New Evidence Supporting a Natural Limit to the Flux of Energetic Electrons Injected into the Inner Magnetosphere

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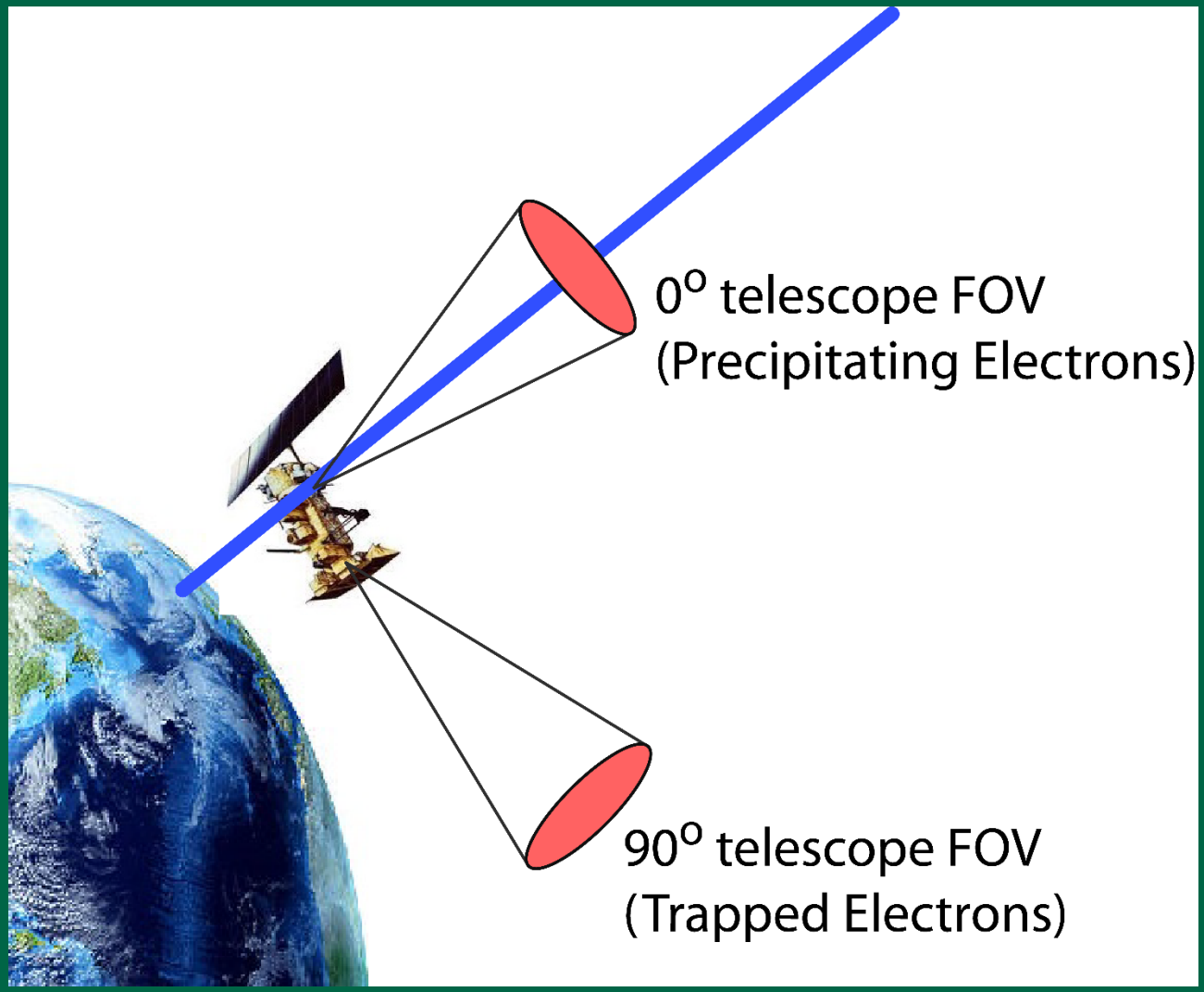
Motivation

- Test the ideal of self-limiting trapped energetic electron flux theorized by Kennel-Petchek (1966)

Data Selection

- POES data from the 0º and 90º teles.
- L=4.5 - 5 (northern hemisphere)
  - (Rodger et al., JGR, 2010a, 2010b)

