CGS | CENTER FOR GEOSPACE STORMS

Advances in Understanding Stormtime Magnetotail Dynamics

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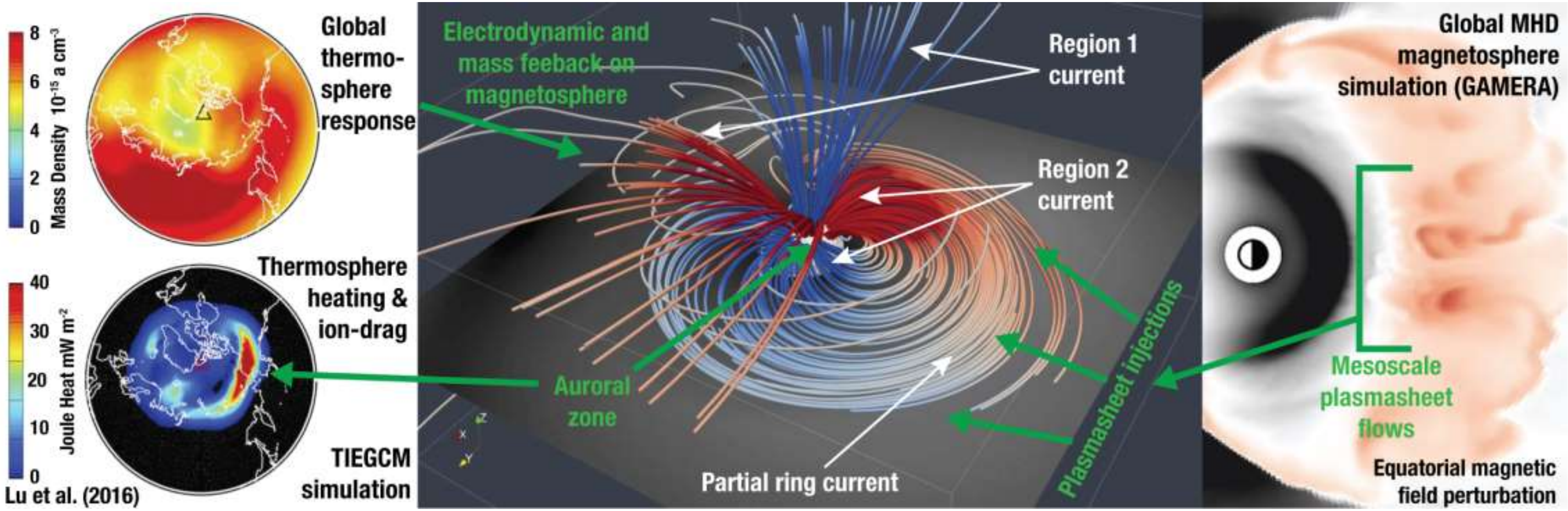
CGS Science Theme 1

Multiscale plasma sheet transport, ring current build-up, and their global impacts throughout stormtime geospace

