Inner Magnetosphere Response to IMF Changes

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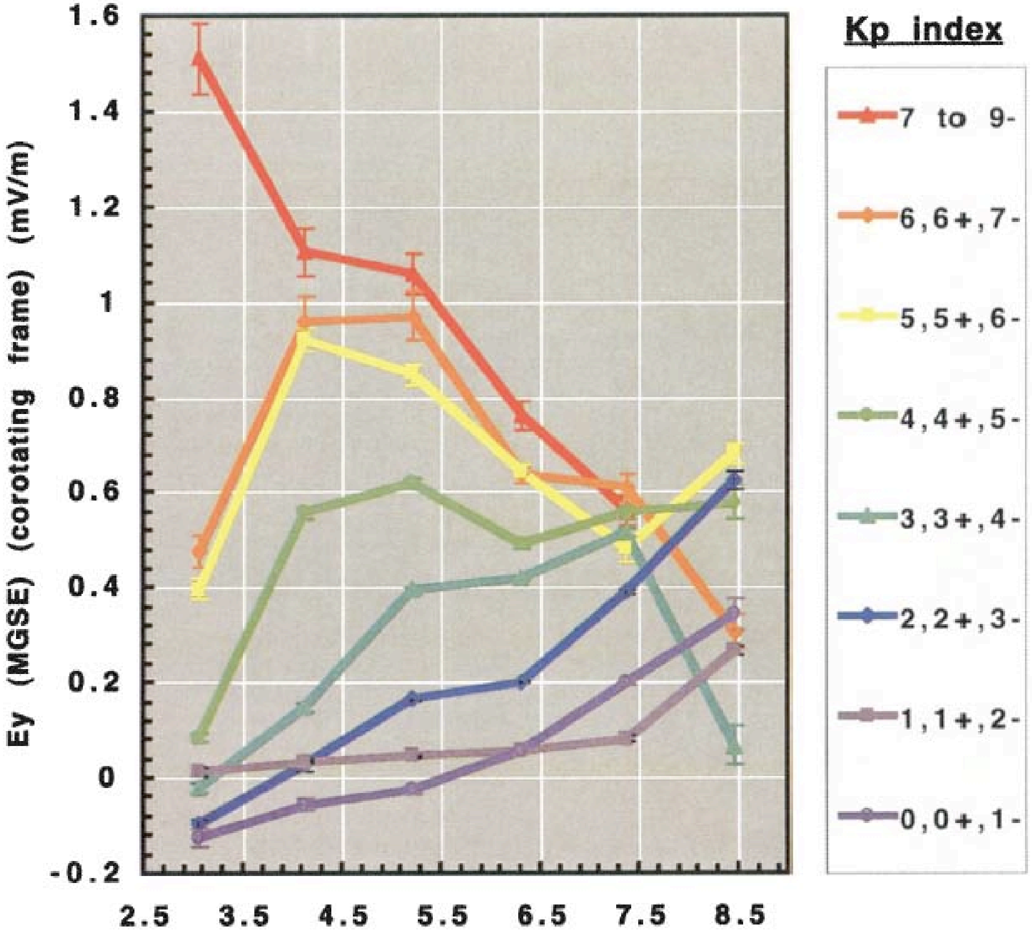
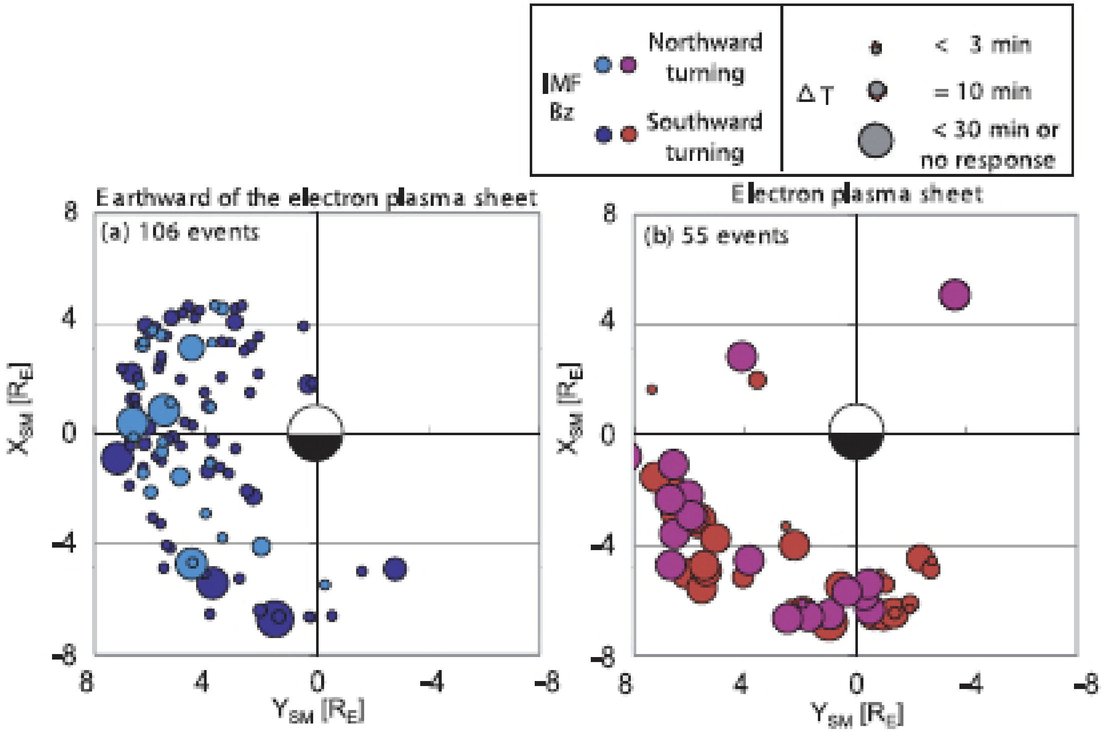
Outline

