

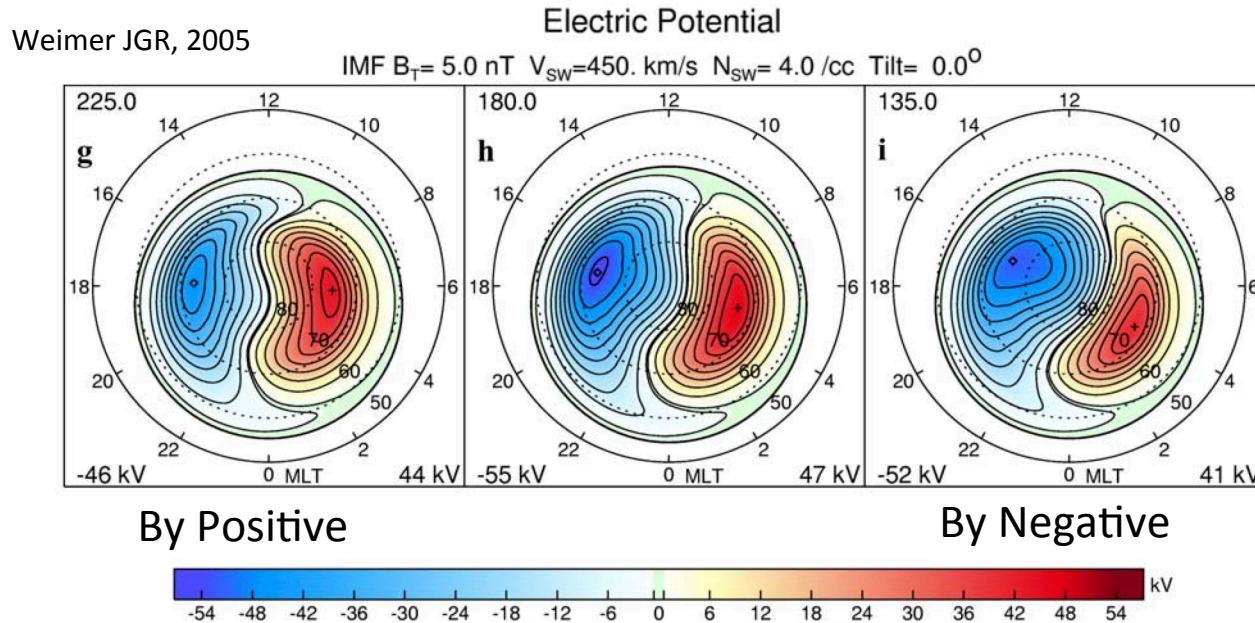
# Describing the High Latitude Ionospheric Convection Pattern

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## Outline

- **Variability in Convective Flows.**
- **Magnetospheric Constraints to Descriptions of the Convective Flow.**
- **Impacts on Data Assimilation.**