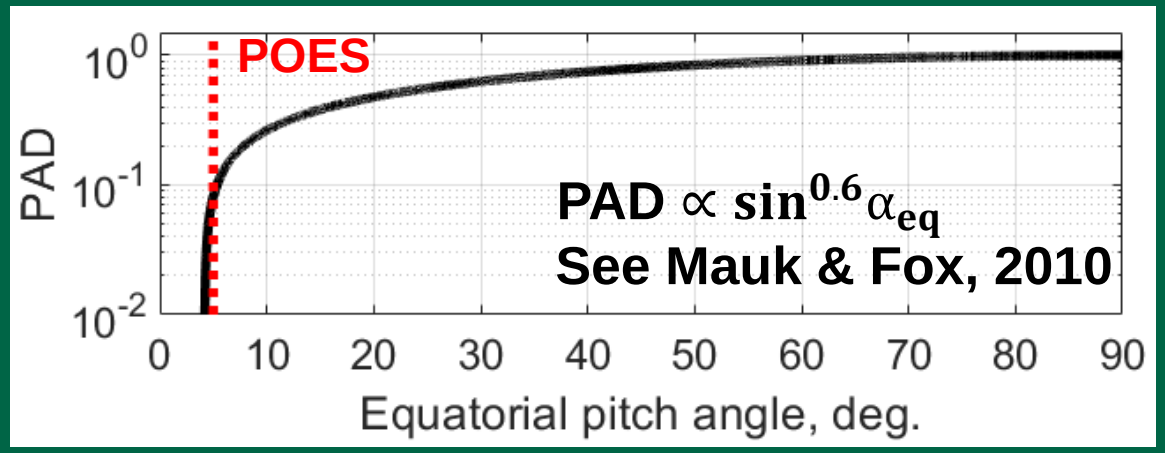


E1 > 30 keV, E2 > 100 keV, E3 > 300 keV

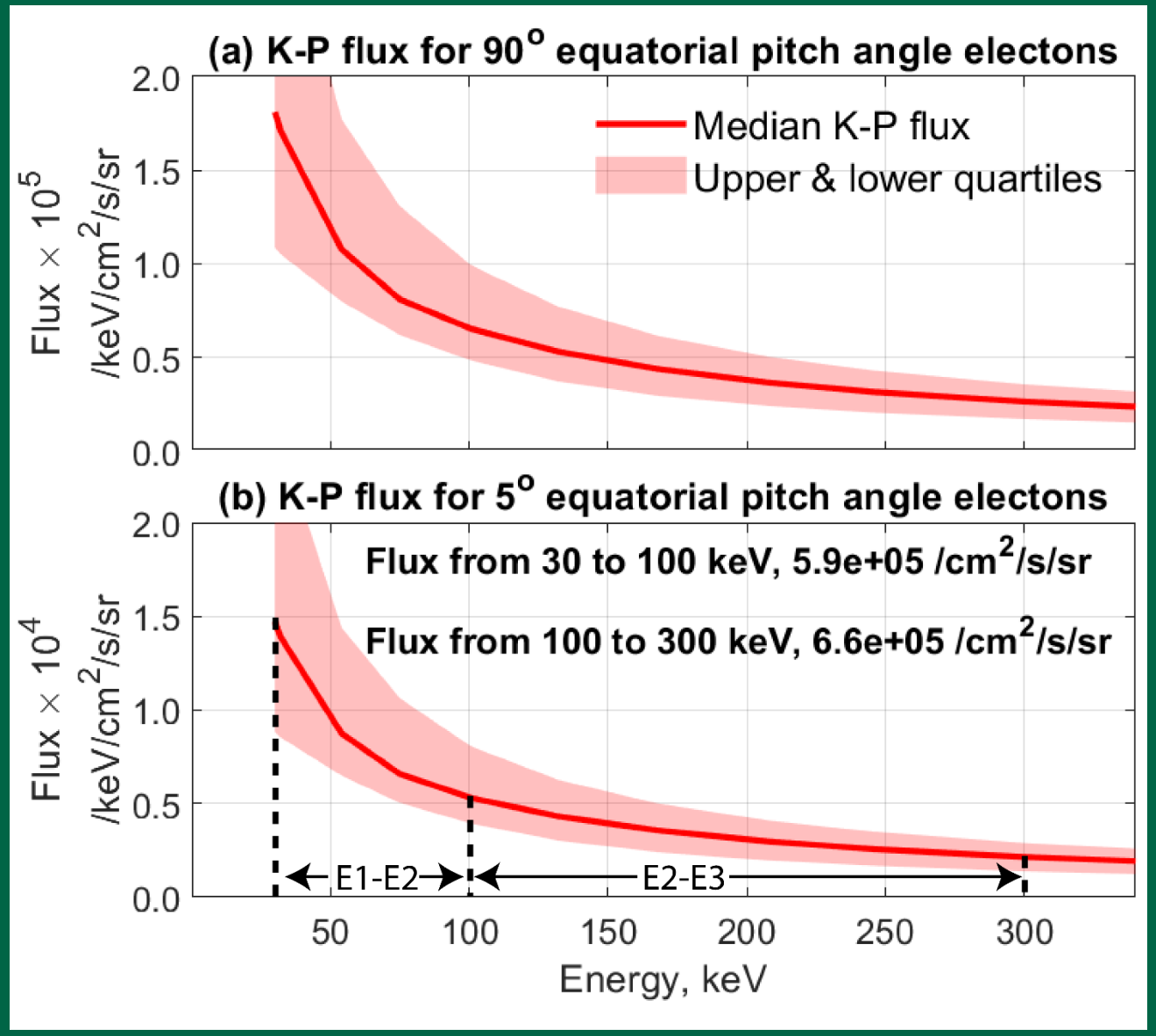
Estimating the Kennel - Petchek Limit

- Kennel-Petchek trapped flux limit for equatorially mirroring electrons
  (see, Mauk & Fox, 2010; Olifer et al., 2020)

- 90º local pitch angle electrons at POES alt. map to ~5º equatorial pitch angles

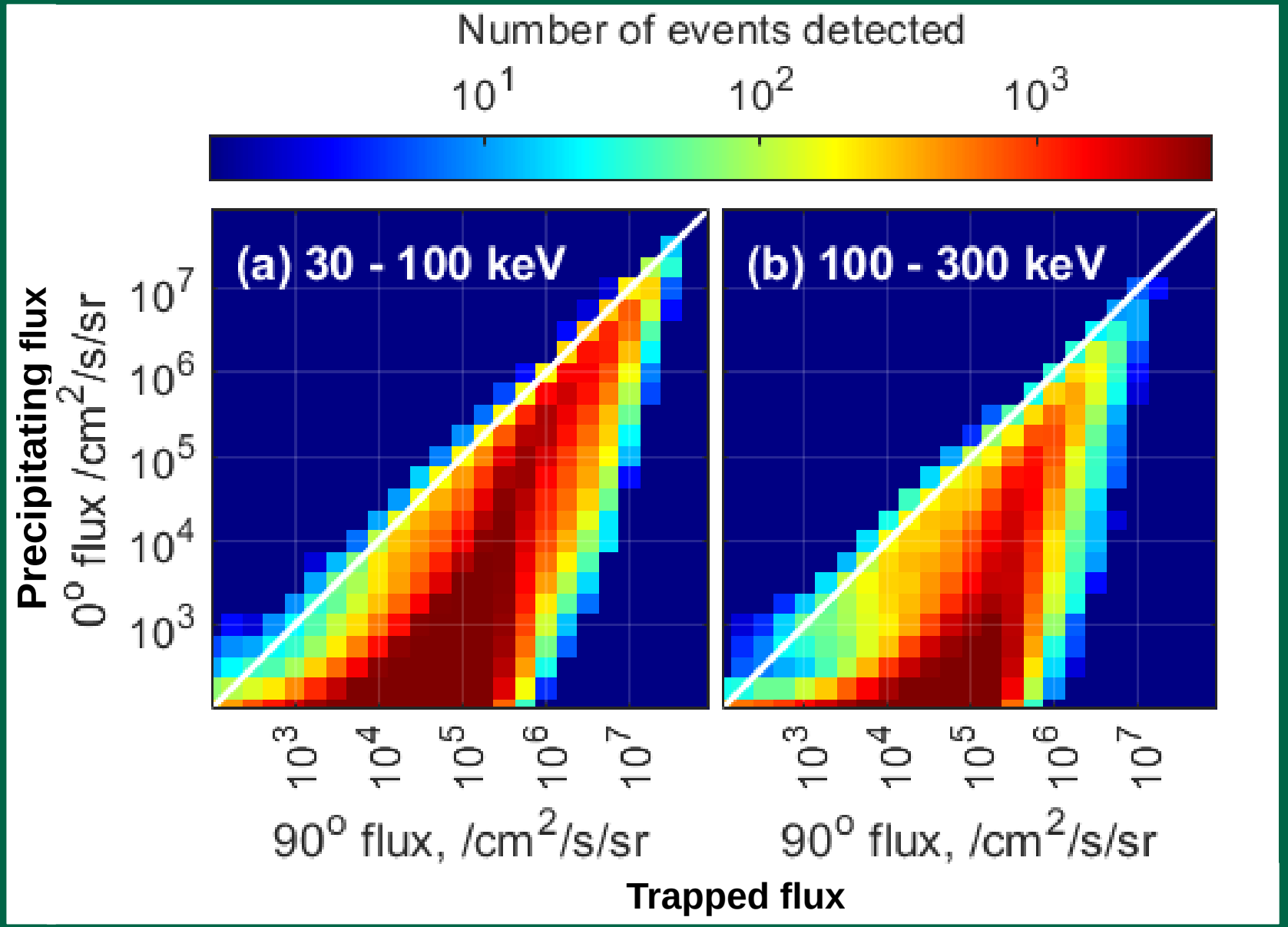


- Differential Kennel-Petchek flux converted to integral flux, integrated between
  - 30 keV to 100 keV ➔ channels E1-E2
  - 100 keV to 300 keV ➔ channels E2-E3



Testing the Kennel-Petchek Theory with POES data 1

- Color scale indicates number of events detected at each value of trapped & precipitating flux
- Diagonal line indicates points with equal trapped & precipitating flux
- Low trapped flux
  - Precipitating flux << trapped flux
- High trapped flux
  - Precipitating flux ~ trapped flux
- Very few events exceed K-P flux limit (vertical line)