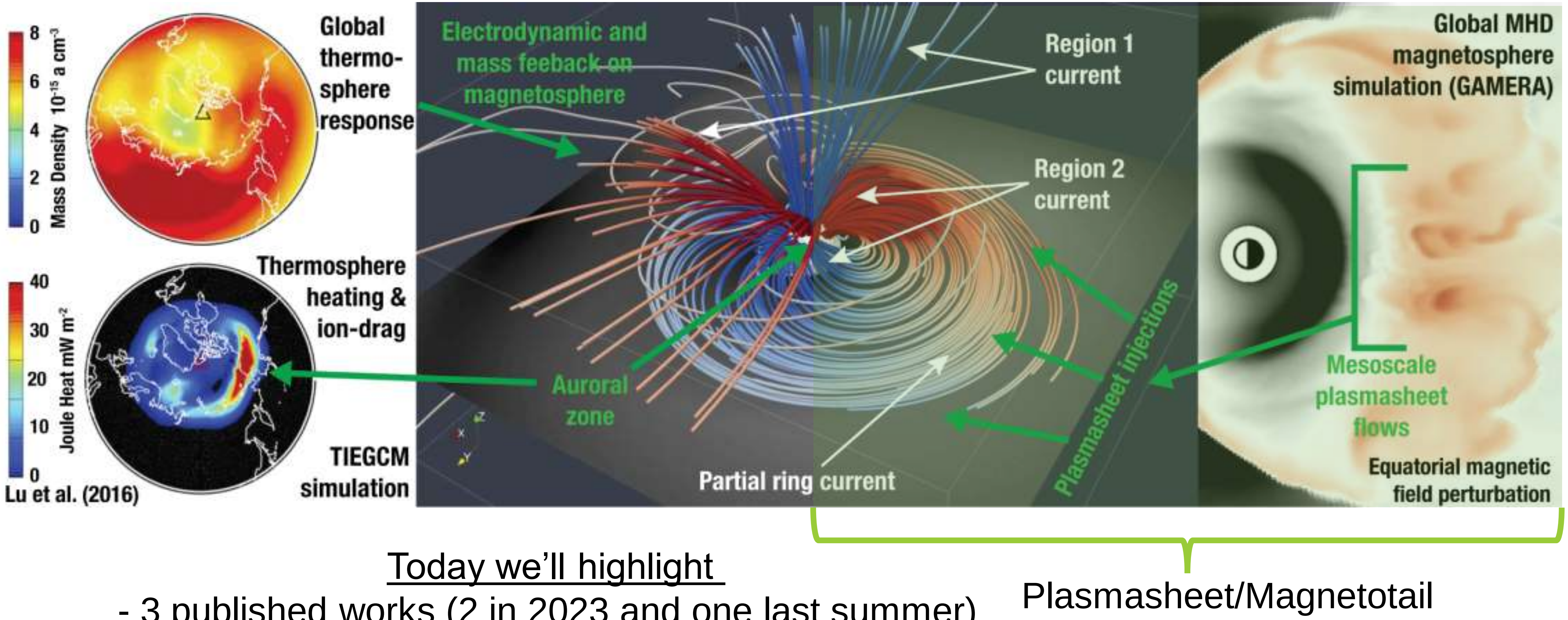


Today we'll highlight

- 3 published works (2 in 2023 and one last summer)
- 1 ongoing effort

CGS Science Theme 1

Multiscale plasma sheet transport, ring current build-up, and