Pitch Angle Isotropy of Relativistic Electron Microbursts as Observed by SAMPEX/HILT: Statistical and Storm-time Properties

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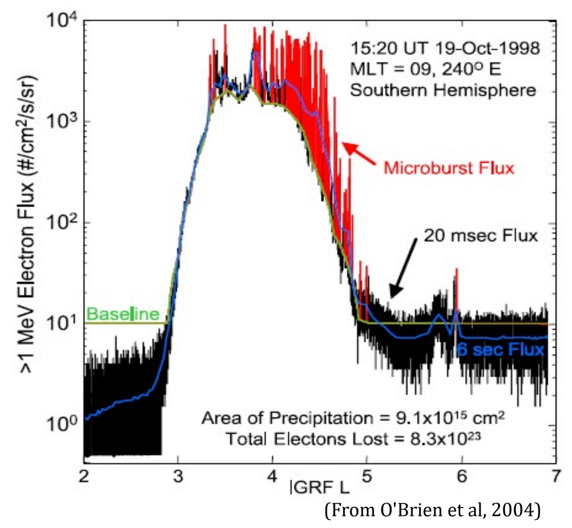
Background

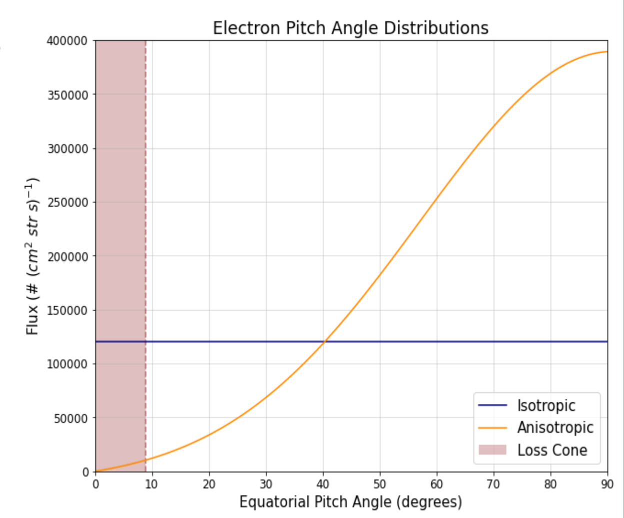
- Earth's radiation belts are composed of rapidly evolving electron populations that are affected by many source and loss mechanisms

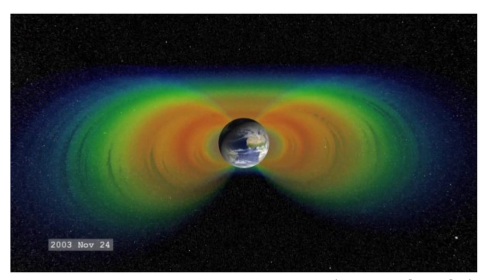
- Microbursts are loss mechanisms that are caused by resonances between gyrating electrons and plasma waves which generate sub-second enhancements of pitch angle scattered electrons

- Microbursts are typically assumed to be fully isotropic, but the statistical qualification of electron pitch angle distributions within these features has not yet been explored

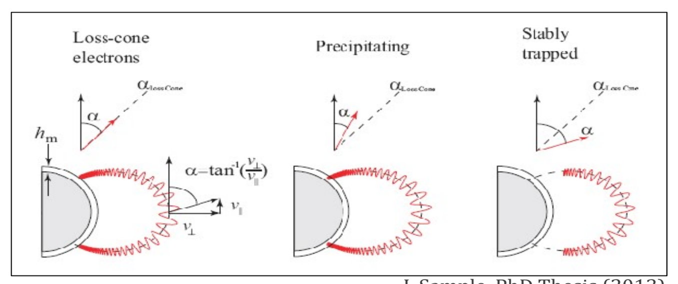


(From O'Brien et al, 2004)





(From Wikipedia)



J. Sample, PhD Thesis (2013)

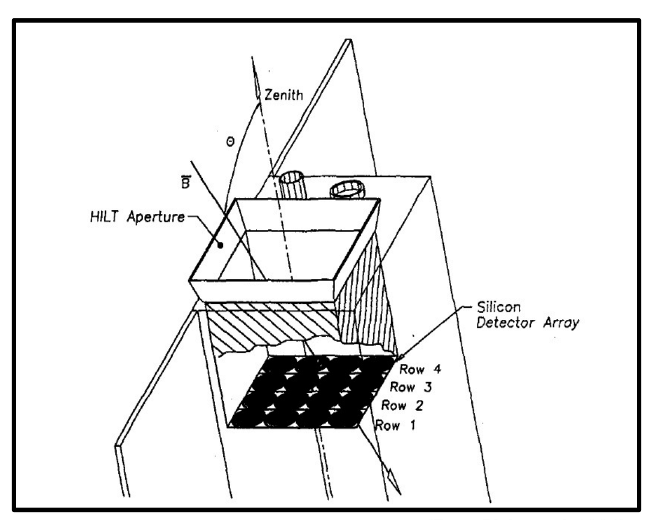
Goal: To develop a qualitative electron pitch angle isotropy index and use it to understand the spatial and storm-time dependence of electron pitch angle distributions within MeV microbursts in Earth's radiation belts