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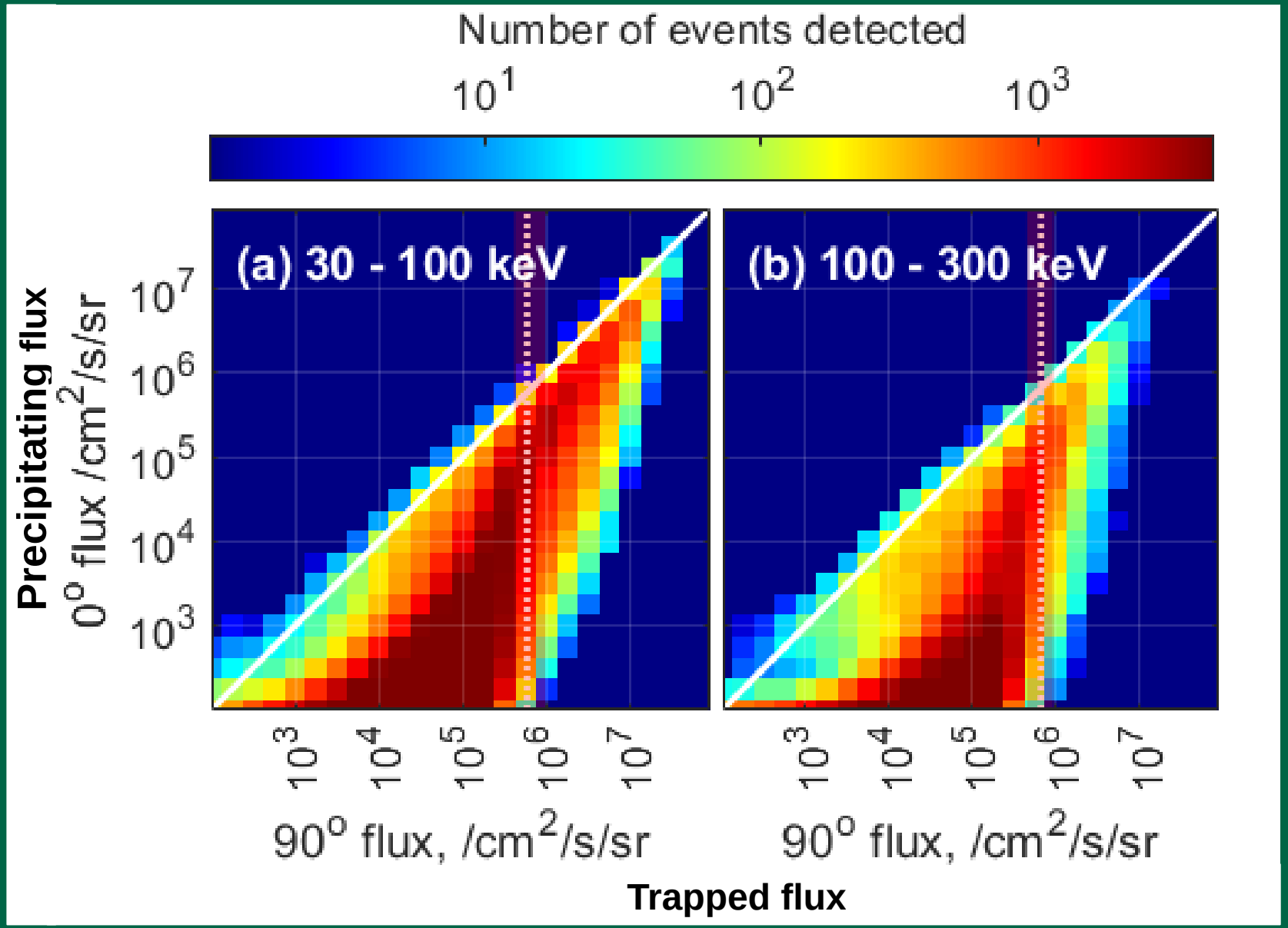
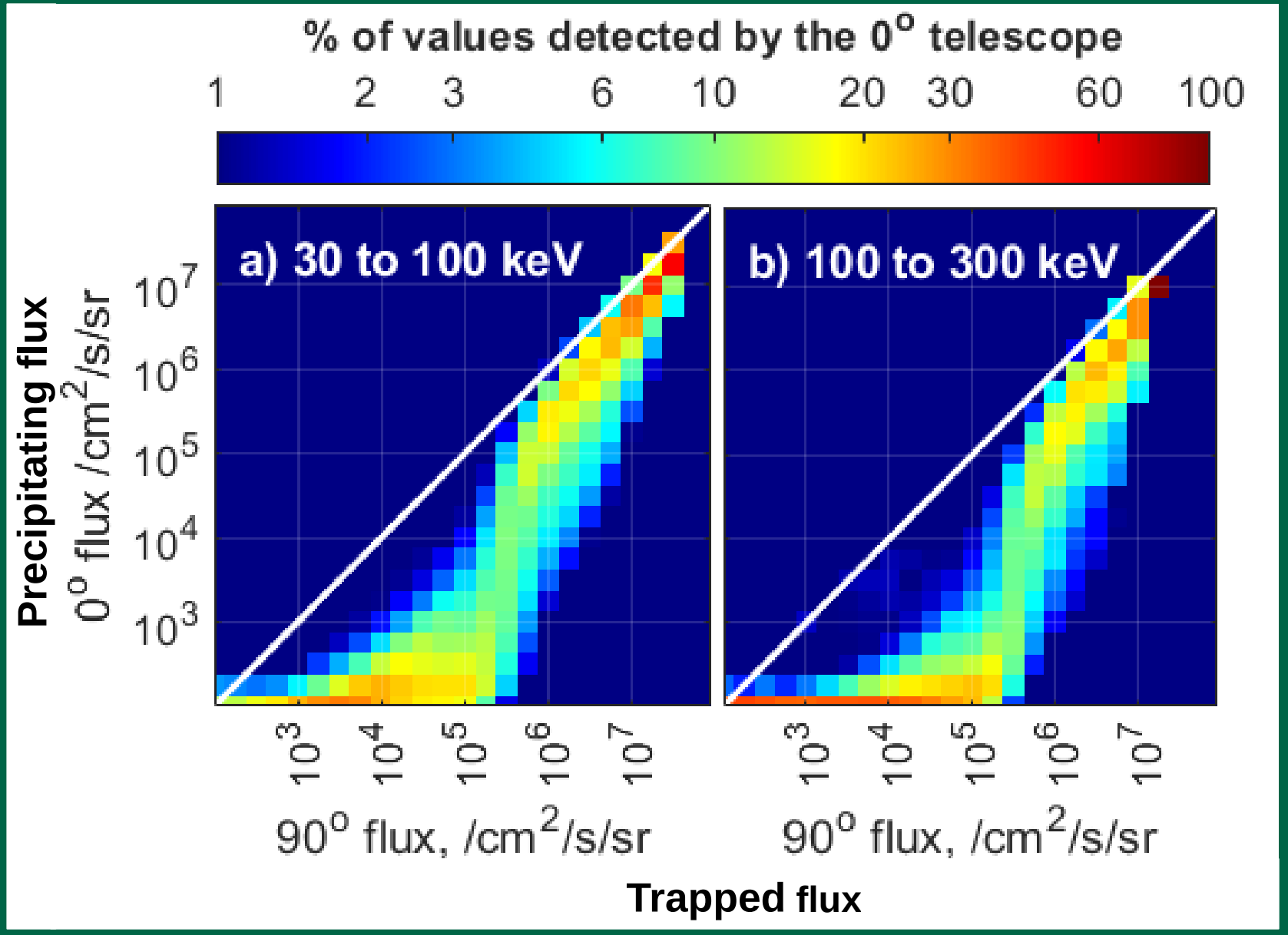


Testing the Kennel-Petchek Theory with POES data 2

- Probability distribution of events detected by the 0^o telescope

- At Kennel-Petchek limit
  - precipitating flux almost matches trapped flux
  - transition from weak to strong diffusion