their global impacts throughout stormtime geospace



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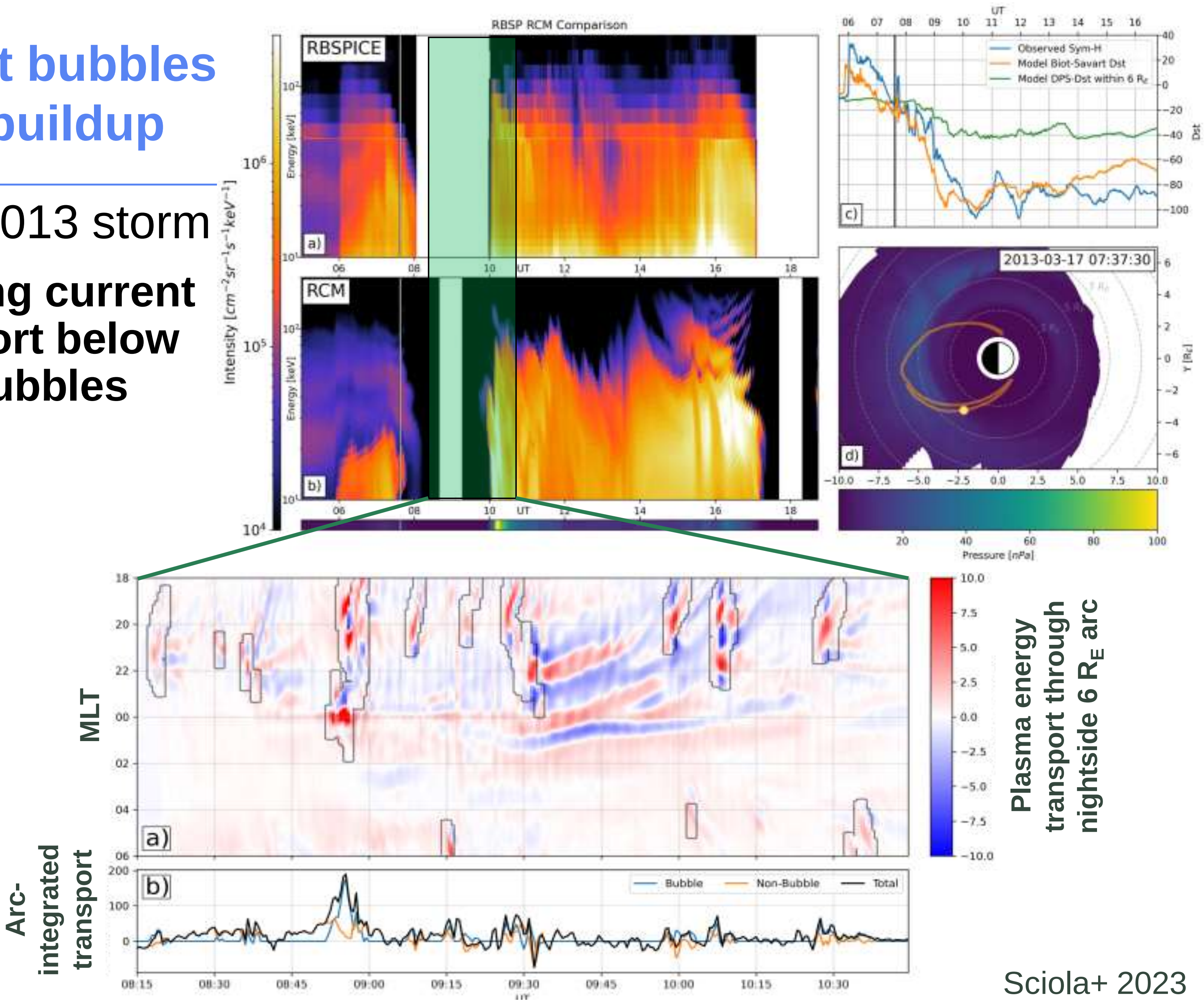
Contribution of plasma sheet bubbles to stormtime ring current buildup