- CRRES observations
  - Strong inner magnetosphere electric fields for high Kp [Rowland & Wygant, 1998]
  - Timing shows inner magnetosphere moves first [Nishimura, 2009]
- Prompt Penetration Electric Fields
  - The surface ionosphere waveguide [Kikuchi, 2005]
- Alternative Mechanism
  - Fast-mode waves (rarefaction wave) driven by enhanced dayside reconnection
- Summary – Observational Tests
  - Poynting vector measurements – field-aligned or perpendicular?

Large Electric Fields for High Kp

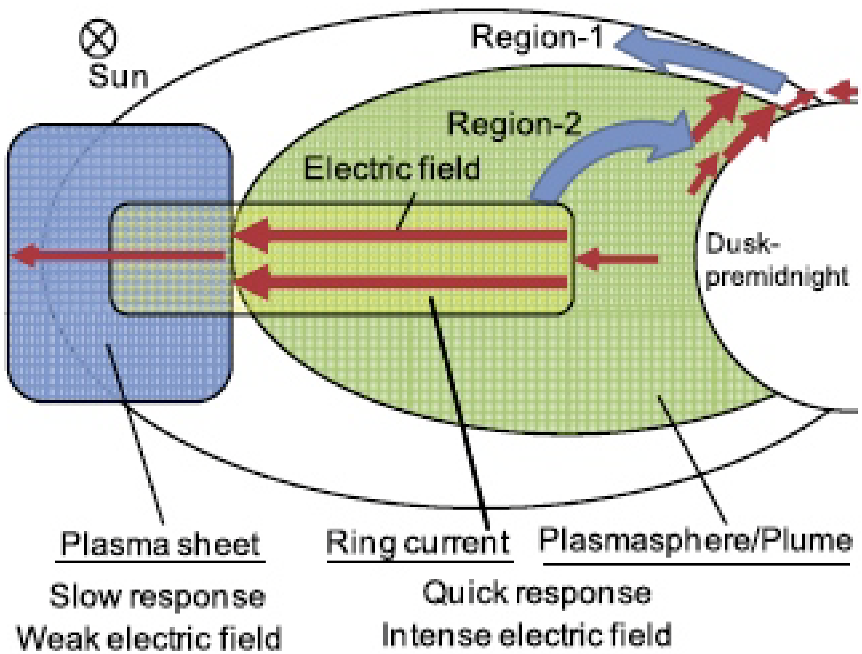


Nishimura [2009]



