



# Steady Magnetospheric Convection: A SuperDARN Perspective

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# Motivation

- Understanding the stability of a system is fundamental to understanding the system as a whole
- Steady Magnetospheric Convection is a special and relatively rare state of dynamic equilibrium of the magnetosphere
- SMC has never before been studied using measurements of convection

# Overview

- We must begin with SuperDARN carefully, though...
- *a priori* statistical convection patterns may cause problems
- Used SuperDARN to improve previous ad hoc definitions of SMC based on Auroral Electrojet indices

# Topics for Discussion

- *Review of New SMC Selection Criterion:*
  - developed variable AE index threshold
  - reduces photo-conductivity effects
- *SuperDARN & SMC*
  - compare SMC events with “typical” and “non-enhanced” intervals statistically
  - superposed epoch analysis
  - scatterplot comparisons

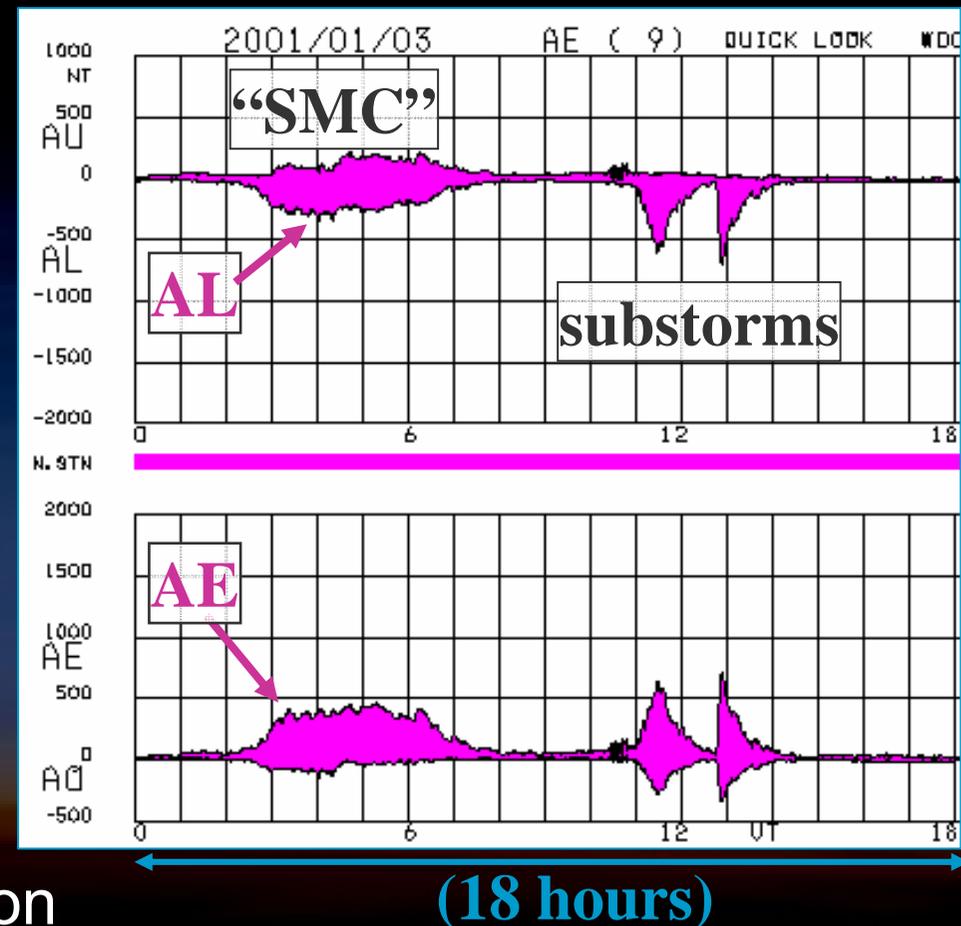
# Finding a Definition of SMC

- Initial SMC definition:

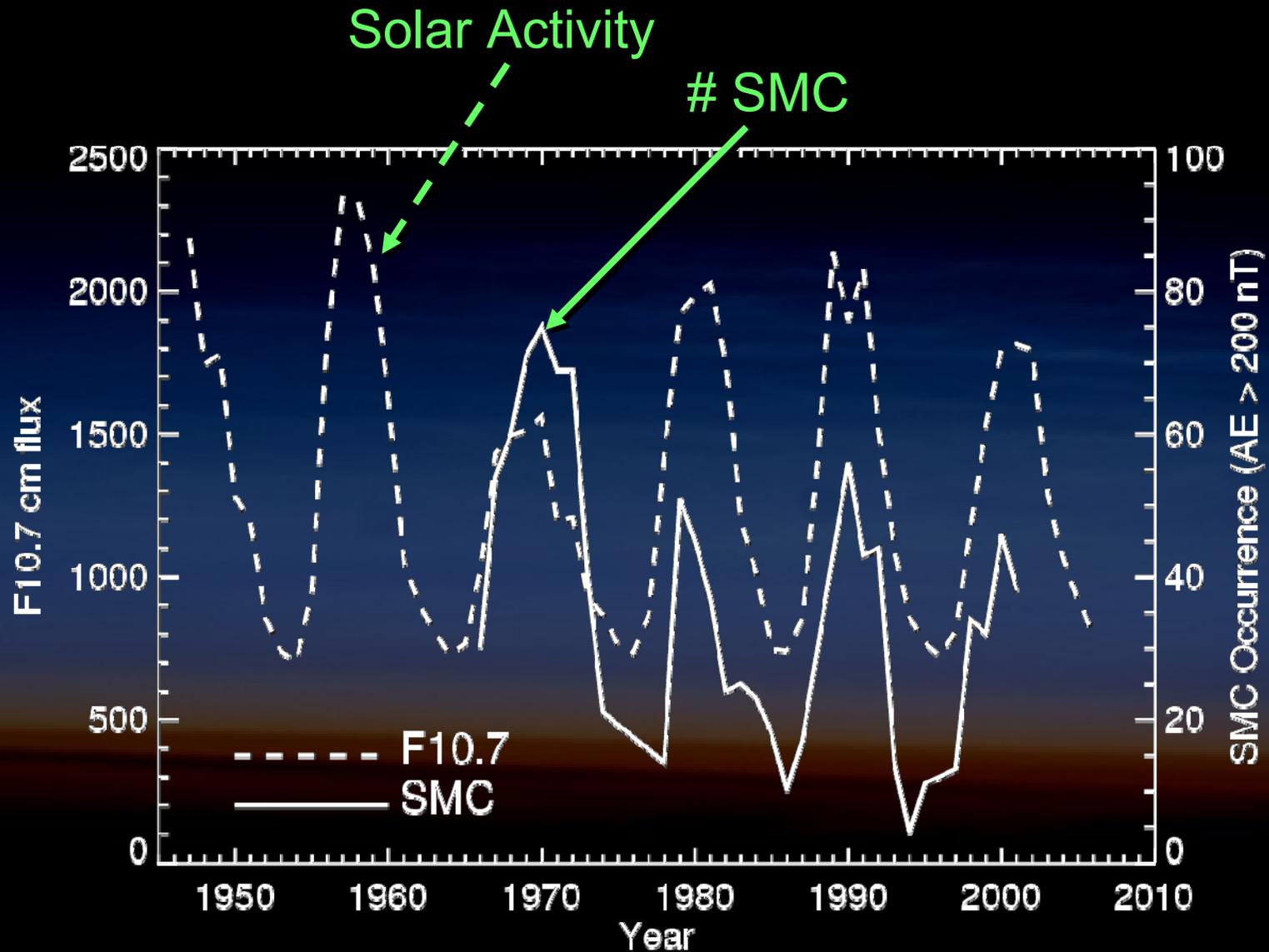
- $AE \geq 200$  nT  
("enhanced" convection)
- $dAL/dt \geq -25$  nT/min  
(no substorm)
- duration  $\geq 3$  hours
- (based on O'Brien et al., 2002)