SAMPEX/HILT Observations

a) HILT Instrument:

- HILT instrument onboard the SAMPEX satellite consisted of a 4x4 Silicon detector array that recorded >1 MeV electron counts

- The high cadence (100ms time resolution) measurements of HILT allowed for the observation of microbursts using the following detection algorithm developed by O'Brien et al (2003):



(From Blake et al, 1996)

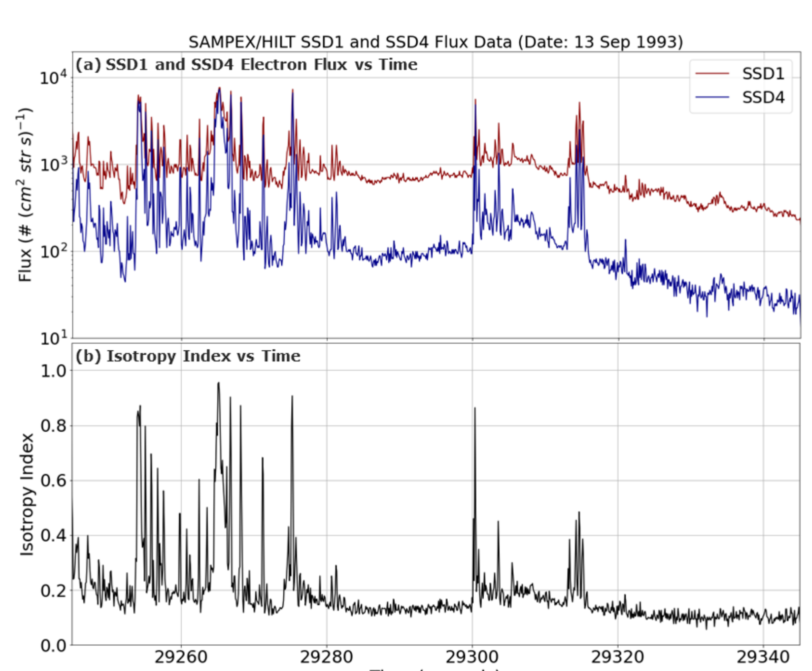
$$(N_{100} - A_{500})/\sqrt{1 + A_{500}} > 10$$

b) Isotropy Index Formula:

- Interpreting SSD1-SSD4 electron flux measurements:
  - High flux differential -> Anisotropic
  - Even flux across rows -> Isotropic

- Ratio of electron fluxes between the minimum flux row and the maximum flux row gives the isotropy index:

$$I = N_{100,min}/N_{100,max}$$

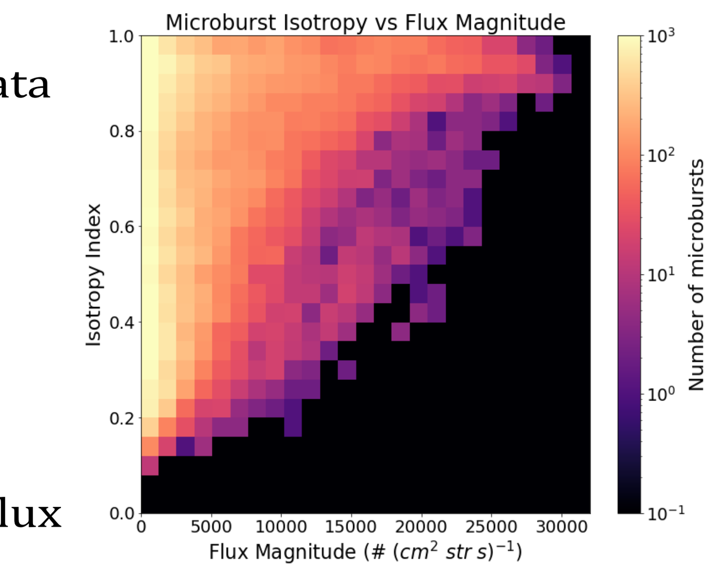


Global Statistical Properties

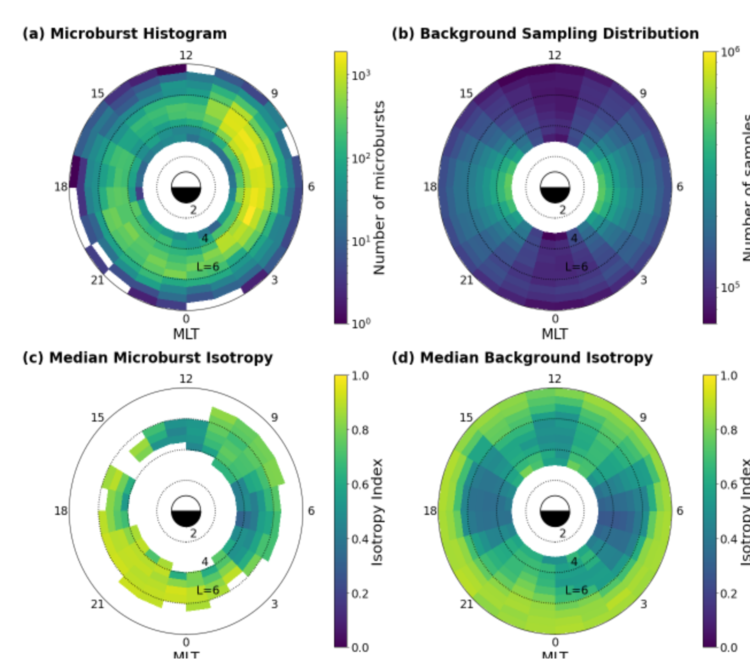
1) Isotropy vs Flux Magnitude:
   - SAMPEX electron counts data selected from the year 1993
   - Analysis of microburst isotropy index dependence on flux magnitude:

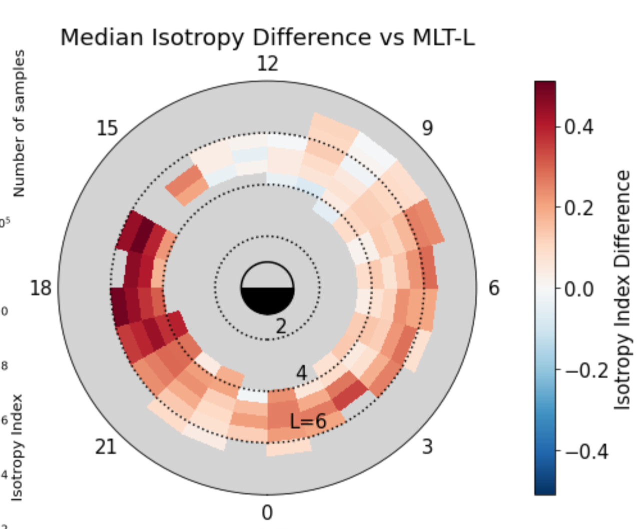
$$M = N_{100} - B_{3000}$$

   - Most microbursts are low flux magnitude
   - Positive correlation between isotropy index and flux magnitude



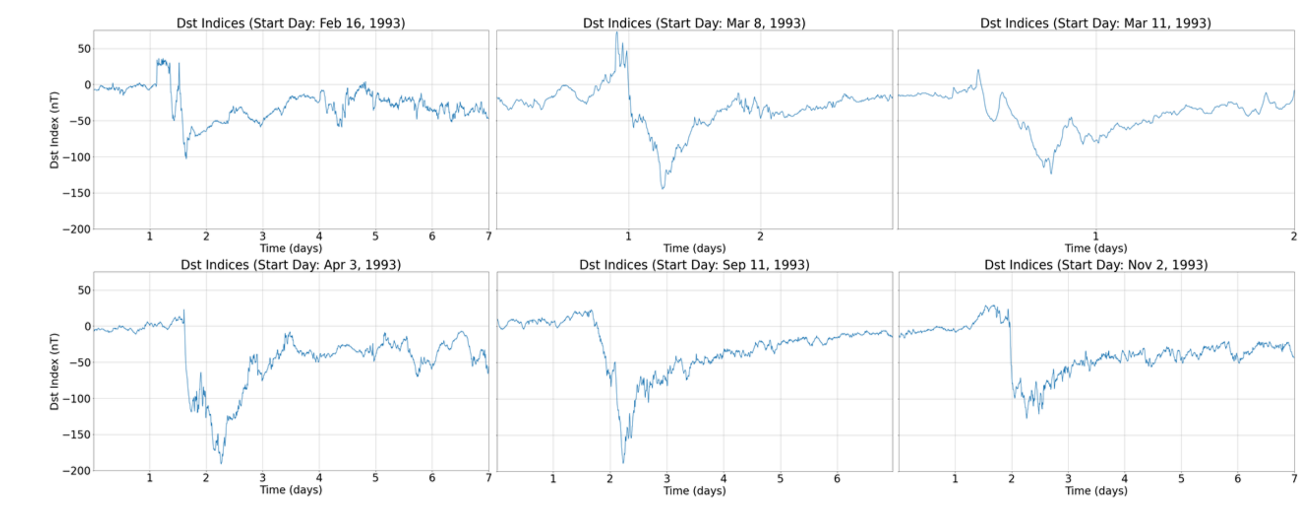
2) Isotropy vs MLT-L:
   - SAMPEX electron counts data selected from the year 1993
   - Analysis of microburst isotropy index spatial dependence on MLT and L-Shell
   - Microburst isotropy relative to background highest in the evening MLT region and lowest in the noon region