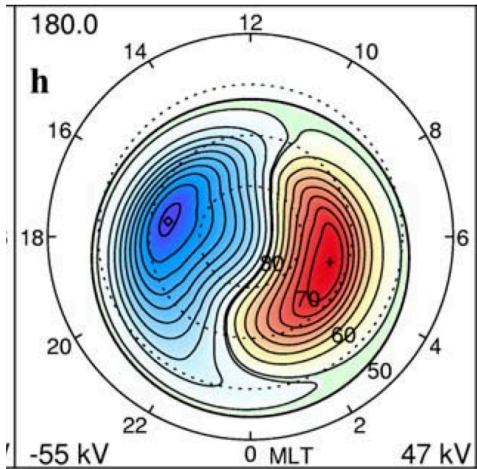
# Ionospheric Convection Pattern



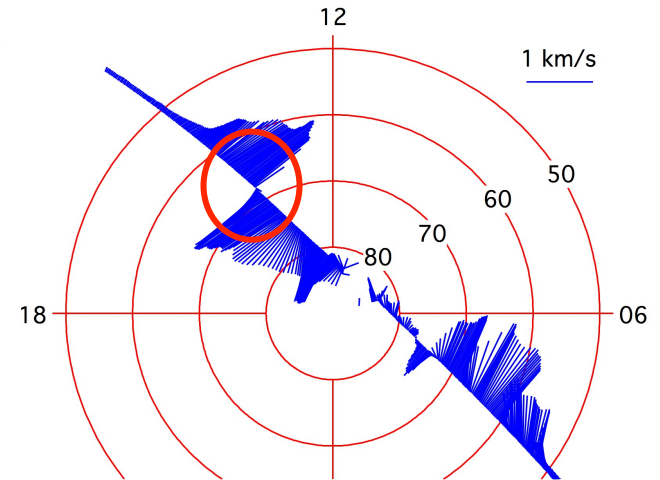
- Average Convection Patterns smear temporal and small scale spatial variations
- No application of Magnetospheric Constraints
  - Where are merging and reconnection sites?
- How does the pattern evolve from one state to another ?
- Patterns are independent of time history

# Model-Measurement Differences

- Average model shows potential extrema as a localized point

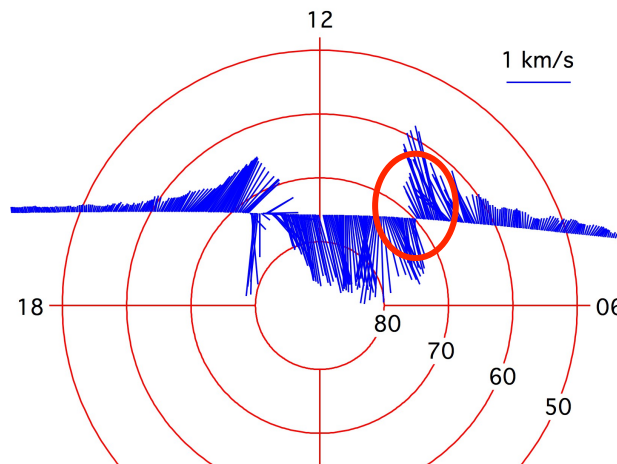


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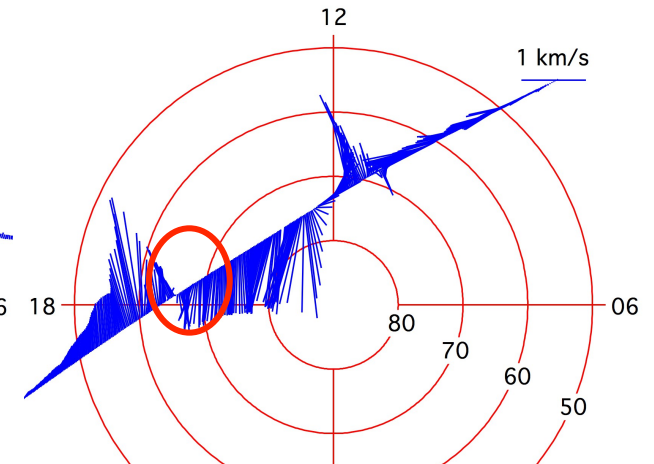


- Observations indicate that convection reversal is often a shear reversal with very small flows across the boundary.