- Problems:

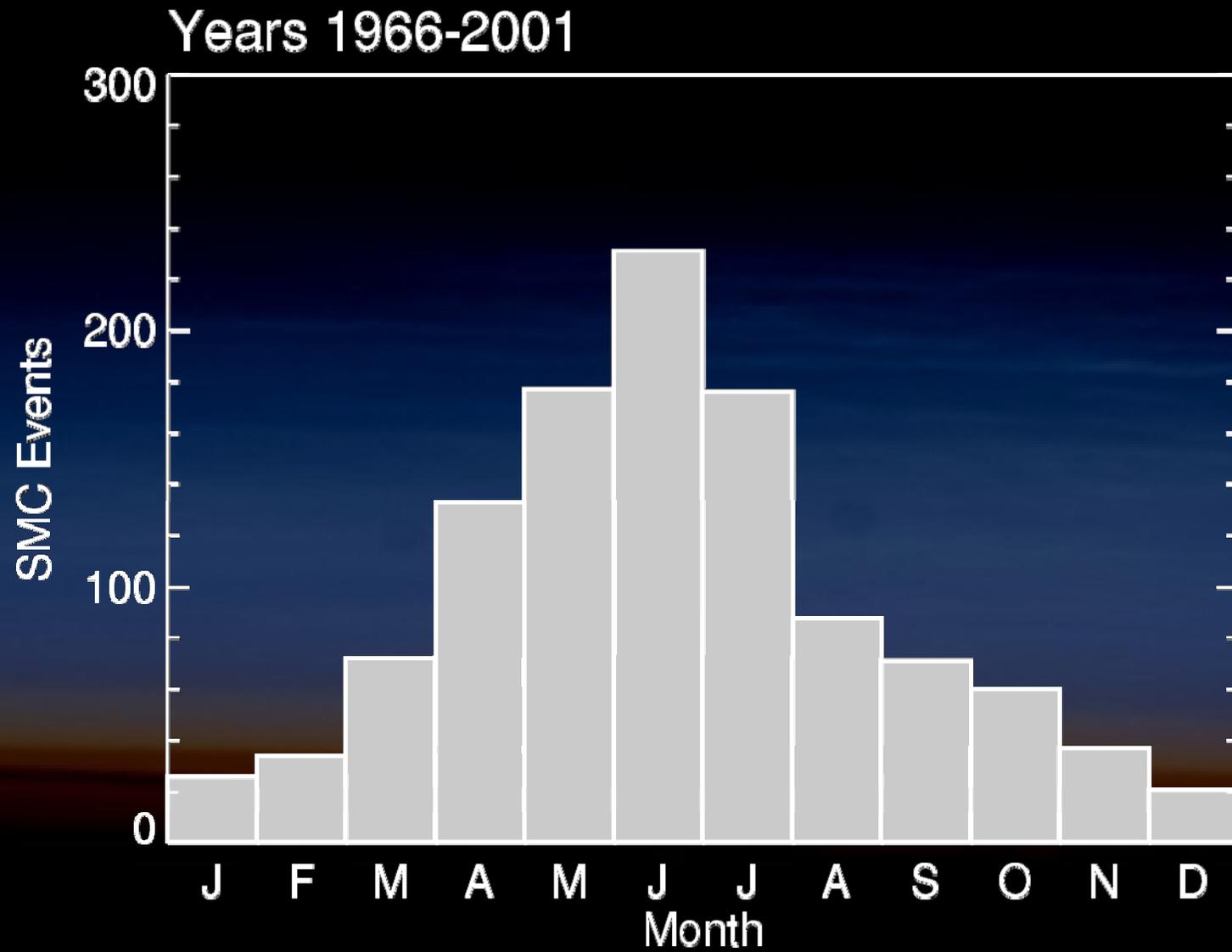
- AE measures currents,  
not convection
- can not separate convection  
and conductivity



# SMC Solar Cycle Dependence



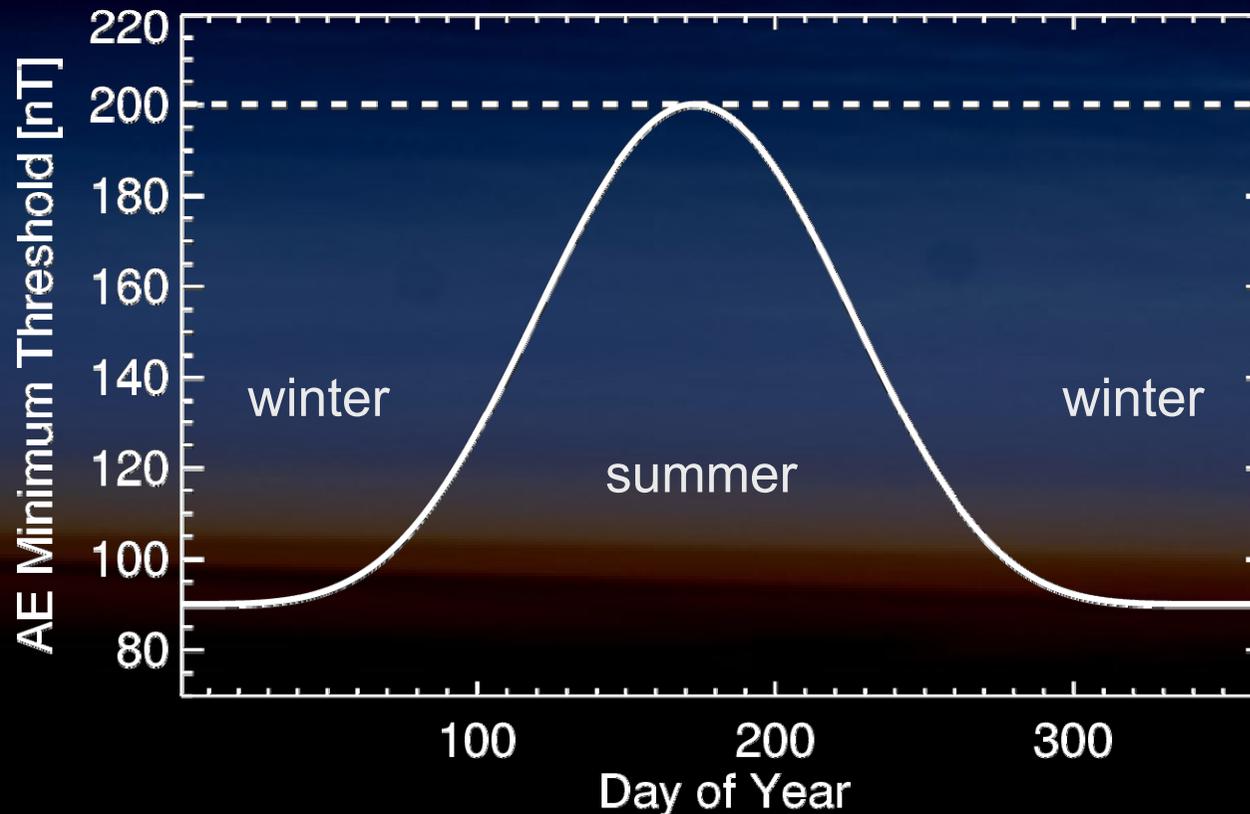
# SMC Seasonal Dependence (AE>200nT)



