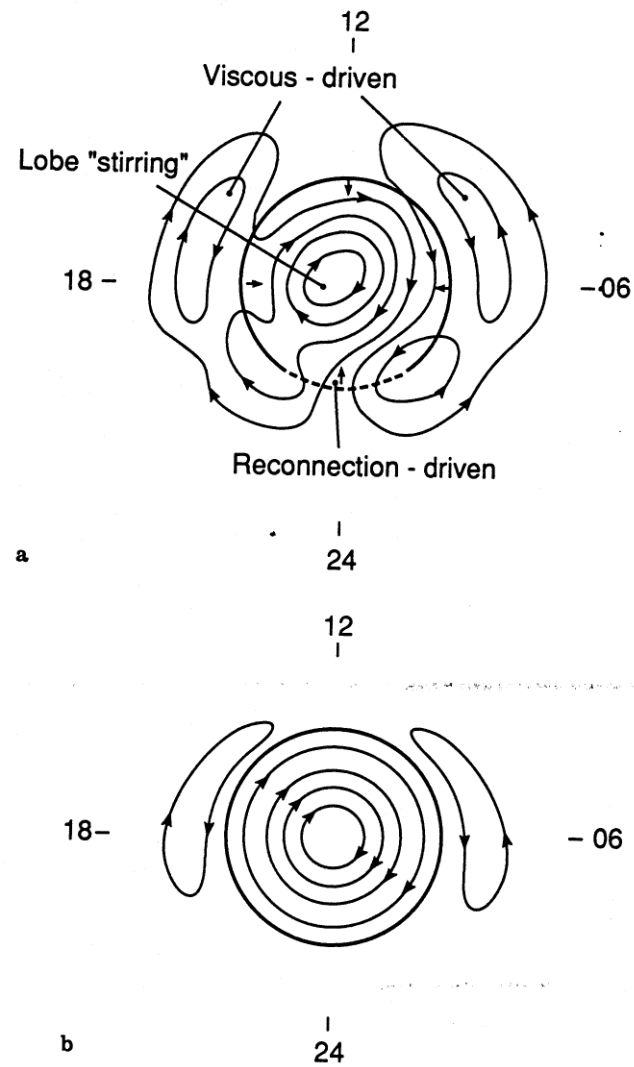
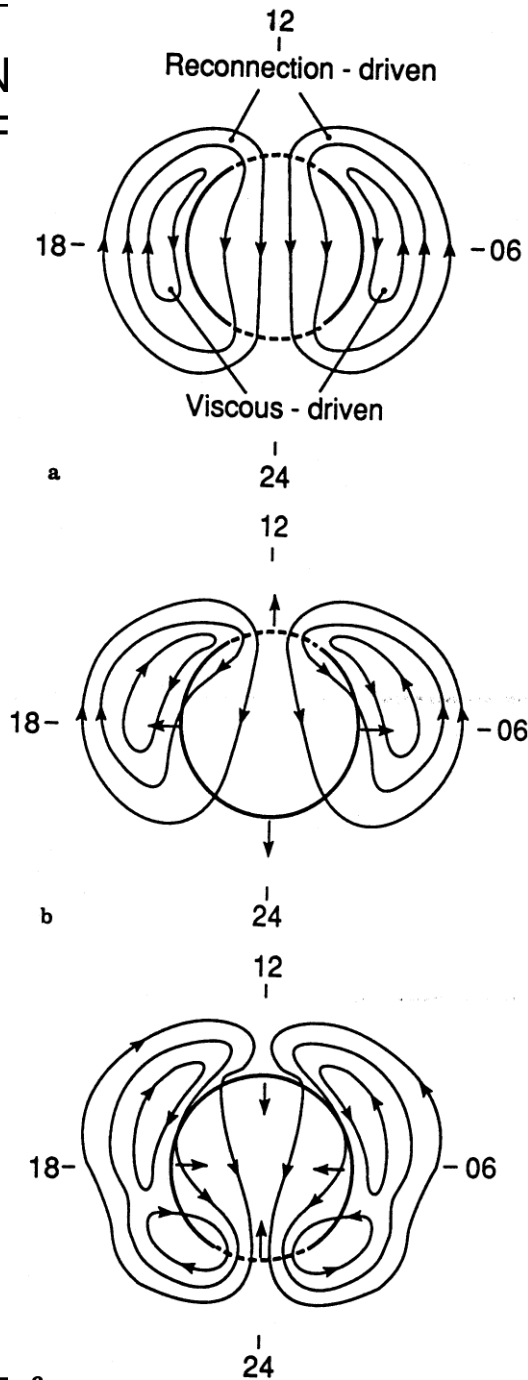
Consistent with the  
Cowley & Lockwood  
1992 flow model