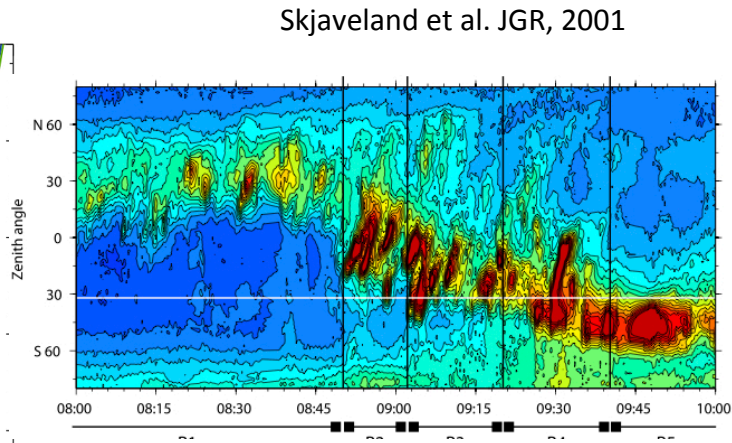
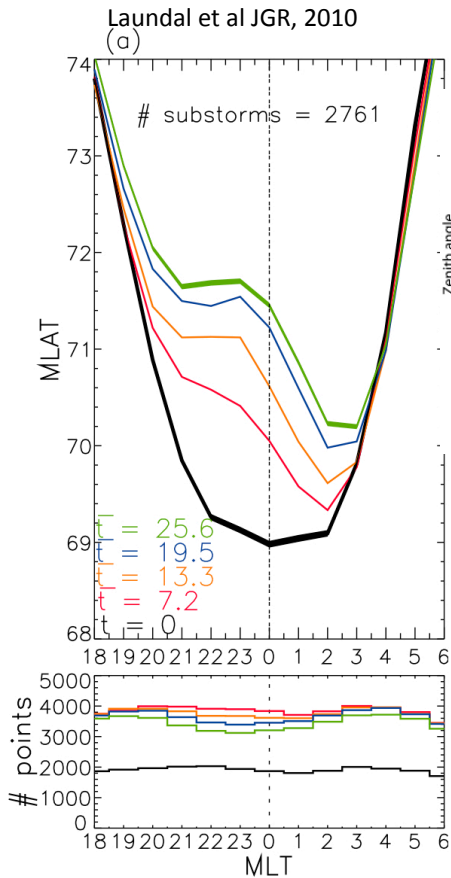
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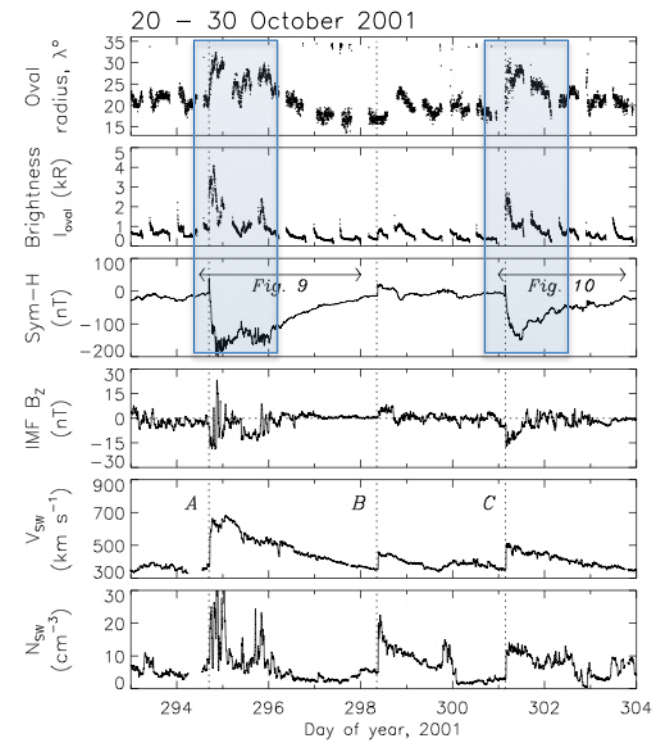


- Potential extrema are lines extended in local time but variable in universal time



Dayside merging events signified  
by poleward moving auroral  
emissions associated with  
equatorward motion of OCB as  
open flux is added to polar cap