The inner magnetosphere, earthward of electron plasma sheet, appears to respond faster than the outer magnetosphere

Magnetospheric Convection Driven by Low Ionospheric Conductivity?



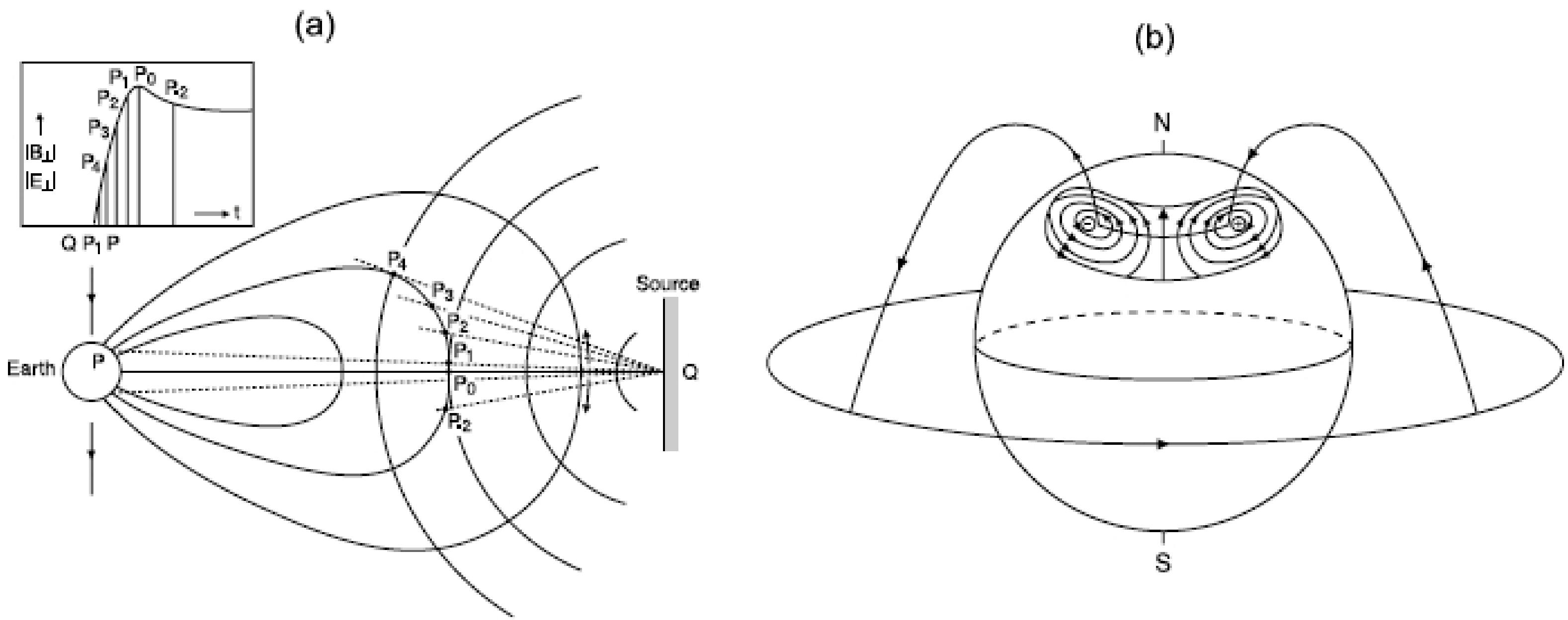
Nishimura argues that electromagnetic energy can flow out of the ionosphere

More easy in regions of low conductivity (e.g., SAPS region)