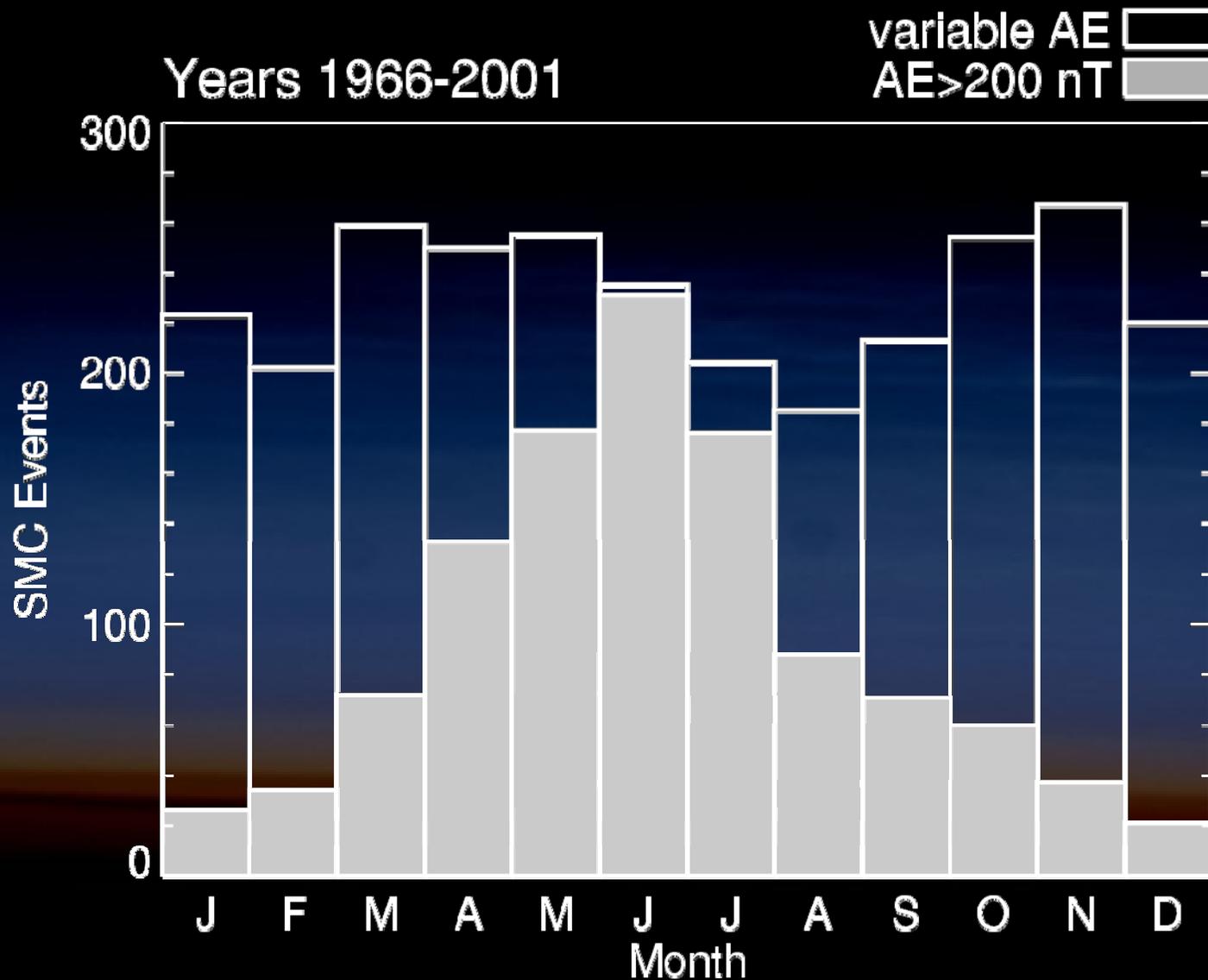
# The Best Function

$$AE \text{ [nT]} \geq 90 + 110 \cos^5 \left( \frac{x - 173}{365} \pi \right)$$

- This new variable AE cutoff should quantify convection above a constant value, rather than be a constant current threshold