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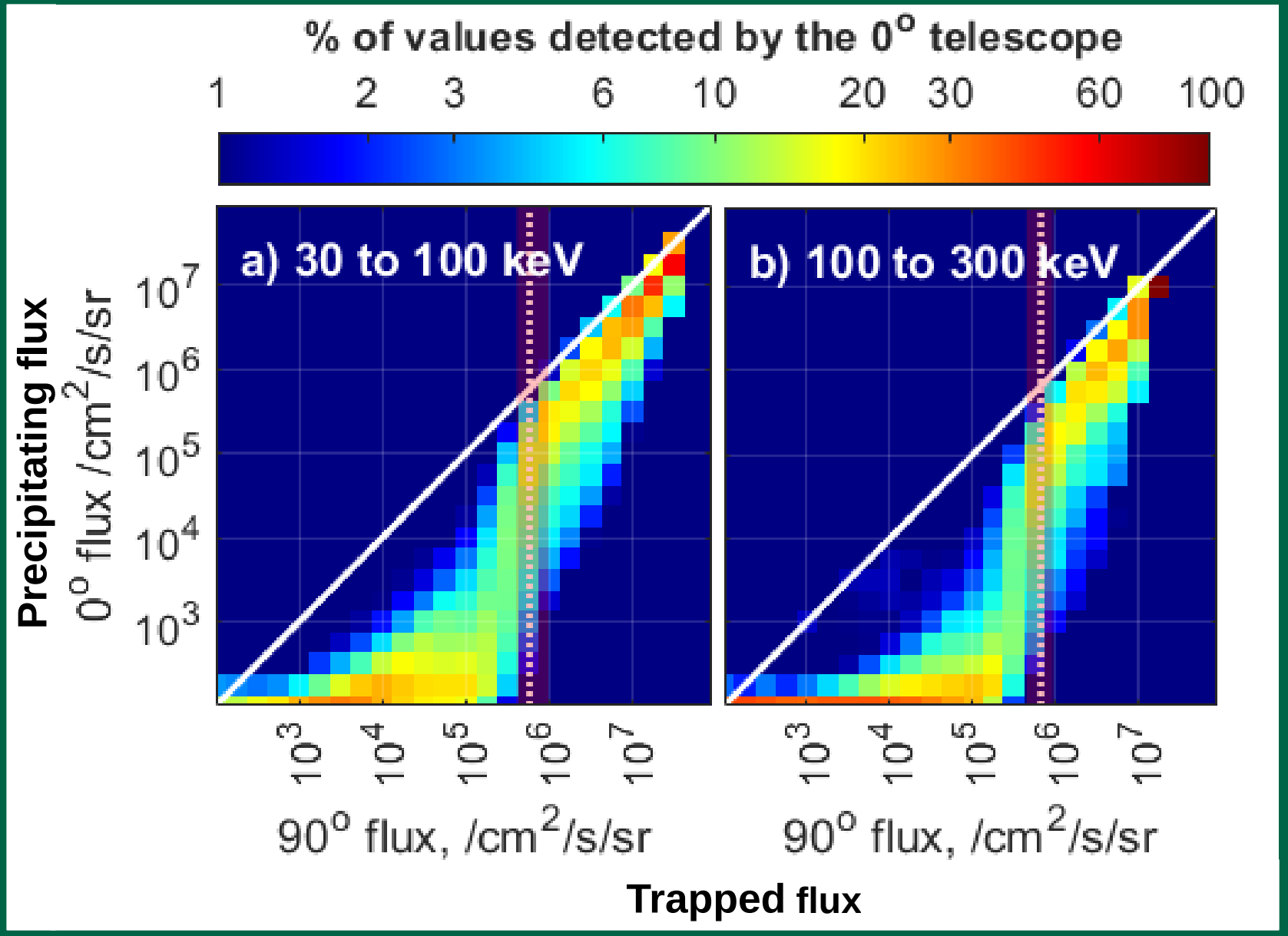
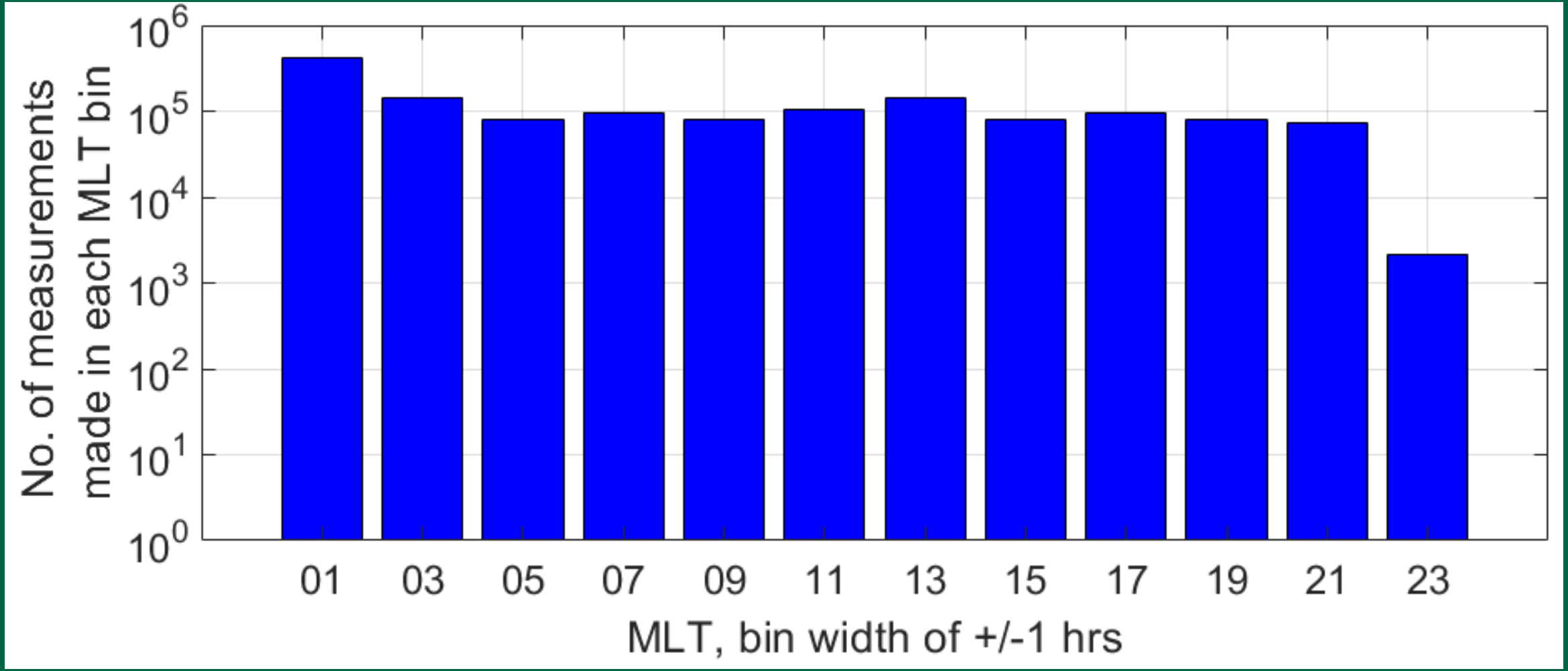
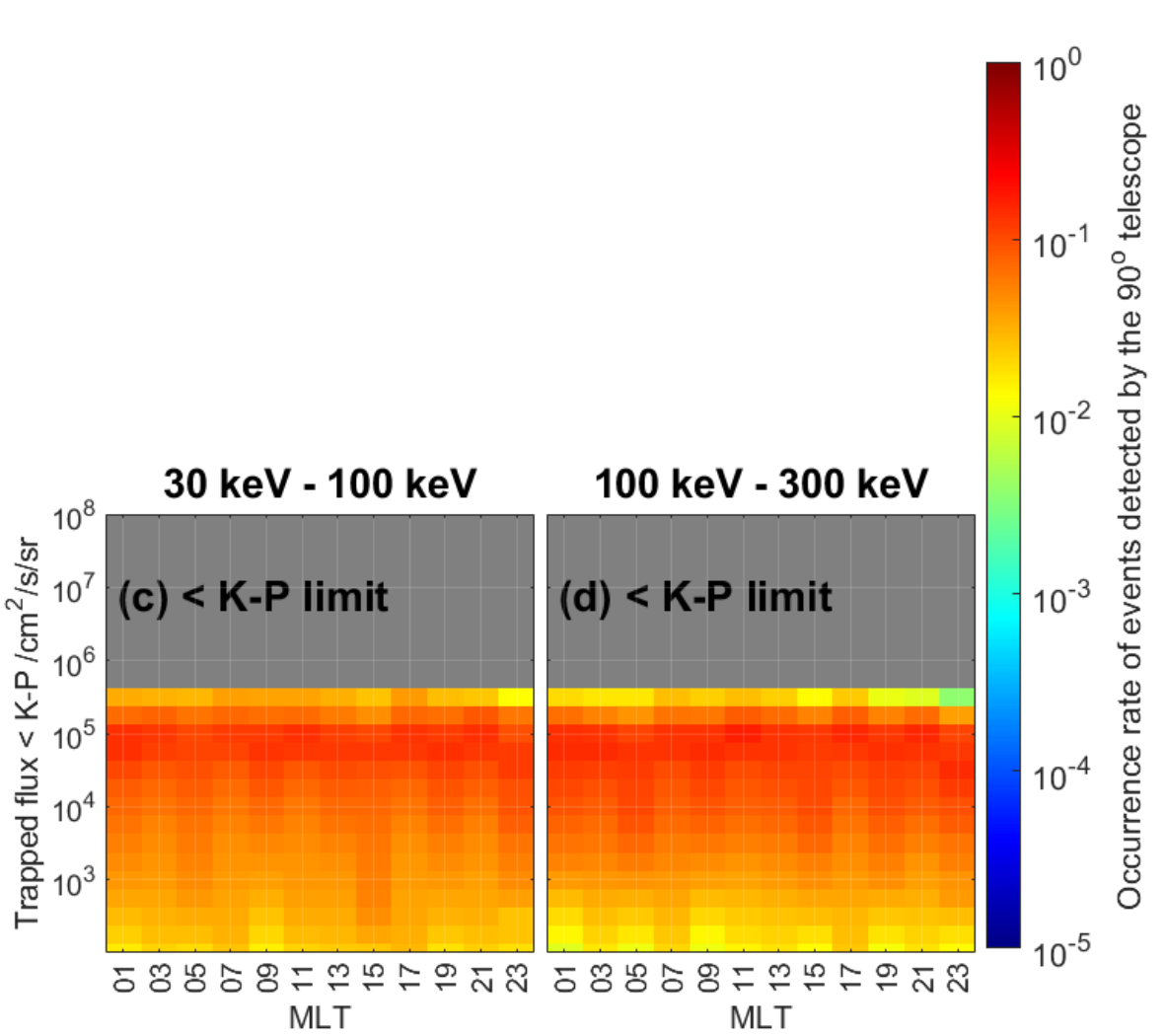