Comparing Ti=2000K with IMF Bz





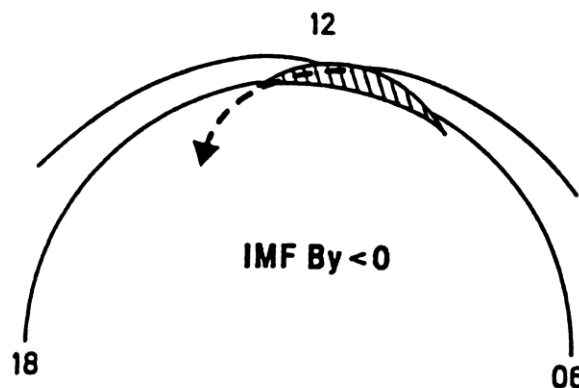
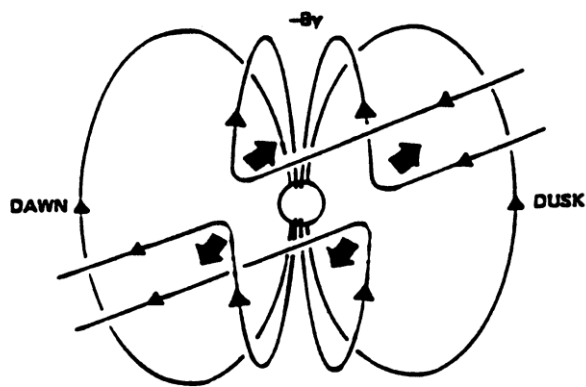
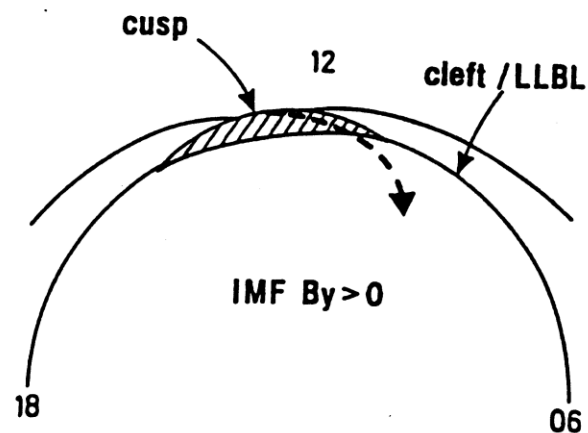
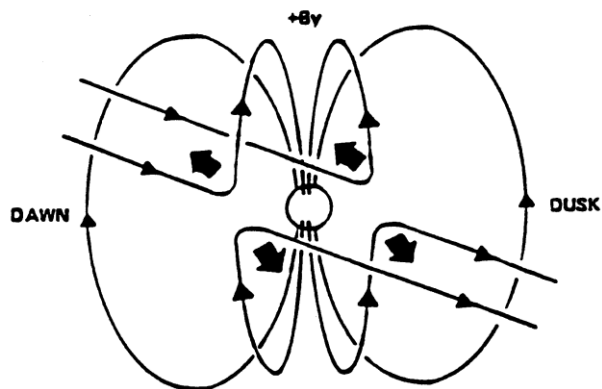
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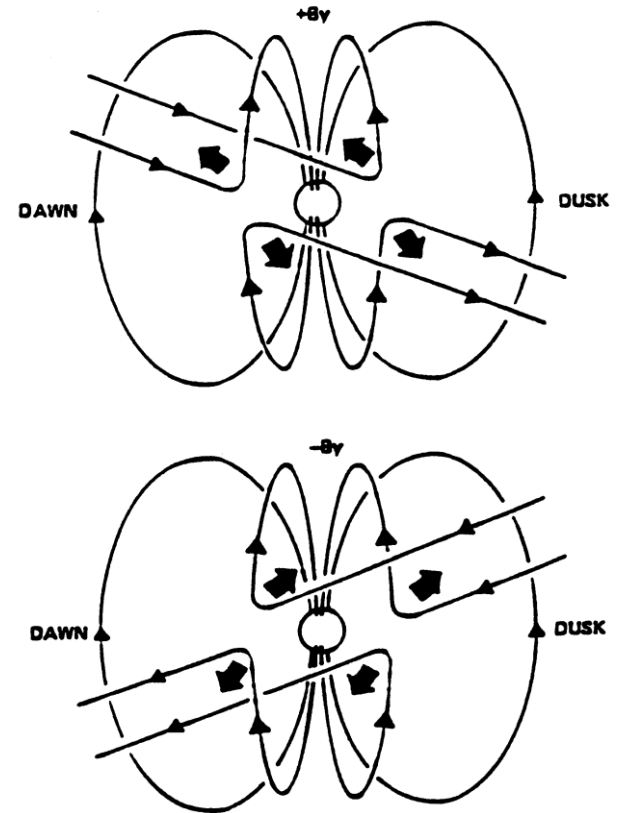
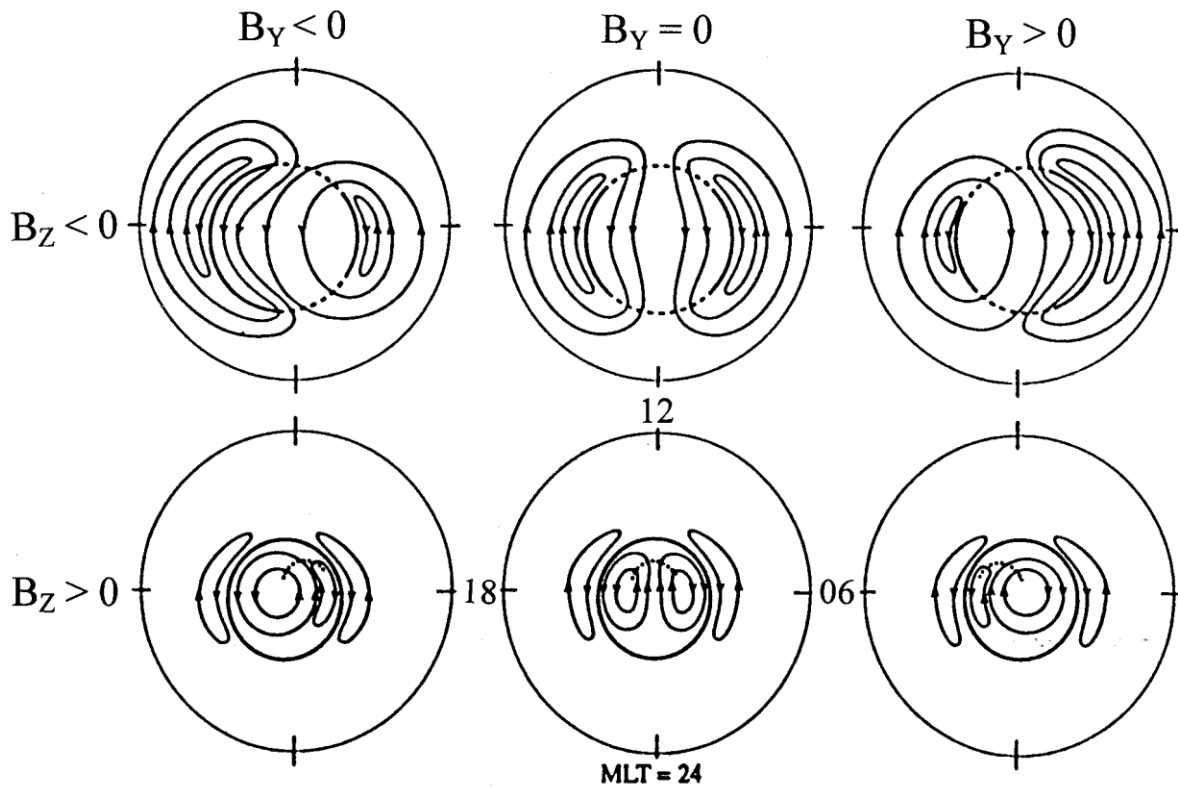
**Fig. 12 a, b.** Sketch of the high-latitude ionospheric flow in the Northern hemisphere for northward-directed IMFs and with IMF  $B_y$  positive, in the same format as Fig. 11. In **a** contributions to the flow are present due to non-reconnection "viscous" coupling at the magnetopause boundary, continued weak tail reconnection, and lobe "stirring" due to reconnection between the IMF and open lobe flux. **b** shows the reduced flow system which occurs in the complete absence of tail reconnection.