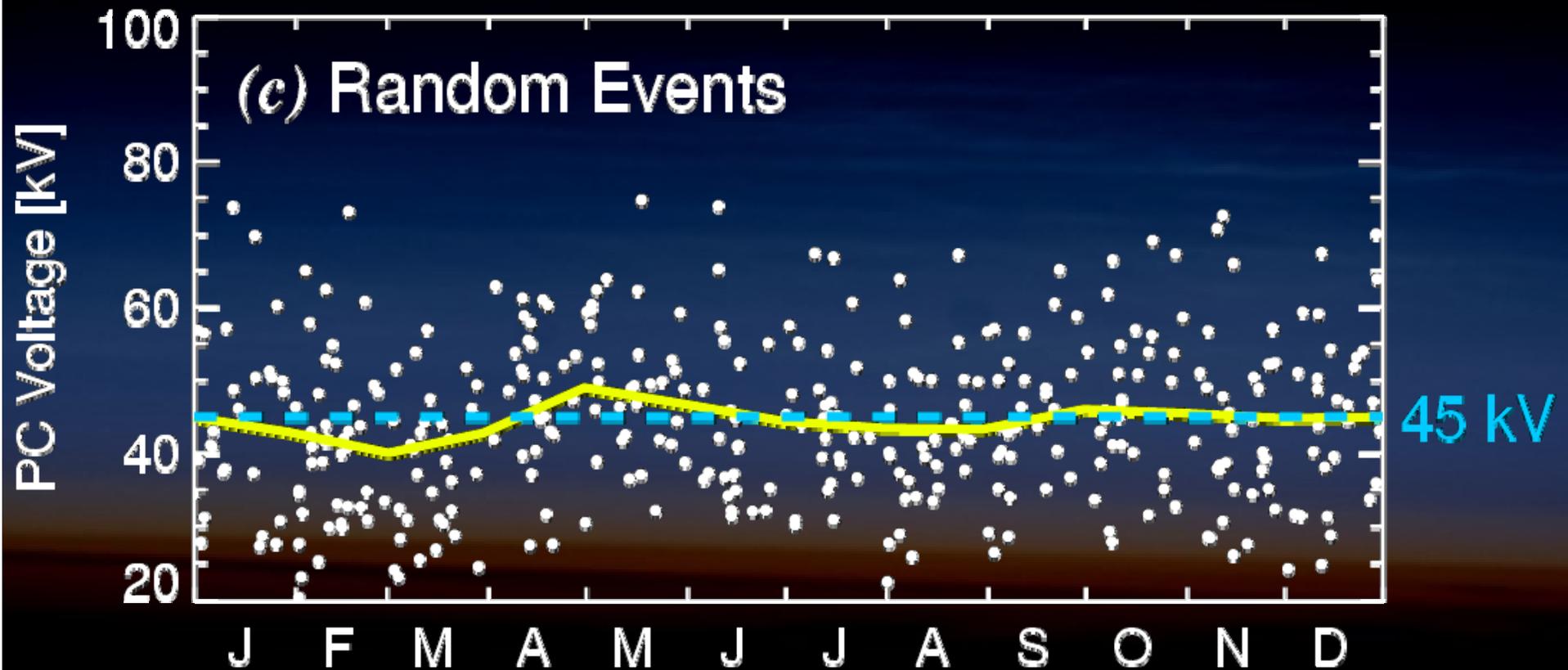
# The New & Improved SMC Distribution



# What Does SuperDARN See, Typically?

## *SuperDARN Voltages:*

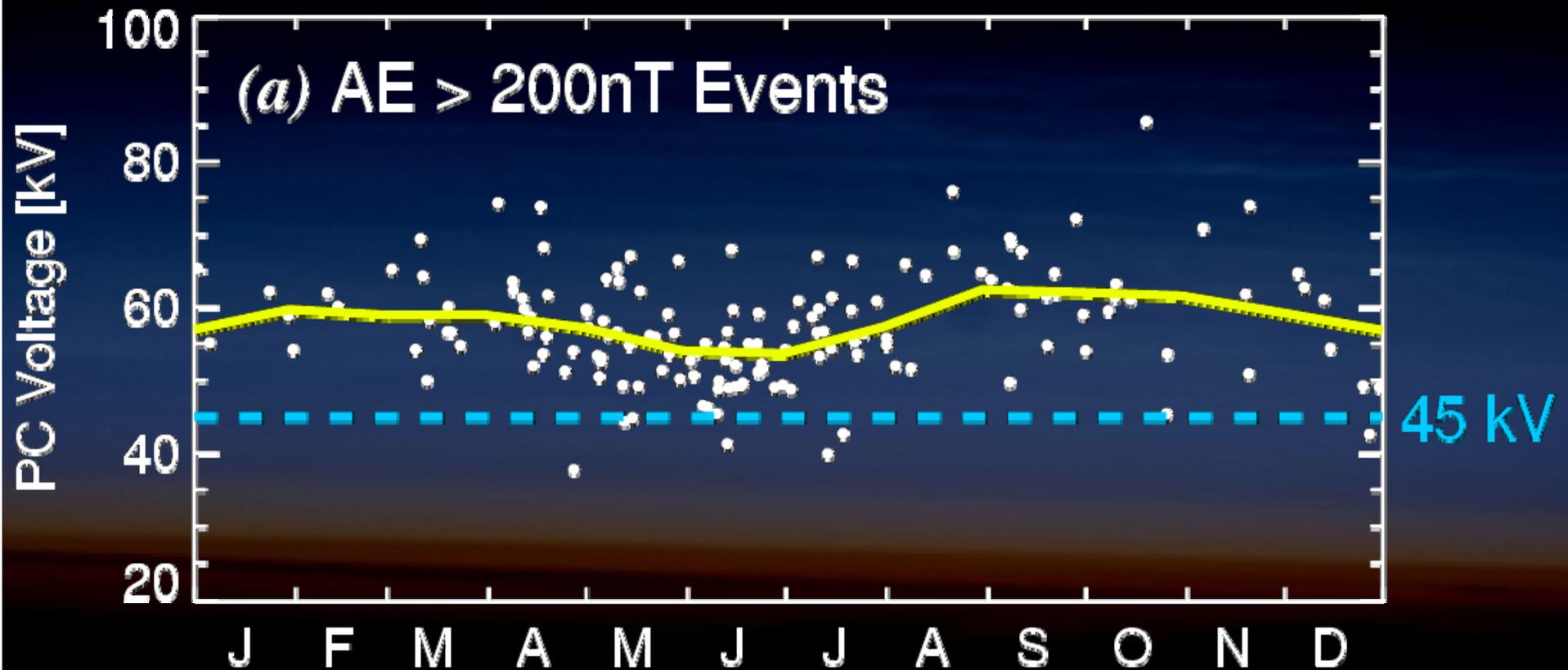
Years 1998-2001



# Constant AE Cutoff (200 nT) SMCs

## *SuperDARN Voltages:*

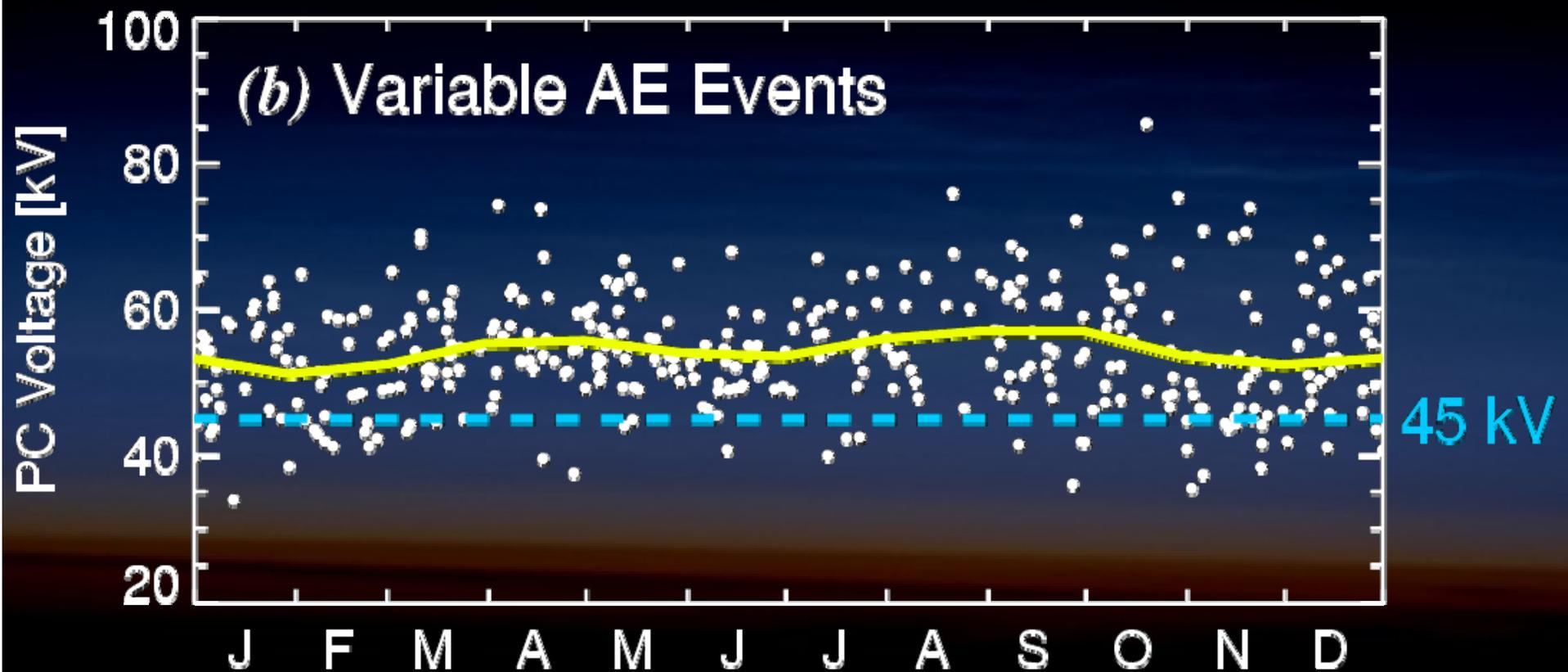