MLT Coverage of POES Measurements from L=4.5 to 5.0



MLT Distribution of the Electrons

Trapped Flux MLT Distribution



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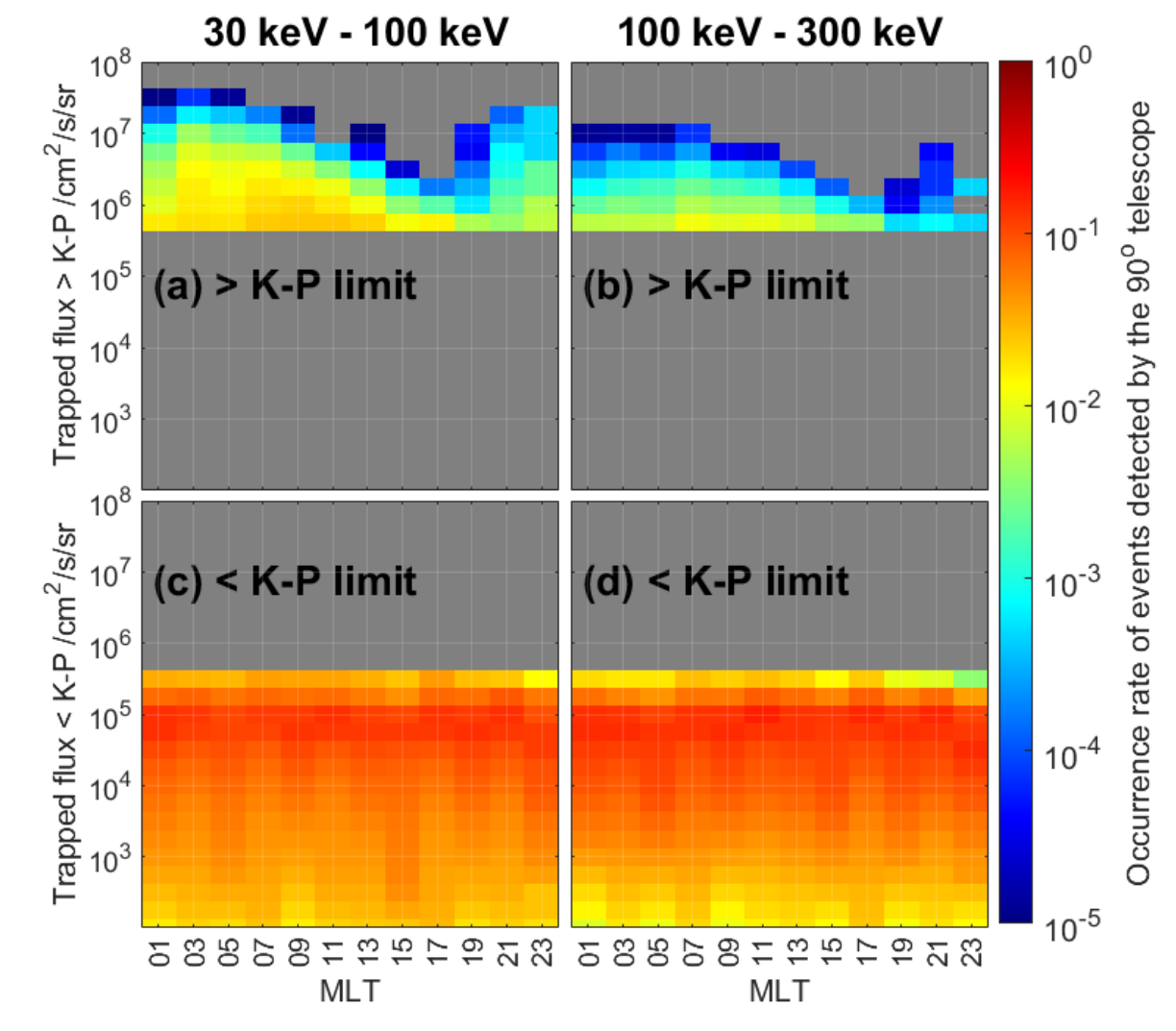