Issues:

- Where do the currents close?
- Current loop strongly suggests Poynting flux into the ionosphere
- Outward Poynting flux requires even stronger magnetic fields below the ionosphere – Kikuchi model

Alternative – Fast Mode transmitting a rarefaction wave to the inner magnetosphere



Tamao Travel Path [from Chi et al., 2006] (in this case modeling a compression response, but same principal applies to a rarefaction)

Fast mode propagates across the field and couples to shear-mode waves

Shear-mode drives convection vortices in the ionosphere

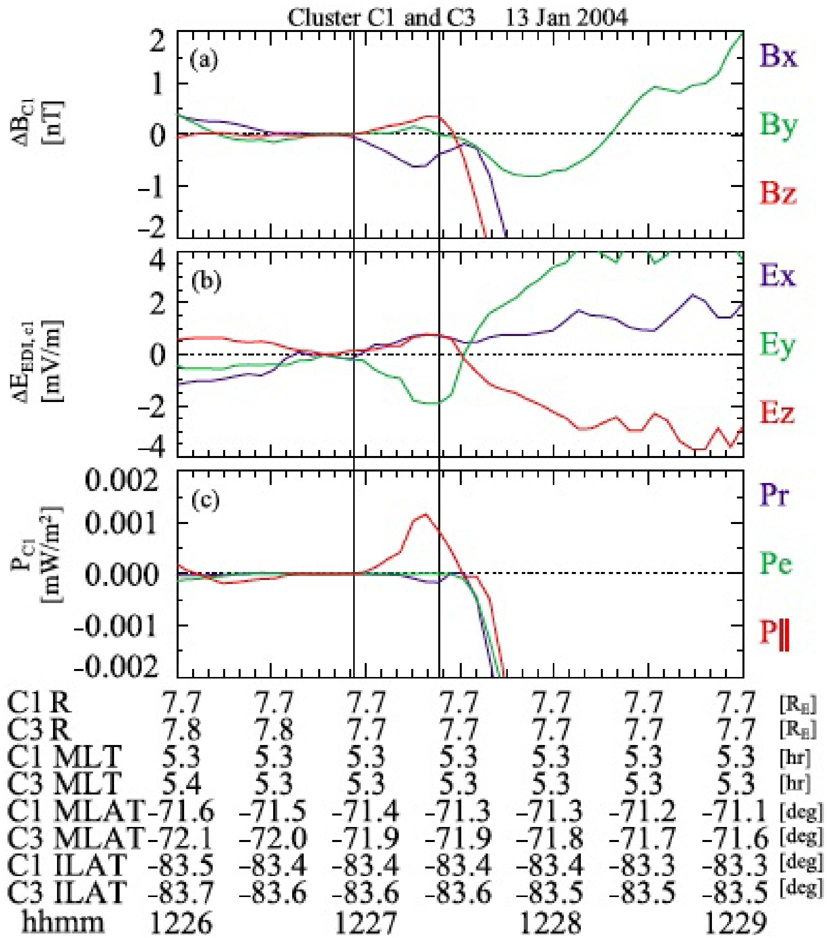
Nishimura 2010 –
Initial Impulse is Reversed Convection

Nishimura finds a brief (30-sec) preliminary impulse.

This impulse appears to have Poynting flux away from the ionosphere.

But, this corresponds to reverse (anti-sunward) convection.

So what is going on?



Summary

- There is clear evidence that the inner magnetosphere responds quickly to changes in the IMF
  - Understanding this response is not only relevant to RBSP science, but also has implications for auroral and sub-auroral phenomens (SAPS)
- How is the convection transmitted to the inner magnetosphere?
  - Low altitude path – earth-ionosphere waveguide or Alfvén resonator waveguide – implies Poynting flux out of the ionosphere
  - Fast mode propagation implies perpendicular Poynting flux
- Issue for RBSP
  - Need *careful* Poynting flux calculations
  - But what matters is the divergence of the Poynting flux
  - How do you separate out that portion that is dissipating?