Years 1998-2001



# "Improved" SMC Events

## *SuperDARN Voltages:*

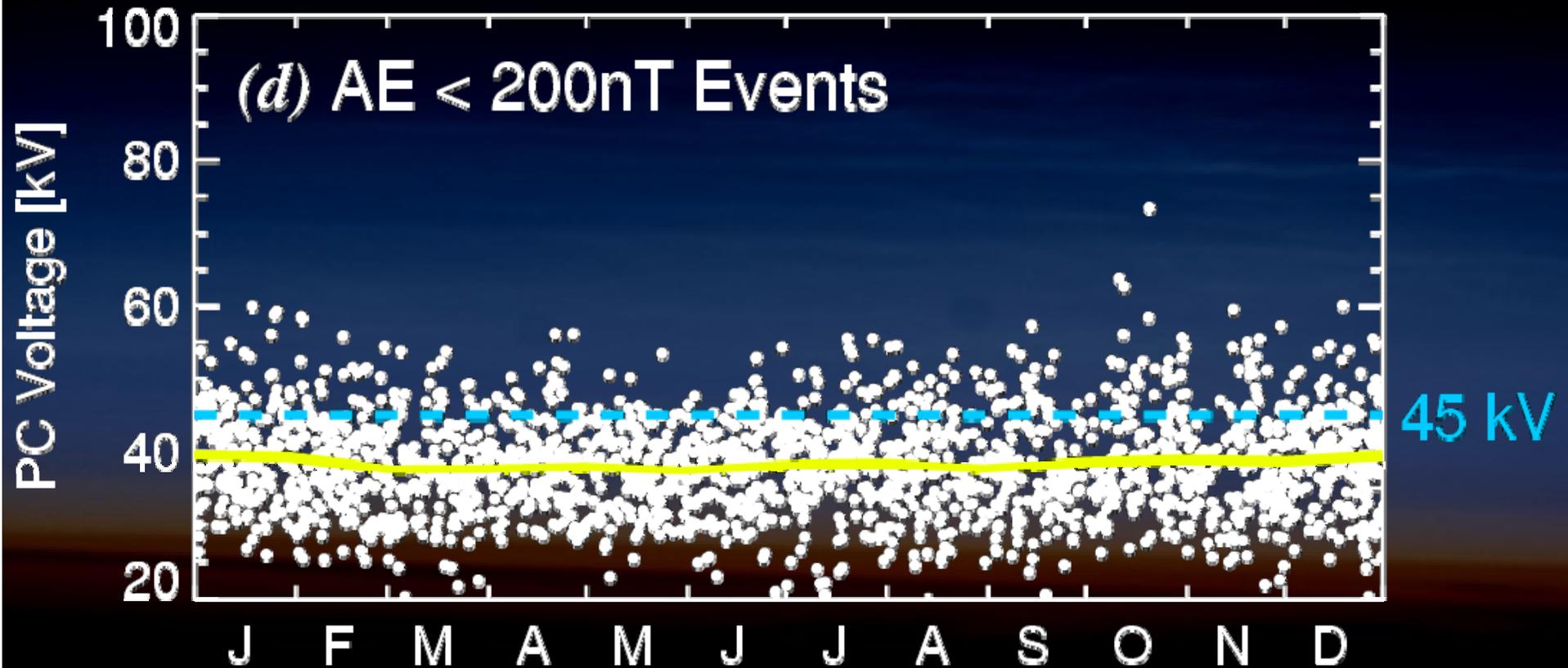
Years 1998-2001



# Cautious Check of AE < 200 nT Intervals

## *SuperDARN Voltages:*

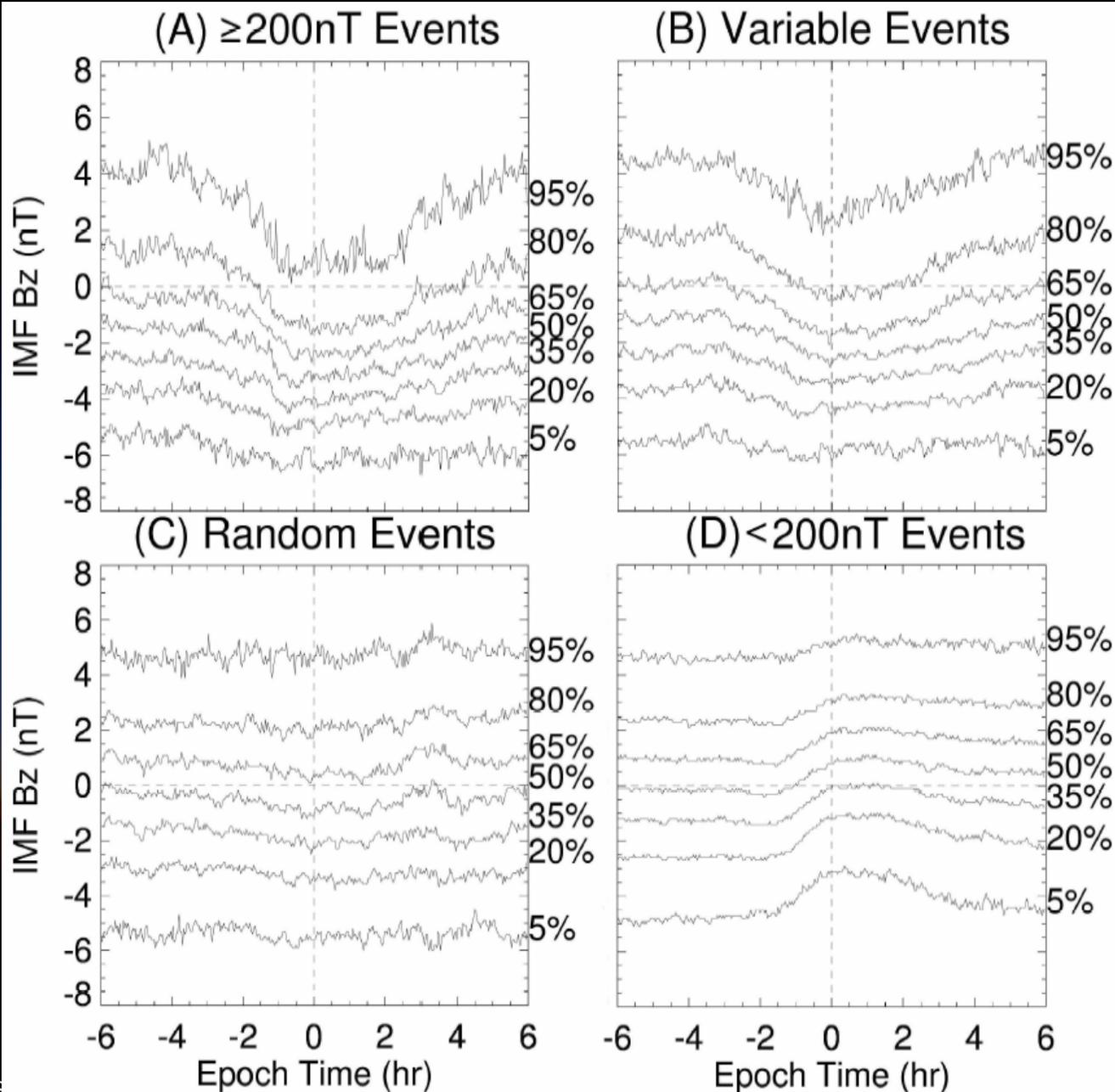
Years 1998-2001



# Cumulative Distributions: IMF Bz

“traditional”  