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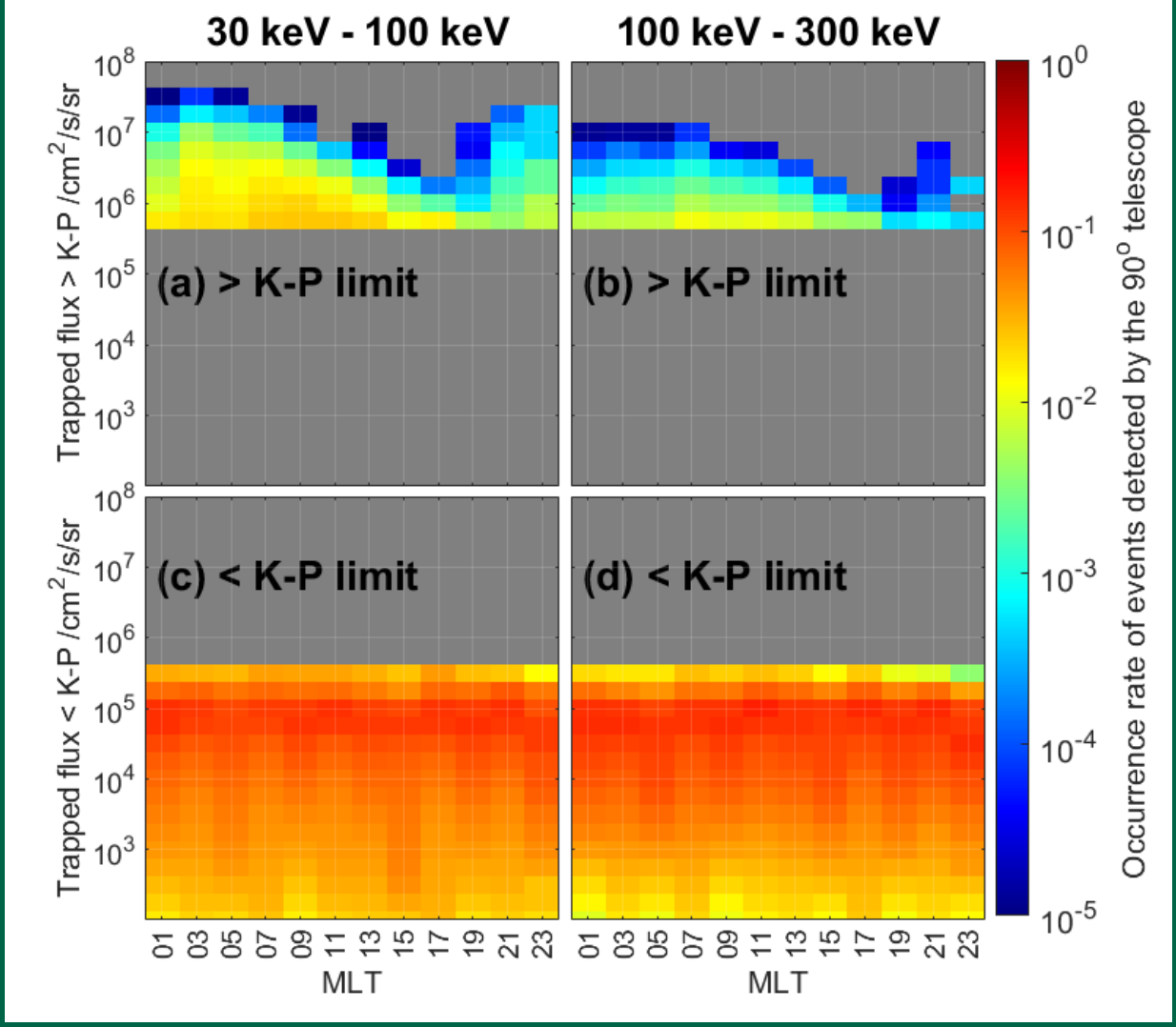
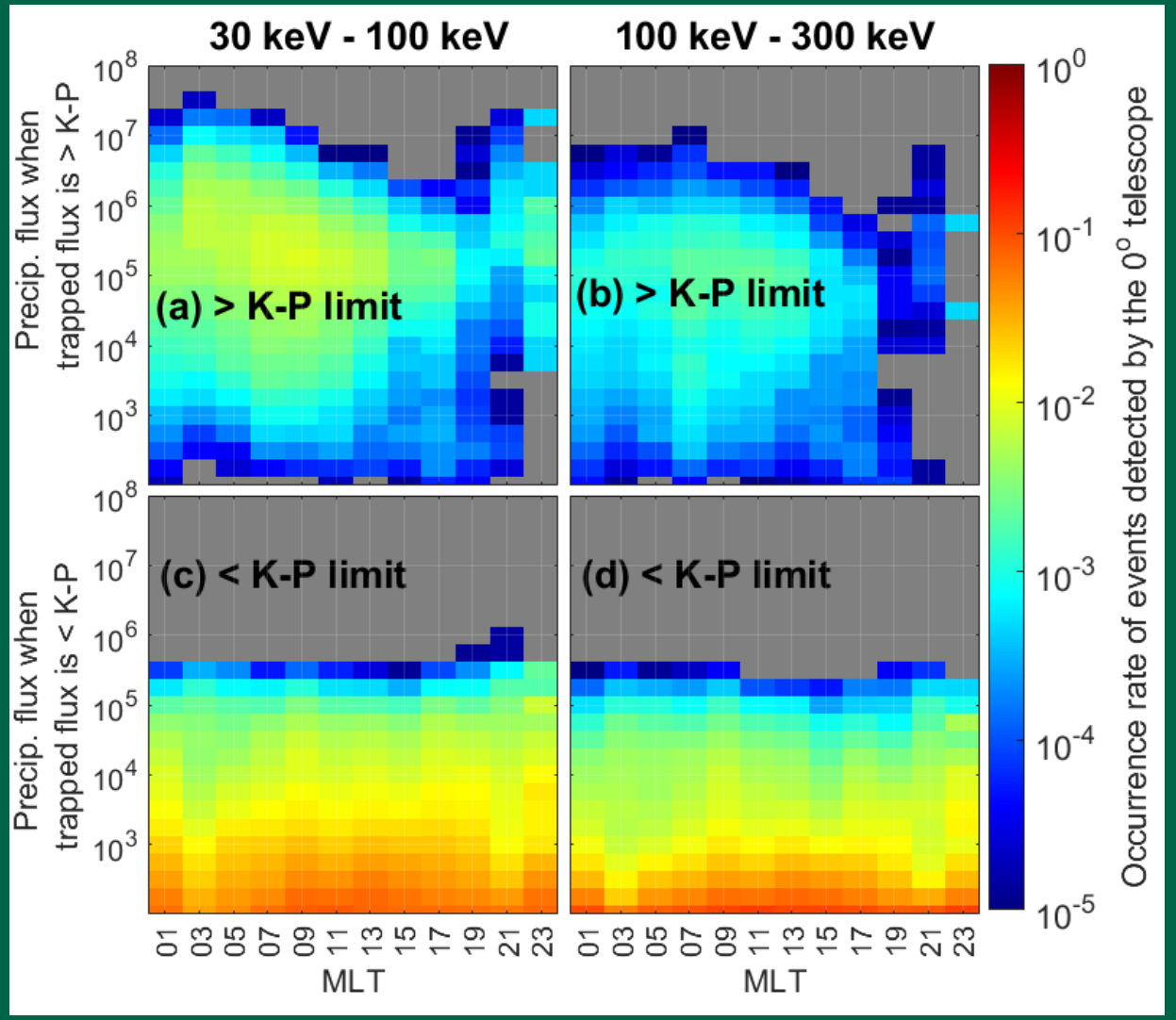
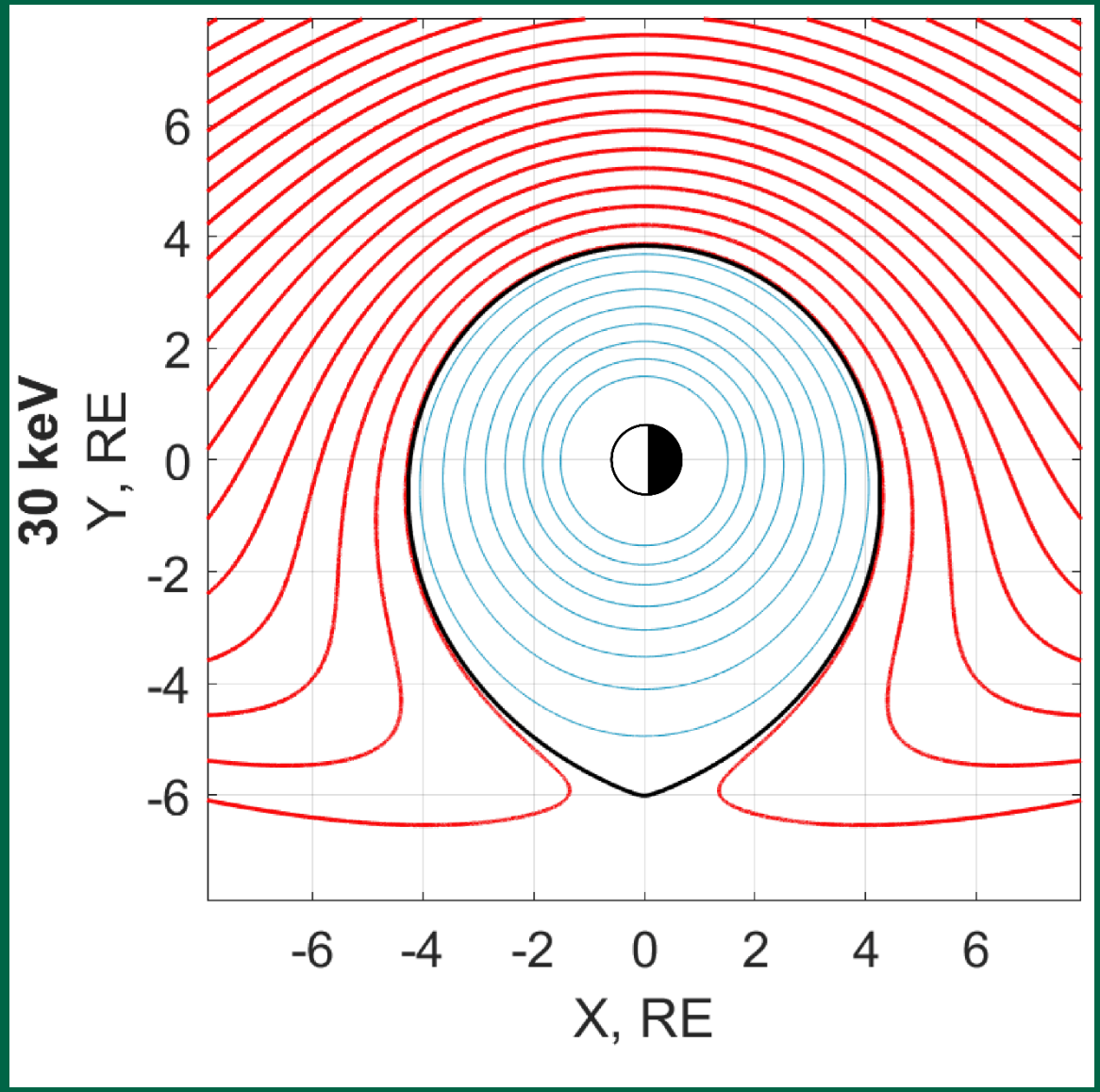