Milan et al. AnnGeophys, 2010

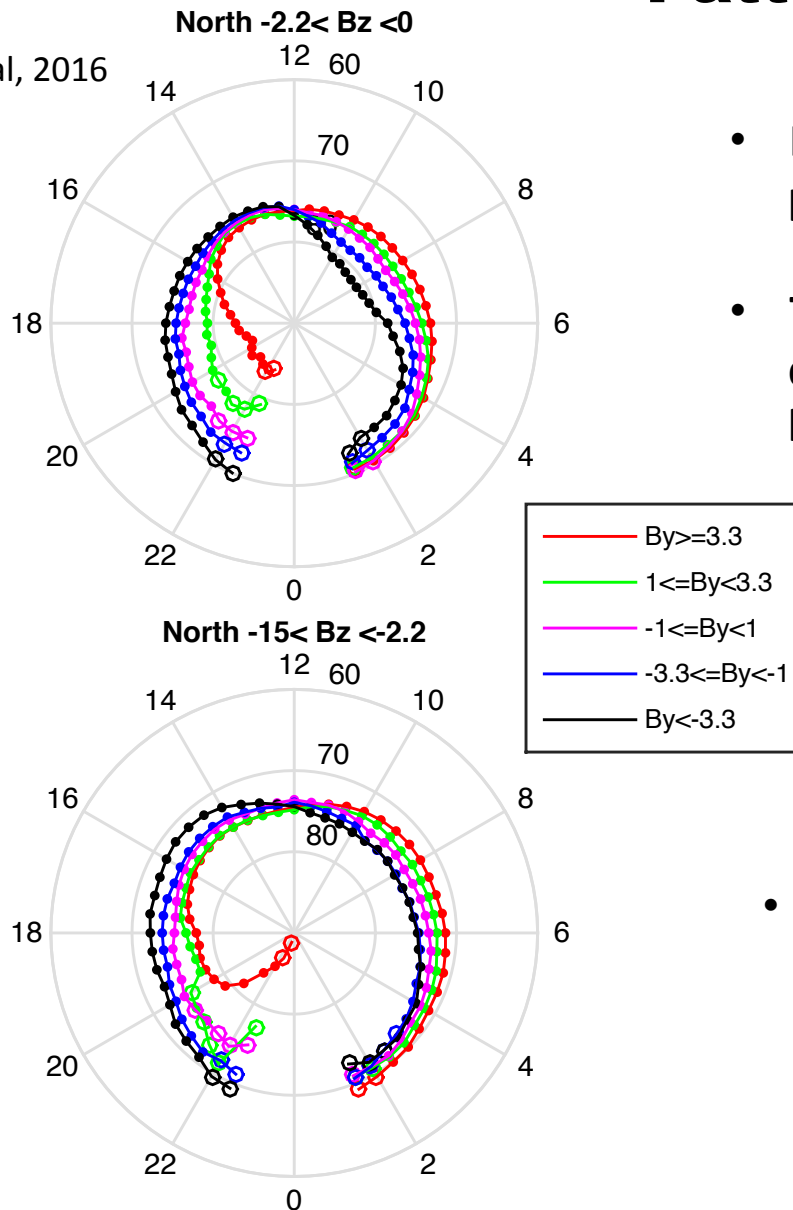


Added open flux as signified  
by decreasing Dst, results in  
expansion of OCB to lower  
latitudes

Nightside Reconnection  
“substorm” events  
associated with poleward  
motion of OCB as open flux  
is removed from polar cap.