SMC

“typical”  
conditions

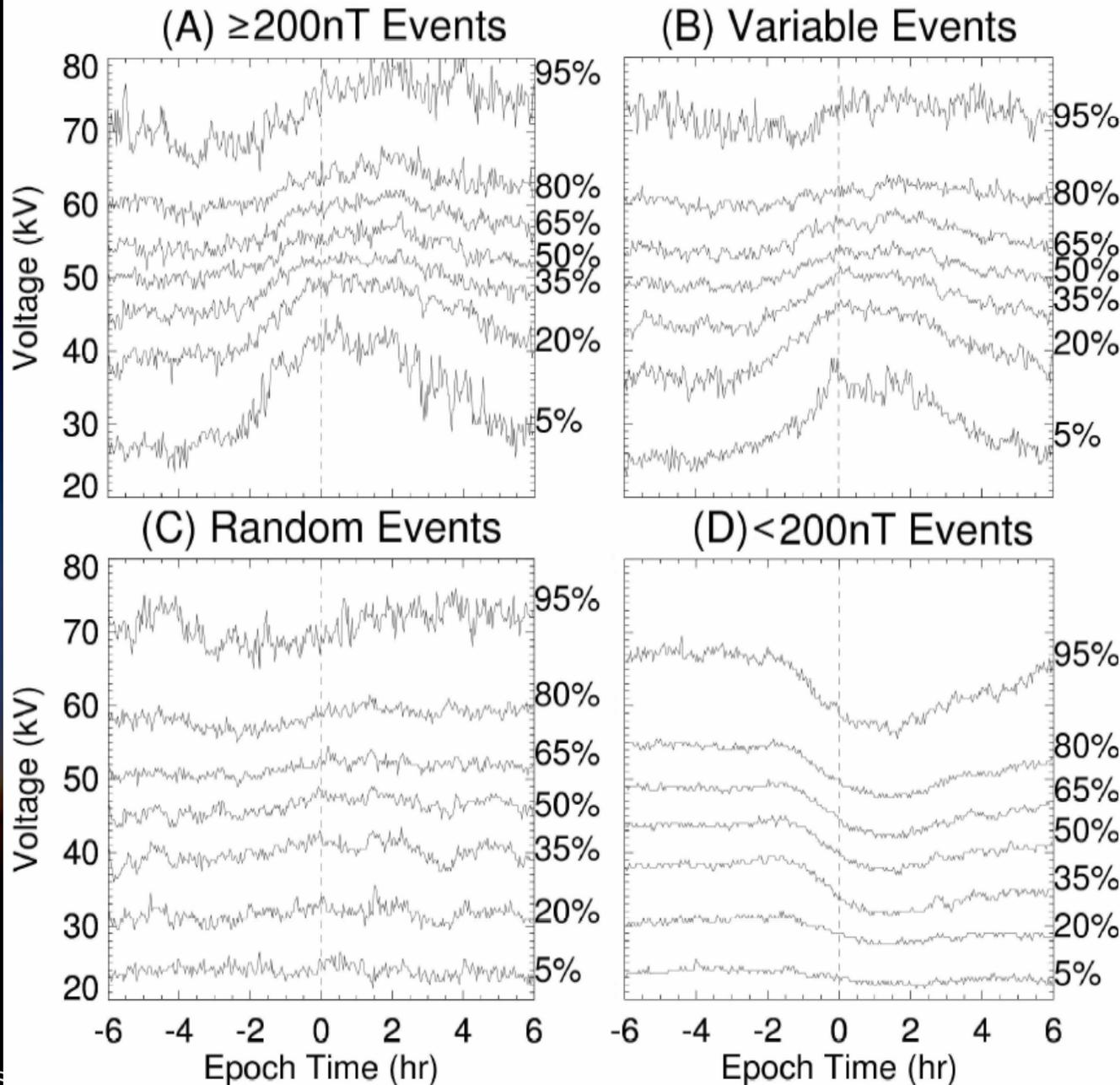


“improved”  
SMC

“non-  
enhanced”

# Cumulative Distributions: SuperDARN PCPD

“traditional”  
SMC



“improved”  
SMC

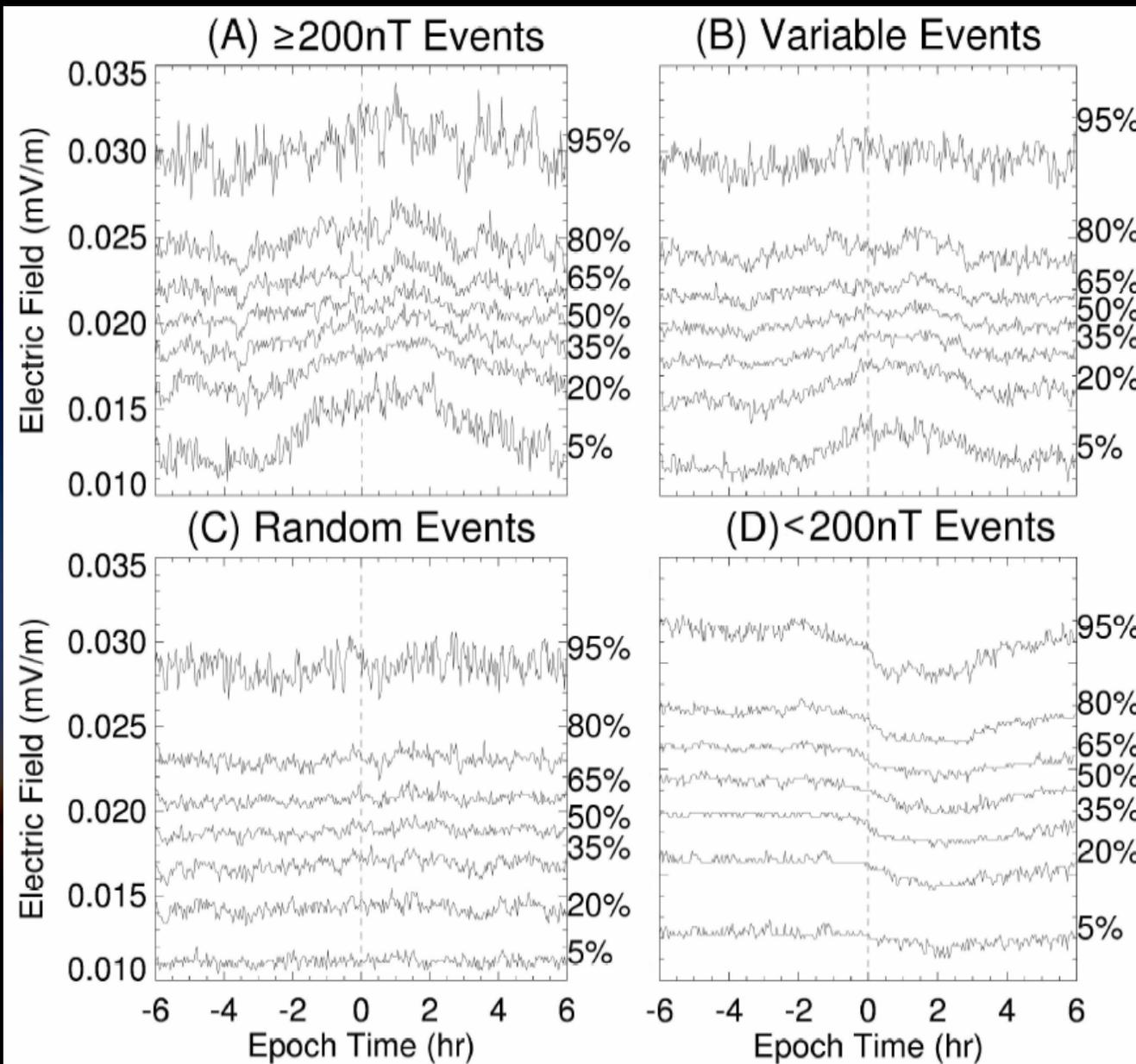
“typical”  
conditions

“non-  
enhanced”