Precipitating Flux MLT Distribution



Injection Drift Paths

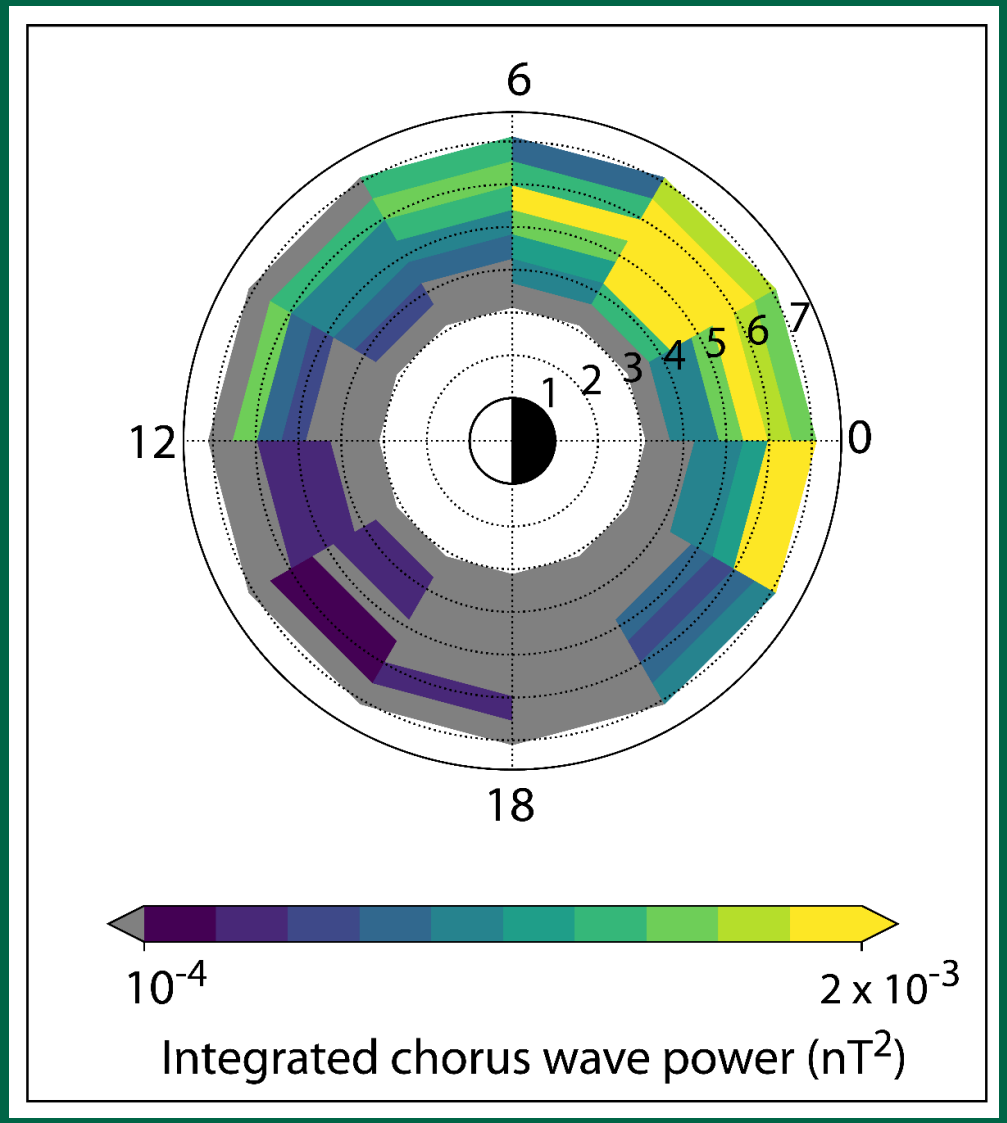
- Injected electrons pass through dawn sector then exit magnetosphere
- Injected drift paths do not reach low L-shells (L~4.5-5) in the dusk sector



Spatial Distribution of Chorus Waves during Storms

- EMFISIS Van Allen Probes data collected during storms, Kp>3 and Dst<-50 nT
- Intense chorus waves occur in the dawn sector during geomagnetically active intervals
  - Consistent with wave generation by injected electrons passing through the dawn sector
  - Power integrated between 0.1 fce to 0.8 fce

Average chorus wave power



Summary

Particle injections → intense dawn sector waves → strong diffusion at K-P limit

(see Ozeke et al., JGR, 2024, under review)