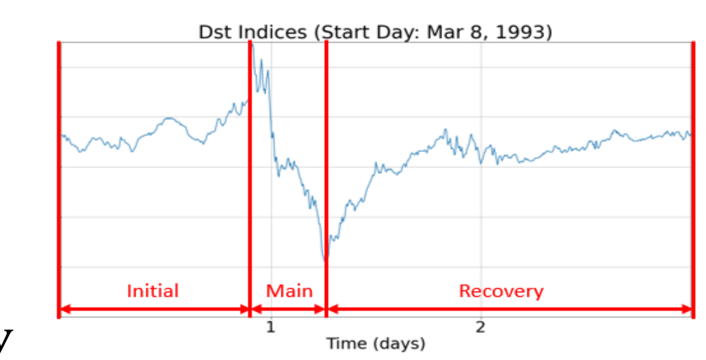


Storm-time Properties

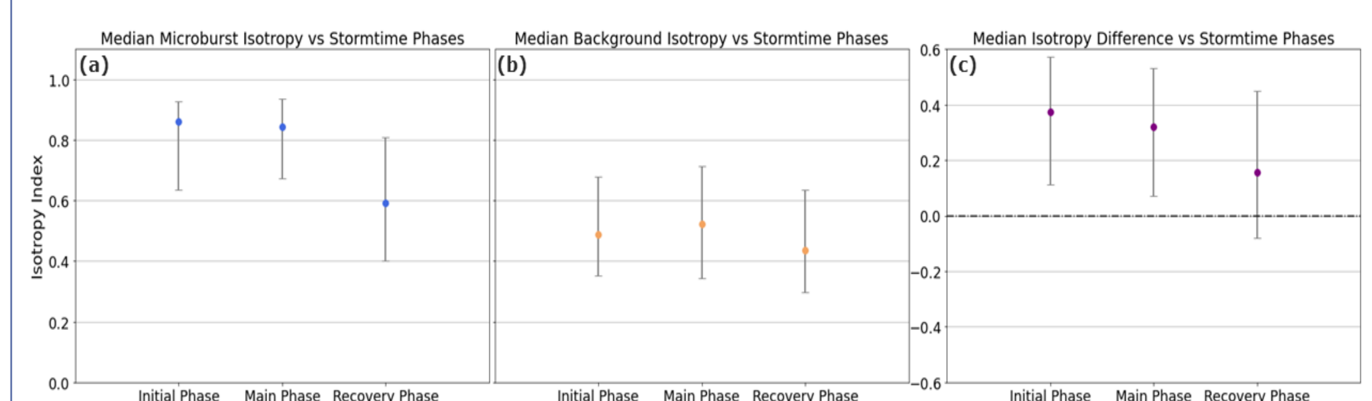
- Out of the 9 geomagnetic storms from 1993 with Dst_{min} < -100 nT, 6 storms with typical Dst profiles were selected for our analysis



-Binned microbursts into initial, main, and recovery phases and used superposed epoch of the 6 storms



- Highest microburst isotropy relative to background in the initial phase of intense geomagnetic storms (error bars show 25th and75th percentiles)



Summary

1) Microburst isotropy is strongly correlated with microburst flux magnitude. Low flux magnitude microbursts are widely varying in isotropy; high flux magnitude microbursts are more isotropic

2) Microburst isotropy compared to the background population is highest in the evening magnetic local time region and lowest in the noon region

3) Microburst isotropy compared to the background population is found to be highest in the initial and main phases of geomagnetic storms and lowest in the recovery phase

4) Lastly, microburst isotropy is higher than the background in each section of the study

Meyer-Reed, C. J., Blum, L.W., Shumko, M. (In prep.)