# Time Varying Convection Pattern

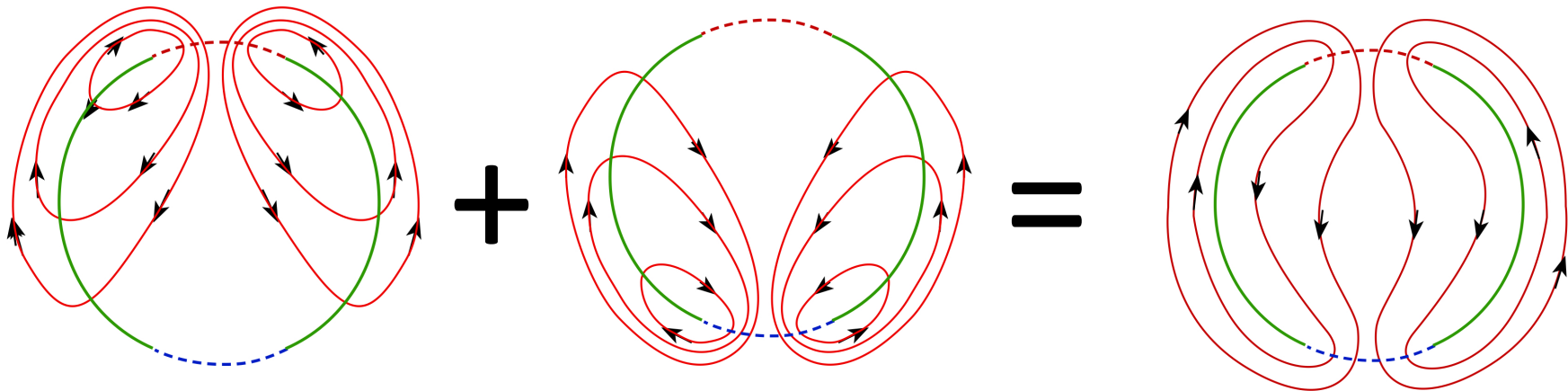
Chen et al, 2016



- Increase in IMF  $B_z$  produces expansion in polar cap boundary.
- Transition from  $B_y$  +ve to  $B_y$  -ve produces duskward displacement of polar cap boundary (in northern hemisphere)

- Large scale reconfiguration of the polar cap boundary in response to changes in IMF  $B_y$  and IMF  $B_z$  are consistent with expanding/contracting model.