- Case study of the March 17, 2013 storm
  - During **initial buildup of the ring current at least 50% of the net transport below 6 R_E is due to plasma sheet bubbles**
- The **return flows** that accompany bubbles as a result of interchange **transport outwards an average of 40% of the plasma energy**
- The evolution of the modeled ring current energy spectra is due to both an evolving source population and energy-dependent losses

Full paper



Sciola+ 2023

Modeling GMDs w/ MAGE

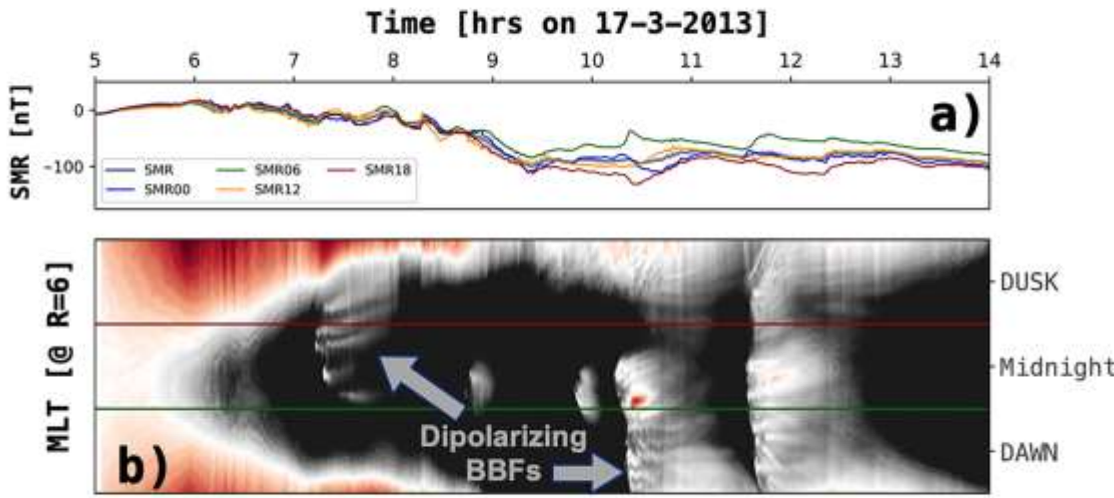
Stormtime MI Coupling

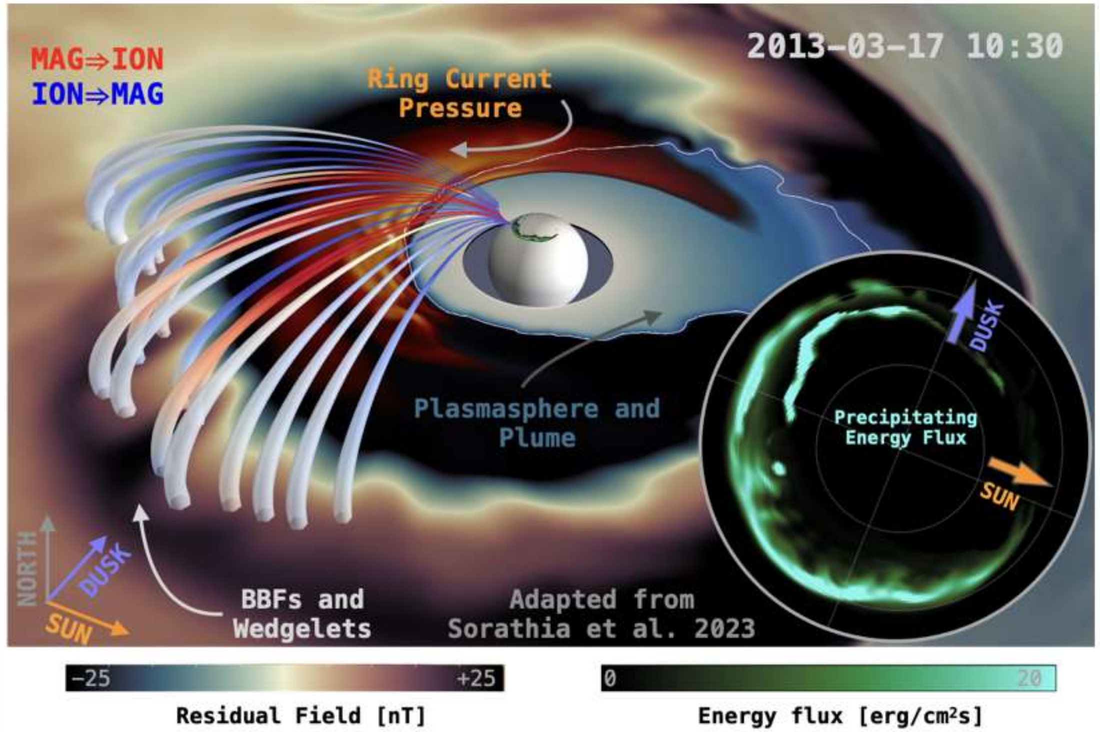
- Dawnside current wedge
    - Ohtani '21 and '23, Sorathia+ '23
- Modeling shows dawnside BBFs during stormtime create multiscale enhancement of the dawnside AEJ
    - BBFs connect to omega bands & large dB/dt

Dawnside GMDs

- dB/dt skewed towards dawn (Schillings+ '22)