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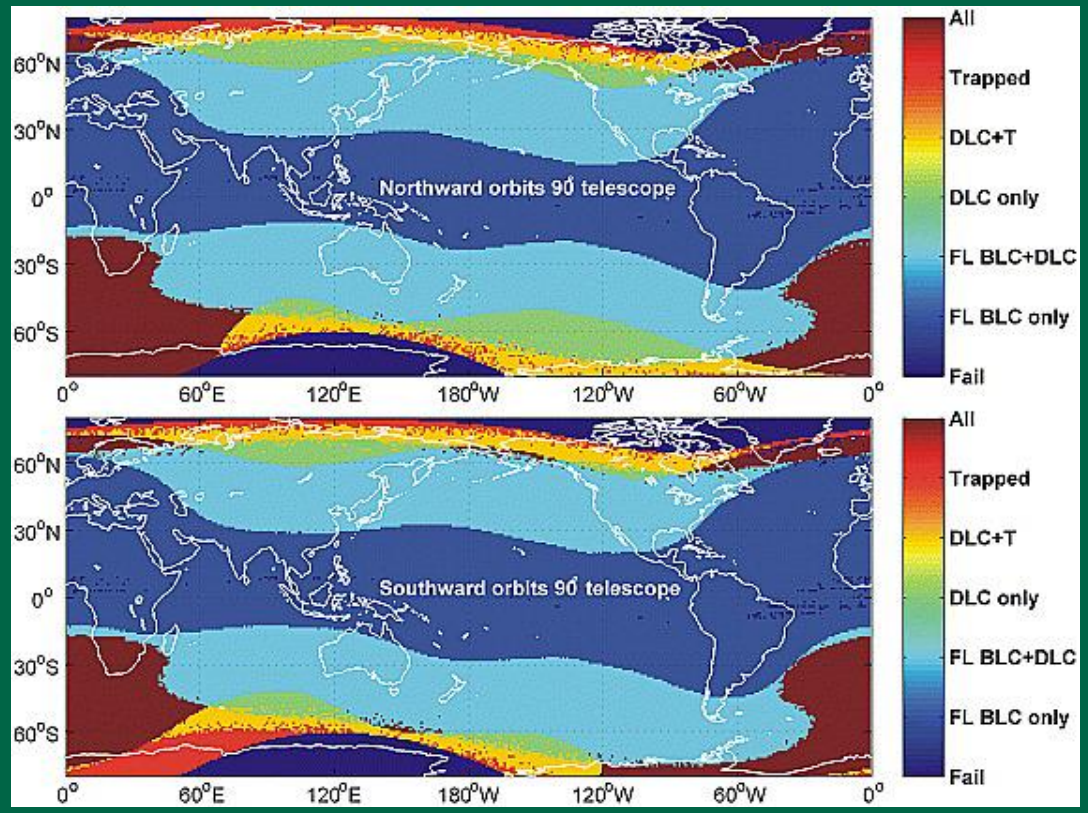
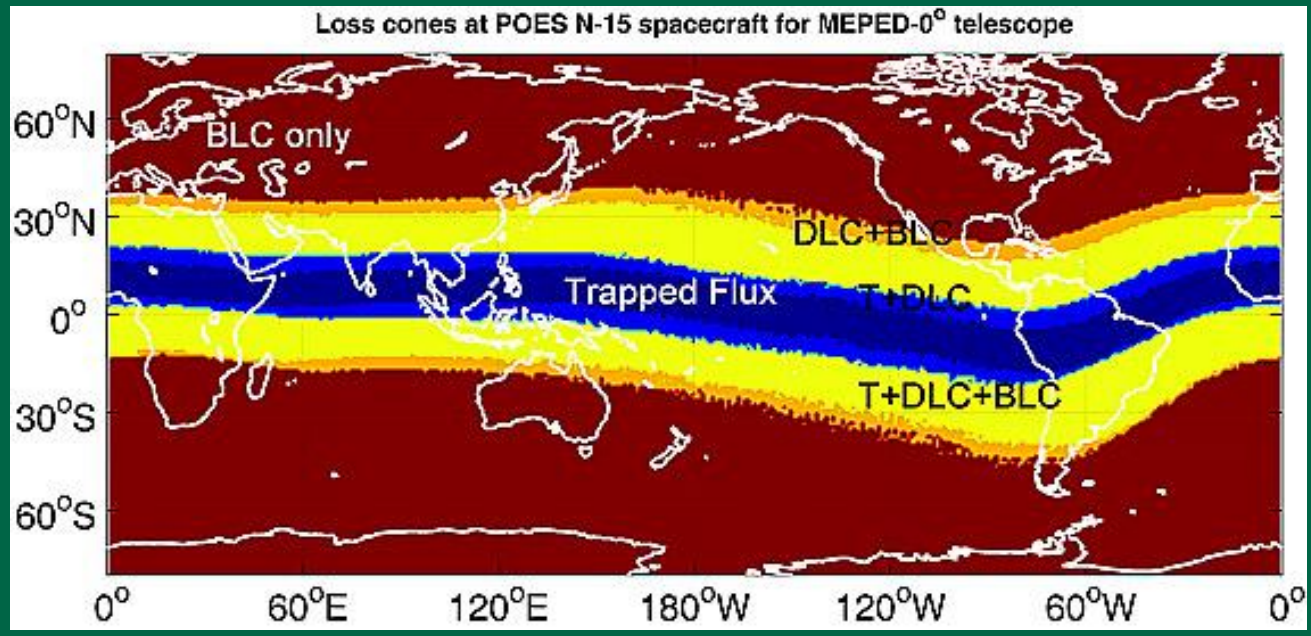


90° telescope is dominated by the trapped electron flux in northern hemisphere between L~4.5 to 5.0.

Taken from Rodger, (2010) doi:10.1029/2010JA015880.

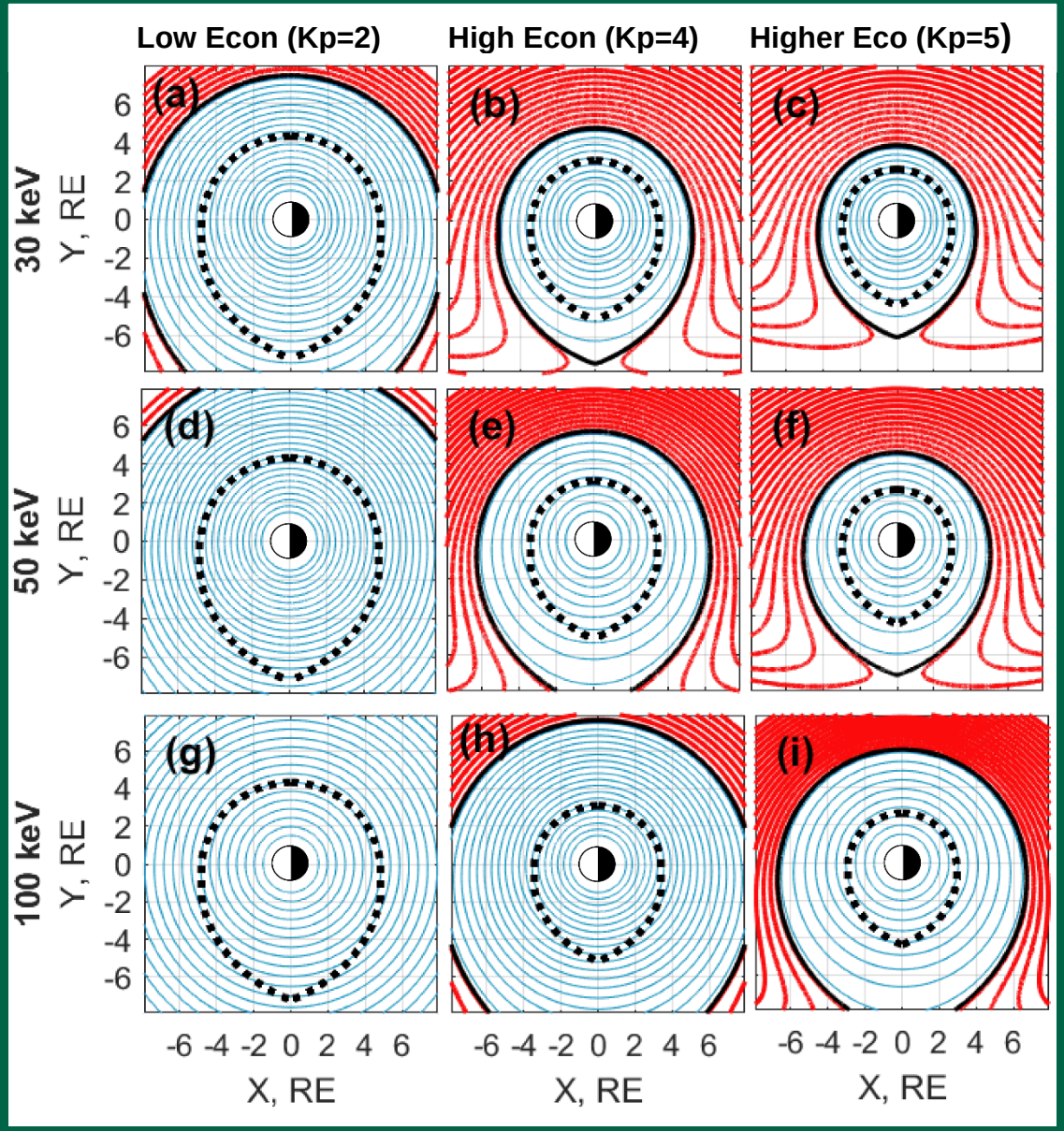


0° telescope only measures BLC electrons at L>1.5

Taken from, Rodger et al. (2010) doi: 10.1029/2008JA014023.

Injection Drift Paths

- Injected electrons pass through dawn sector then exit magnetosphere
- Only during intervals with high convection electric field, ExB drift, do the drift paths reach low L-shells
- Injected drift paths do not reach low L-shells (L~4.5-5) in the dusk sector



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Flux Percentiles between L=4.5 to 5.0 NS