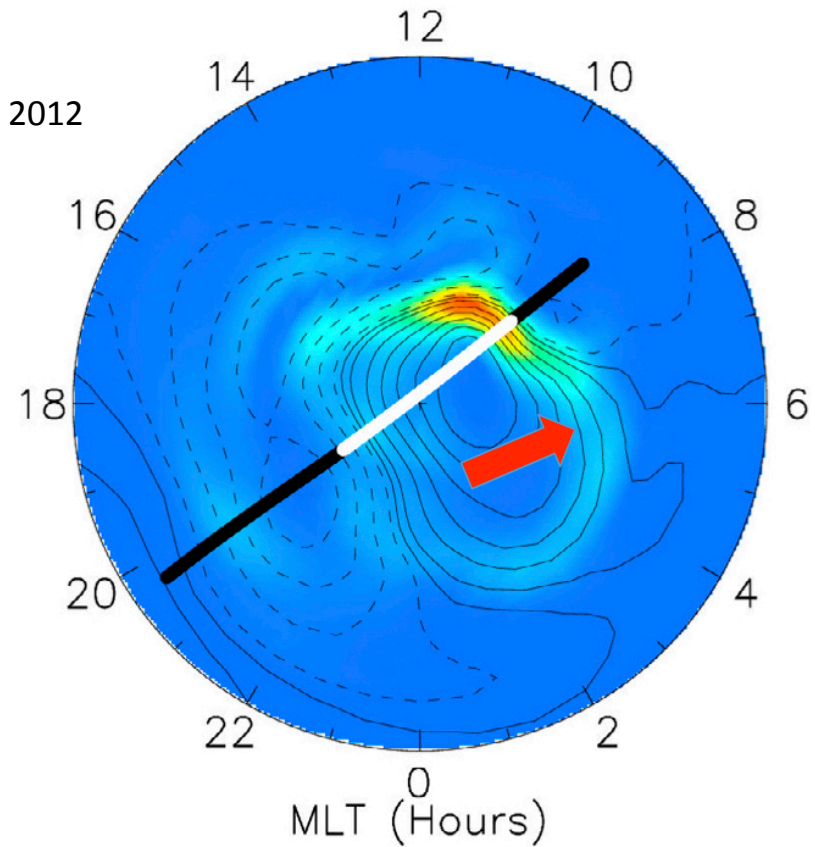
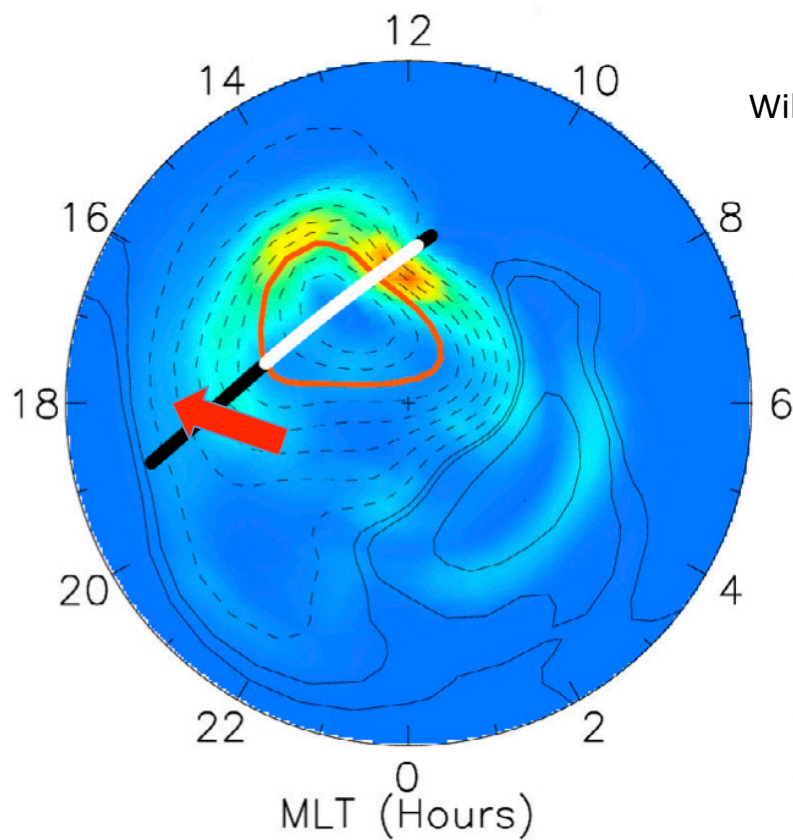
# Temporal Evolution of Convection Pattern



Dynamic Convection Pattern based on Expanding/Contracting Polar Cap Model  
Siscoe and Huang (JGR, 1985) Cowley and Lockwood (Annales 1992)

- **In Quasi-Steady State flow reversals are shear flows as observed**
- **Boundary expands and contracts**
- **Almost no flow across the boundary at the dawn and dusk flanks (4-5 hours in local time )**
- **Substantial portions of the boundary expand and contract in response to imbalances in merging and reconnection rates.**
  - **Boundary motion determined by potential distribution along it.**
- **These magnetospheric influences are not included in any assimilation of ionospheric data ?**

# Evolution of Convection Pattern



**Equatorward Flows near dawn and dusk imply that polar cap boundary is moving equatorward.**

**Pattern at later local time must be consistent with this finding.**

# Time Variations in Data Assimilation

- **Solar –Wind Magnetosphere Interaction limits the local time at which plasma can flow across the polar cap boundary.**
- **Near dawn and dusk plasma cannot flow across the boundary.**
- **Near dawn and dusk the boundary must move in accord with the potential distribution along it.**
- **Convection Pattern at time  $T+\Delta t$  is not independent of Convection Pattern at time  $T$ .**
- **Can this magnetospheric constraint be incorporated into data assimilation techniques?**