Full paper →

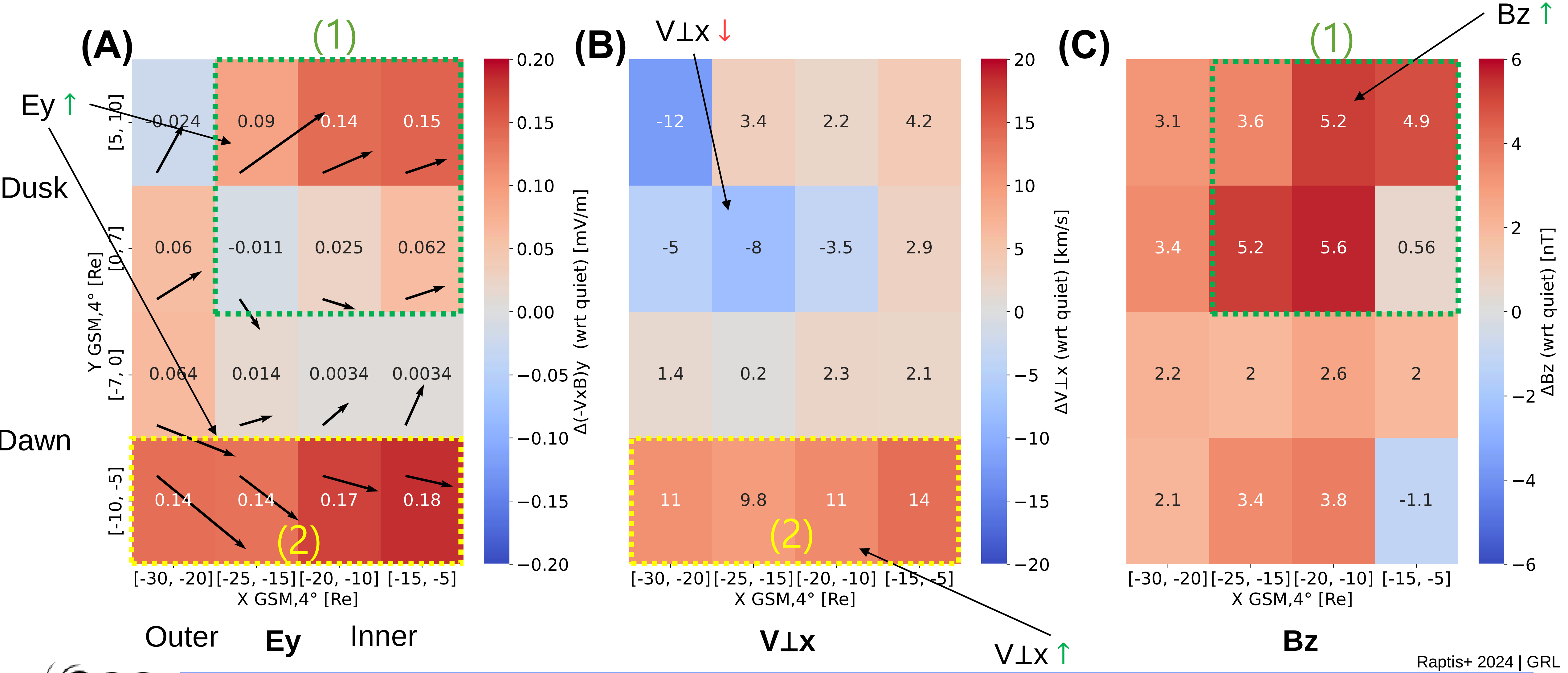




Data Analysis Results

Stormtime Global Convection - Geotail (1994 – 2022)