# Cumulative Distribution: ~PC Electric Field

“traditional”  
SMC

“improved”  
SMC



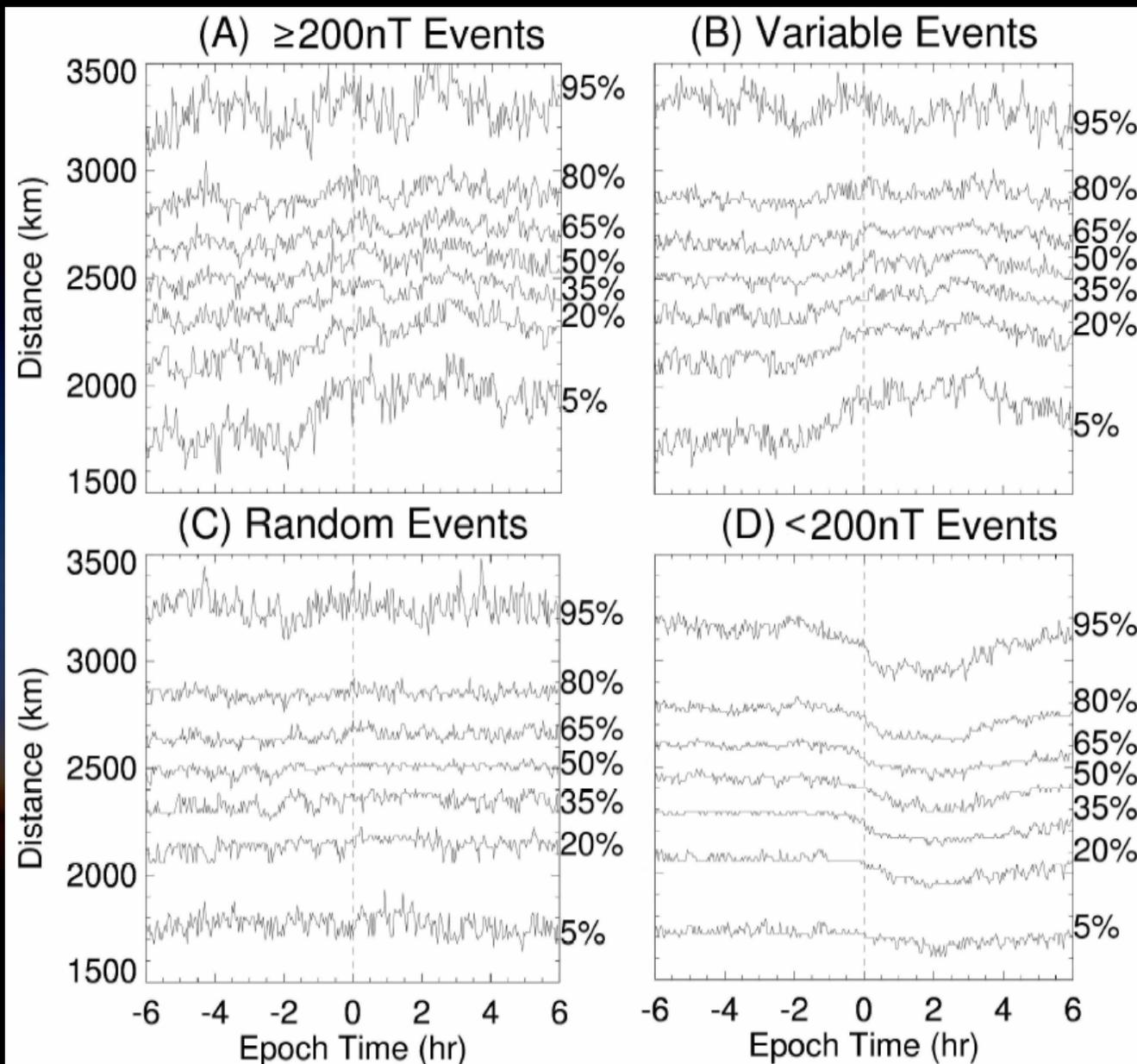
“typical”  
conditions

“non-  
enhanced”

# Cumulative Distribution: ~PC Size

“traditional”  
SMC

“improved”  
SMC

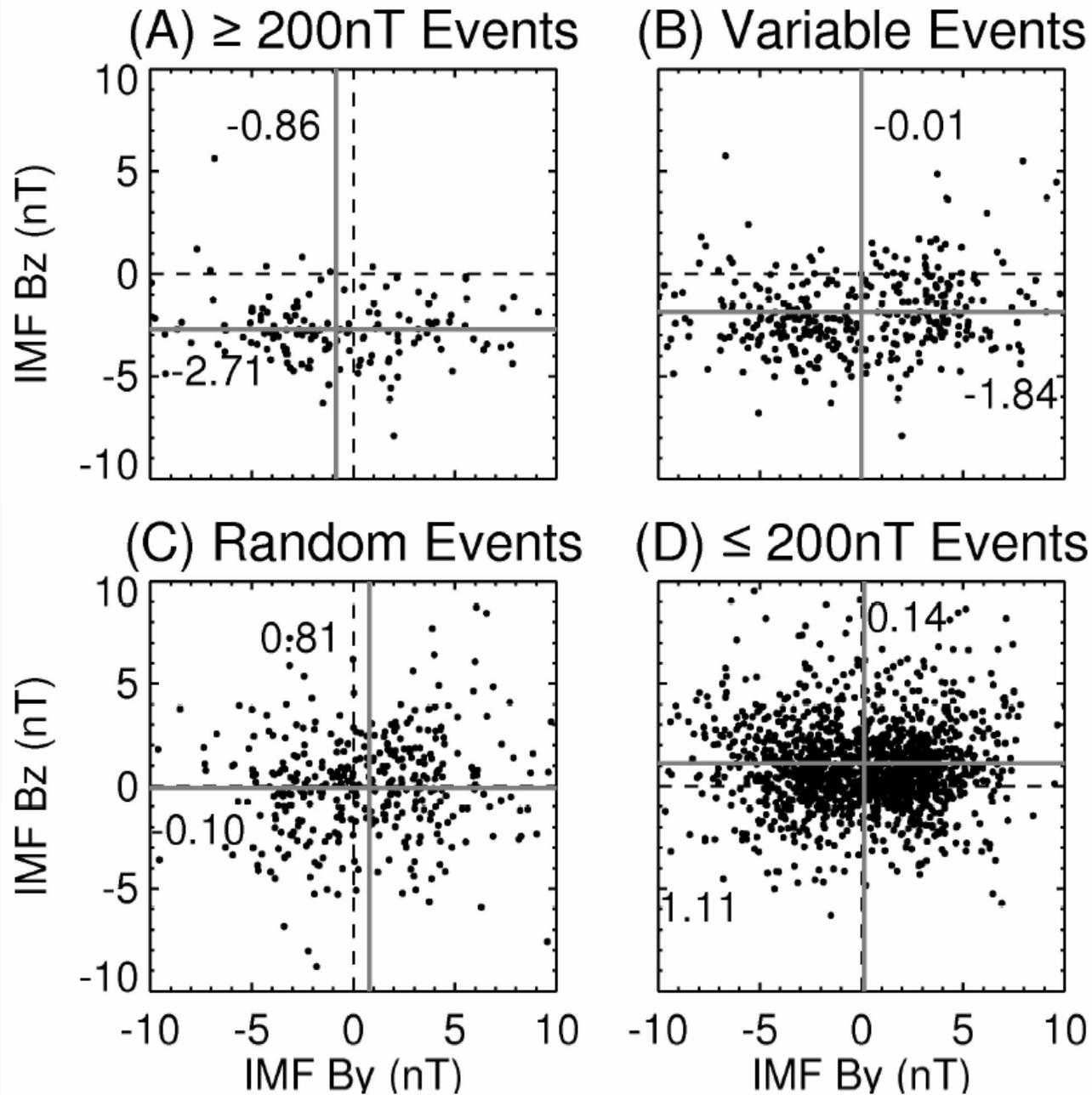


“typical”  
conditions

“non-  
enhanced”