# IMF $B_y$ asymmetry on movement







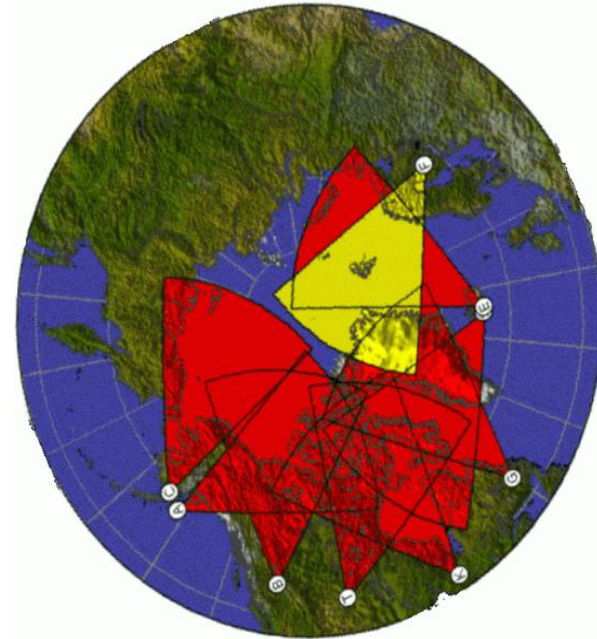
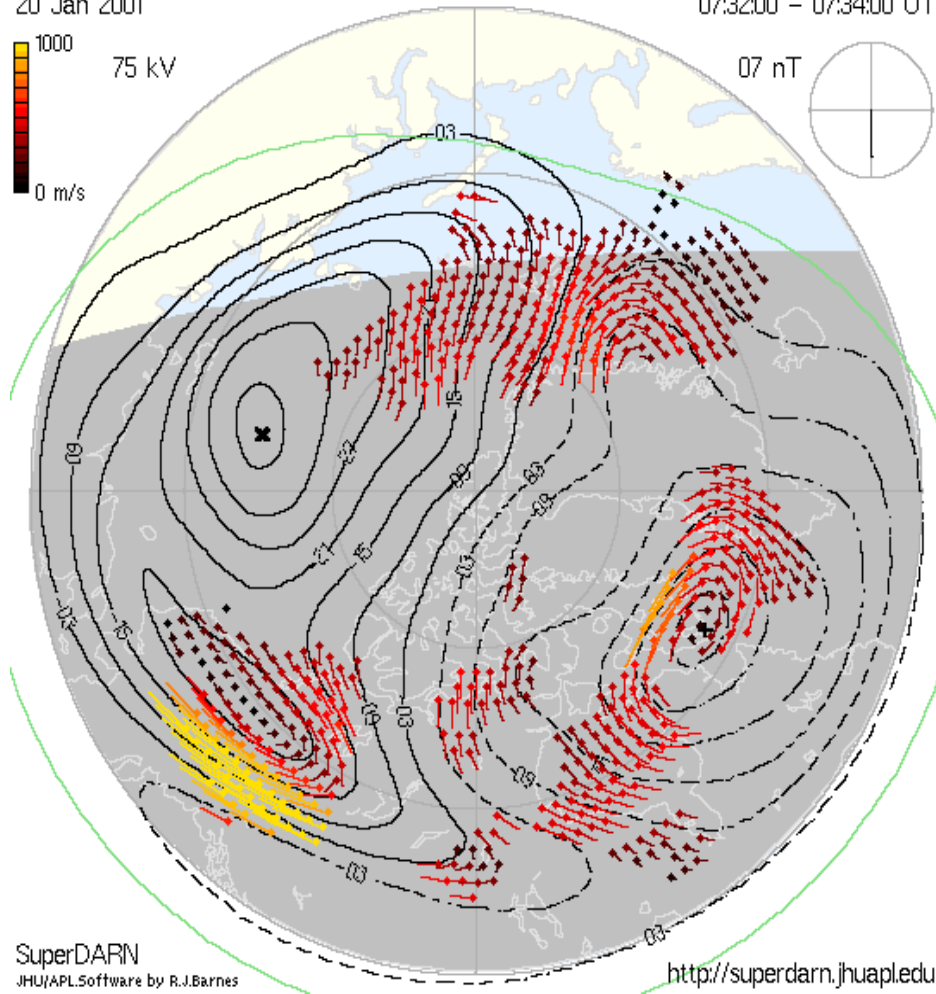
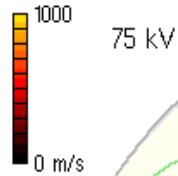


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# SuperDARN Radars

20 Jan 2001

07:32:00 - 07:34:00 UT



*A network of HF radars that monitors the high-latitude ionosphere.*