# IMF Conditions: By vs. Bz

“traditional”  
SMC



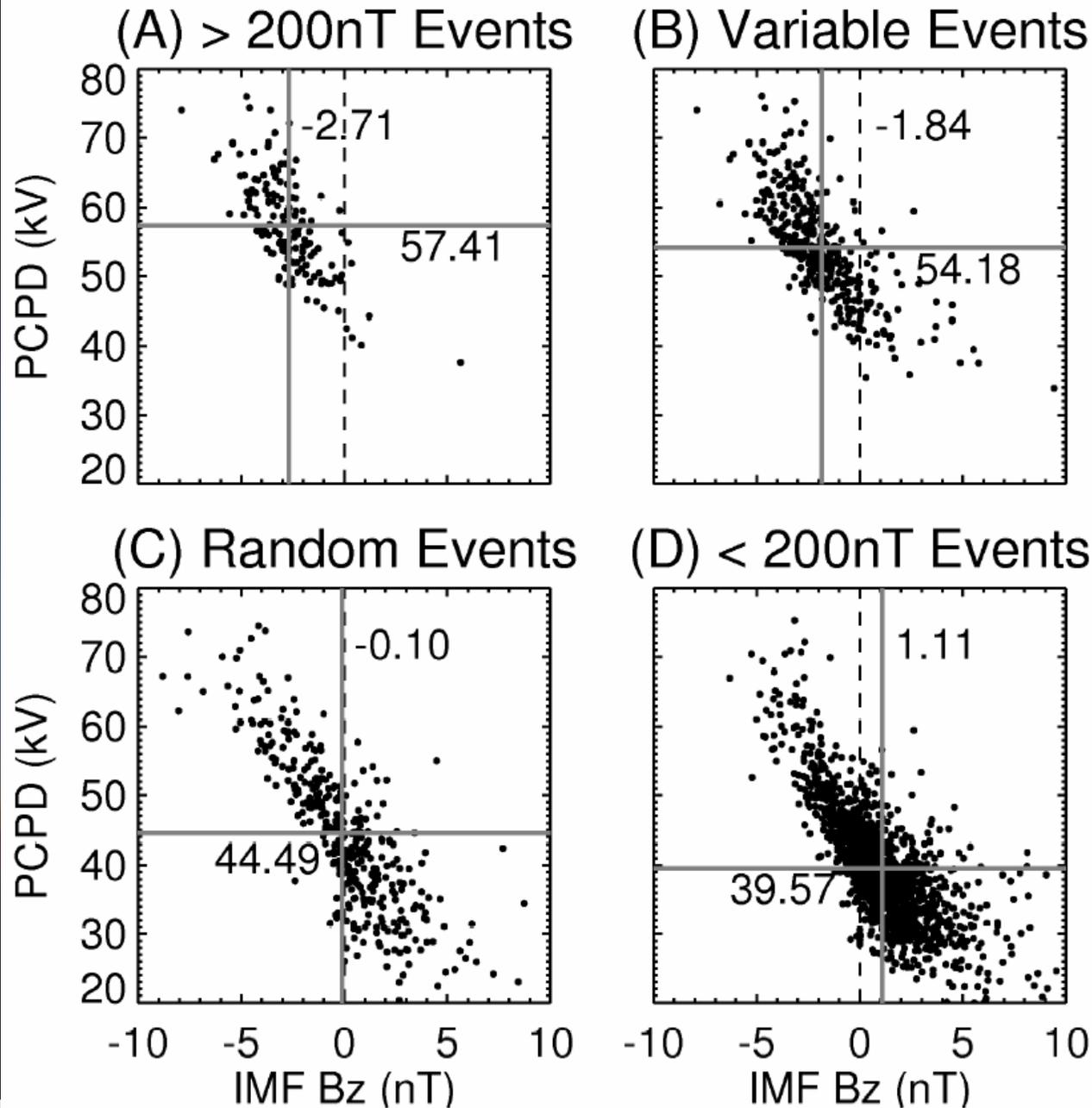
“improved”  
SMC

“typical”  
conditions

“non-  
enhanced”

# Solar Wind Driver: IMF Bz vs. PCPD

“traditional”  
SMC



“improved”  
SMC

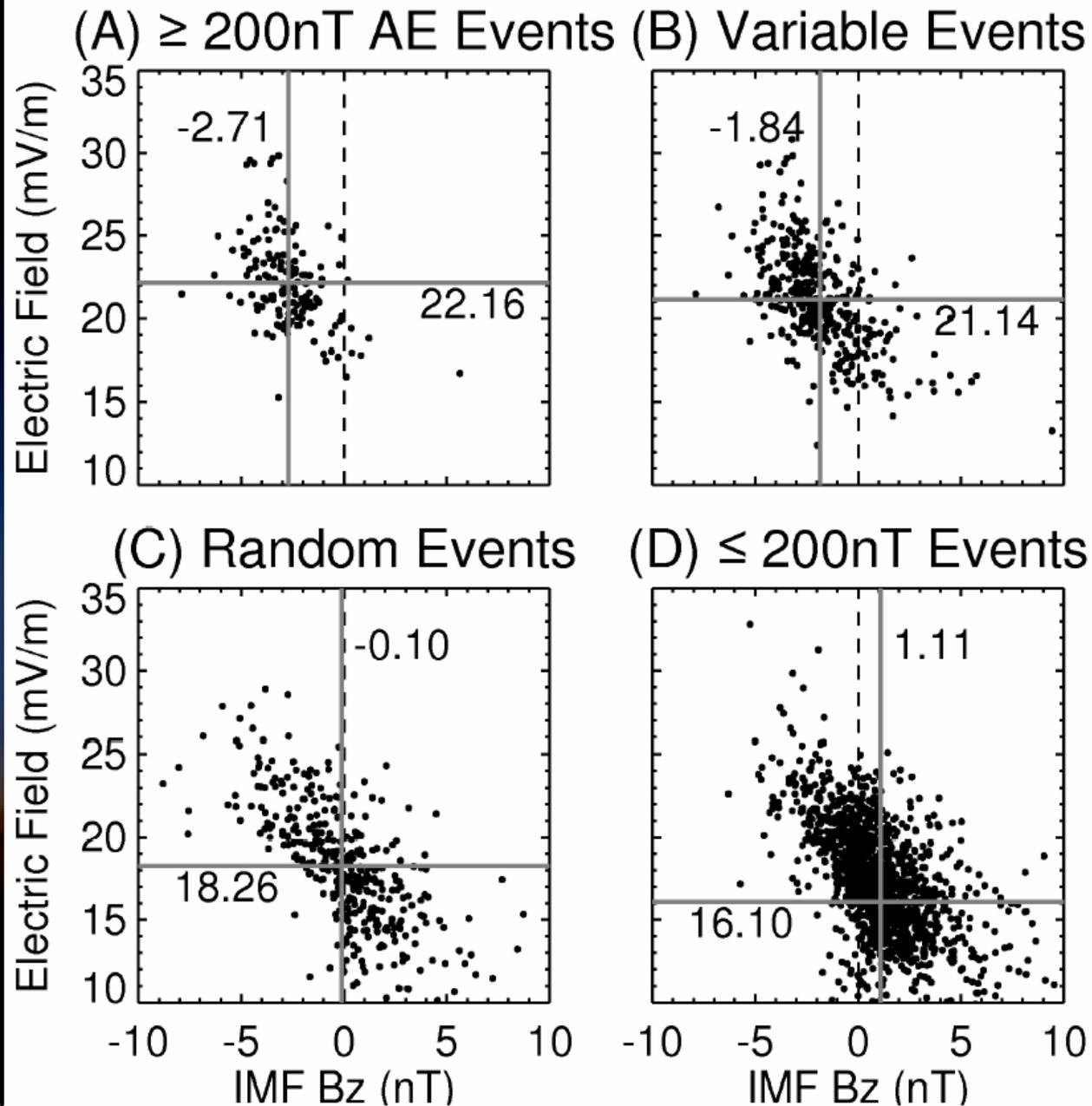
“typical”  
conditions

“non-  
enhanced”

# Solar Wind Driver: IMF Bz vs. PC E-Field

“traditional”  
SMC

“improved”  
SMC



“typical”  
conditions

“non-  
enhanced”

# Properties During SMC

- IMF Bz:
  - moderately negative drives SMC
  - drops for a few (2-4) hours before SMC onset
  - returns to pre SMC values 4-6 hours after onset
  - increased leading up to “non-enhanced” events
- Voltage & Electric Field:
  - PCPD is appropriate proxy for convection during SMC
  - increased a few (2-4) hours before SMC onset
  - when convection strong, stayed strong; when convection weak, became stronger
  - decreased leading up to “non-enhanced” events (surprising!)
- Polar Cap Size:
  - distance between voltage centres large and stable during SMC

# Results of "Improved" SMC Selection

- Extra SMC events:
  - consistent with SMC properties but more moderate:
    - enhanced convection (PCPD & Electric Field)
    - moderately negative IMF Bz
    - PC size stable and large (PCPD and E ~decoupled)

# Future Work

- Develop SuperDARN definition of SMC
  - must be careful of statistical convection pattern constraining global fits
- “improved” SMC events contain more points, on average, than all other events sets studied
  - Does SuperDARN data rate respond to steadiness of system during SMC?
- The SMC steadiness criterion (rate of change of AL index) is problematic
  - data spikes cause problems
  - should the AL criterion be scaled according to AE?
  - changes in AL criterion may impact improved AE criterion
- Examine southern convection maps to determine if seasonal variation is reversed
- Active aurora common during SMC
  - Is auroral “power” steady, despite localized variability (patchiness)?