Full paper

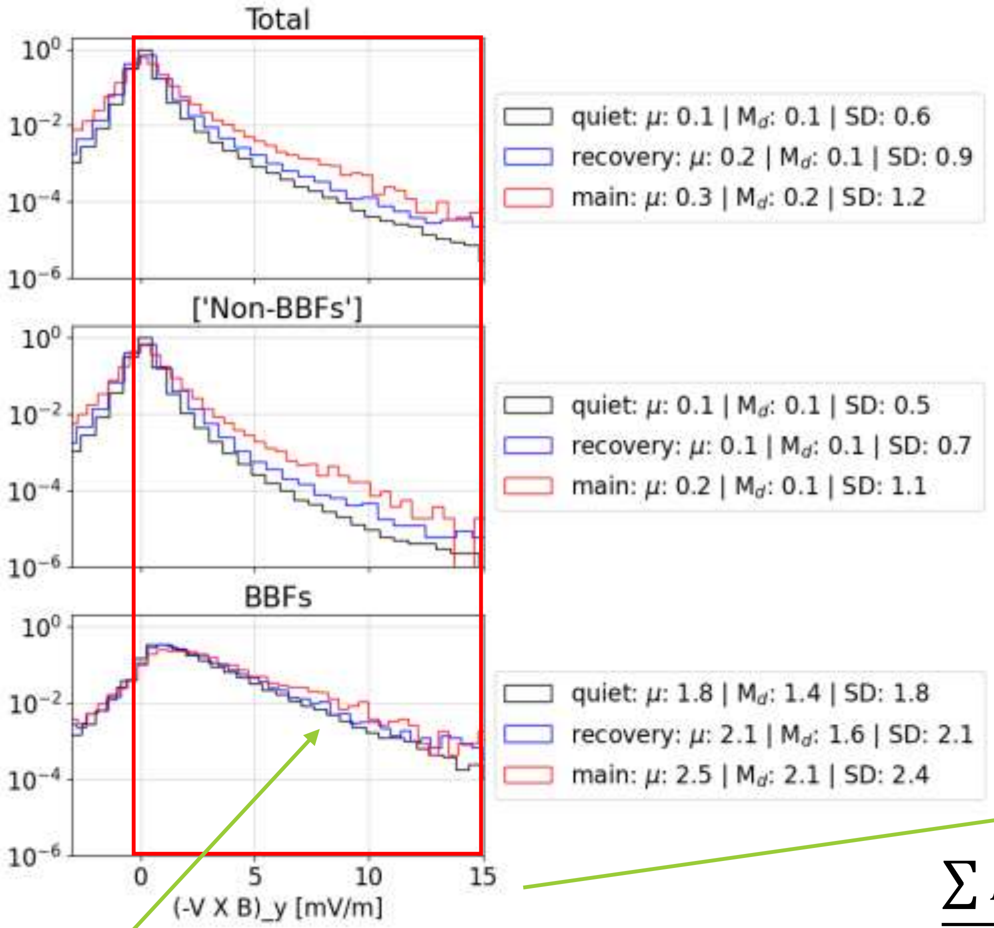


Raptis+ 2024 | GRL

Bursty Magnetic Flux Contribution

Ongoing work

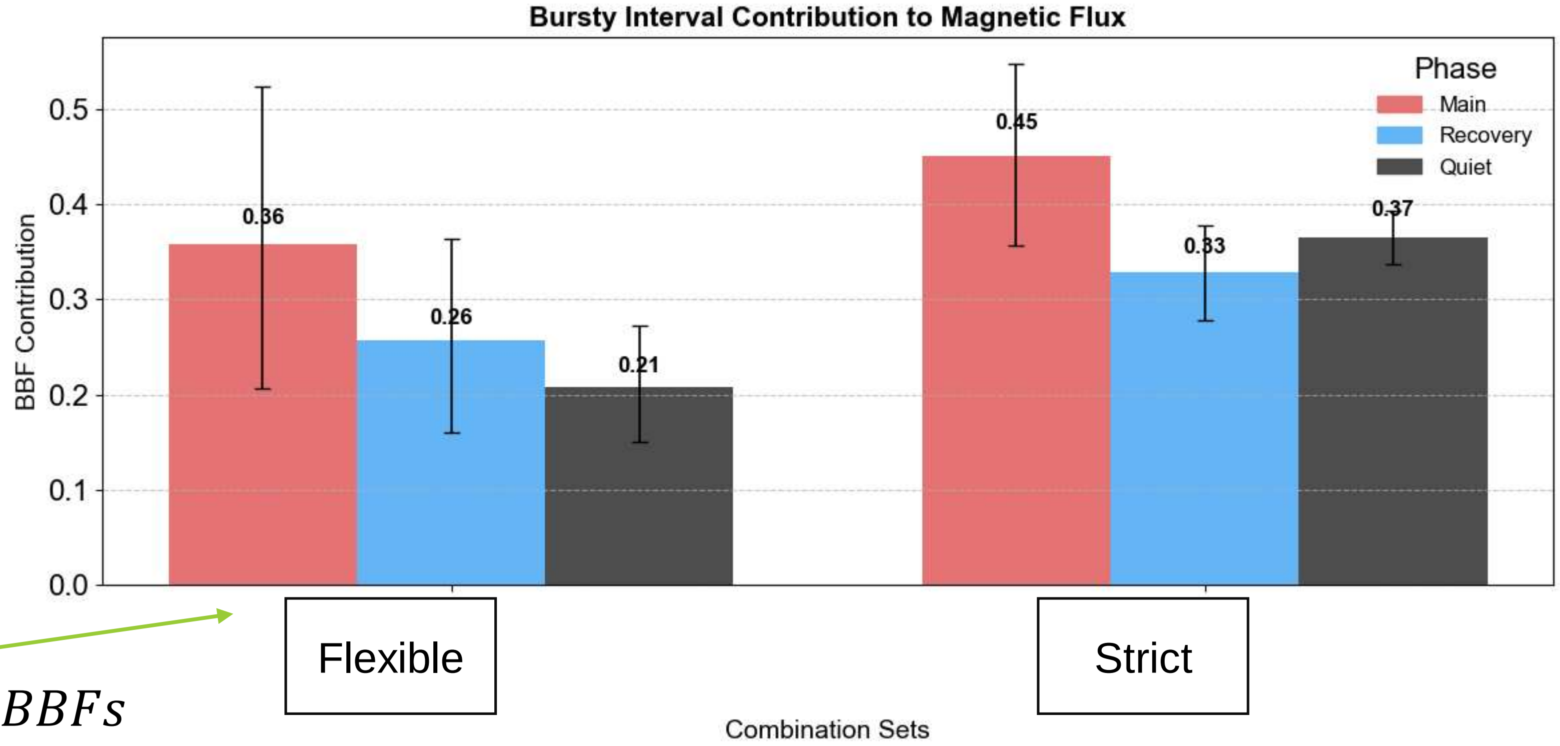
Histograms are normalized per phase



Similar profiles between phases*

BBFs: 1 point : $v_{\perp,x} > 250\frac{km}{s}$ | Interval: $v_{\perp,x} > 100\frac{km}{s}$

Error bars: min/max of dataset variations



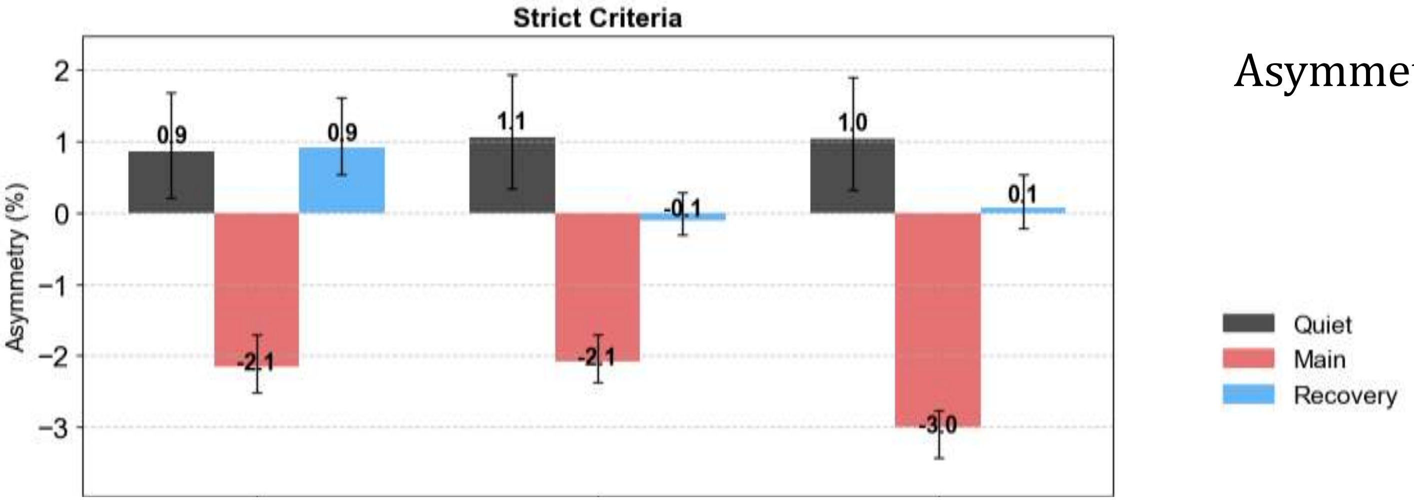
$$\frac{\sum BBFs}{\sum total}$$

Strict and flexible = Different plasma sheet classification

Dawn – Dusk Asymmetry of BBFs/BEIs

Bursty Interval Occurrence: ~2-4% quiet times | ~4-8% main phase

$$\text{Occurence} = \frac{\text{BBF Points}}{\text{Total Points}}$$



DAWN (<-3 Re)
DUSK (>3 Re)

DAWN (<-4 Re)
DUSK (>4 Re)

DAWN (<-5 Re)
DUSK (>5 Re)

$$\text{Asymmetry} = \frac{\text{Occurrence Dusk}}{\text{Occurrence Dawn}}$$

Same message Across all combinations = Dawn preference during main phase and Dusk during quiet

Error bars = min/max based on definition of bursty interval
Different sets = Different definition of dawn/dusk

Consistent with Nagai+ 2023
Reconnection moving Dawnward

Summary

Contribution of Mesoscale Burst Intervals in tail dynamics remains a major unanswered question*

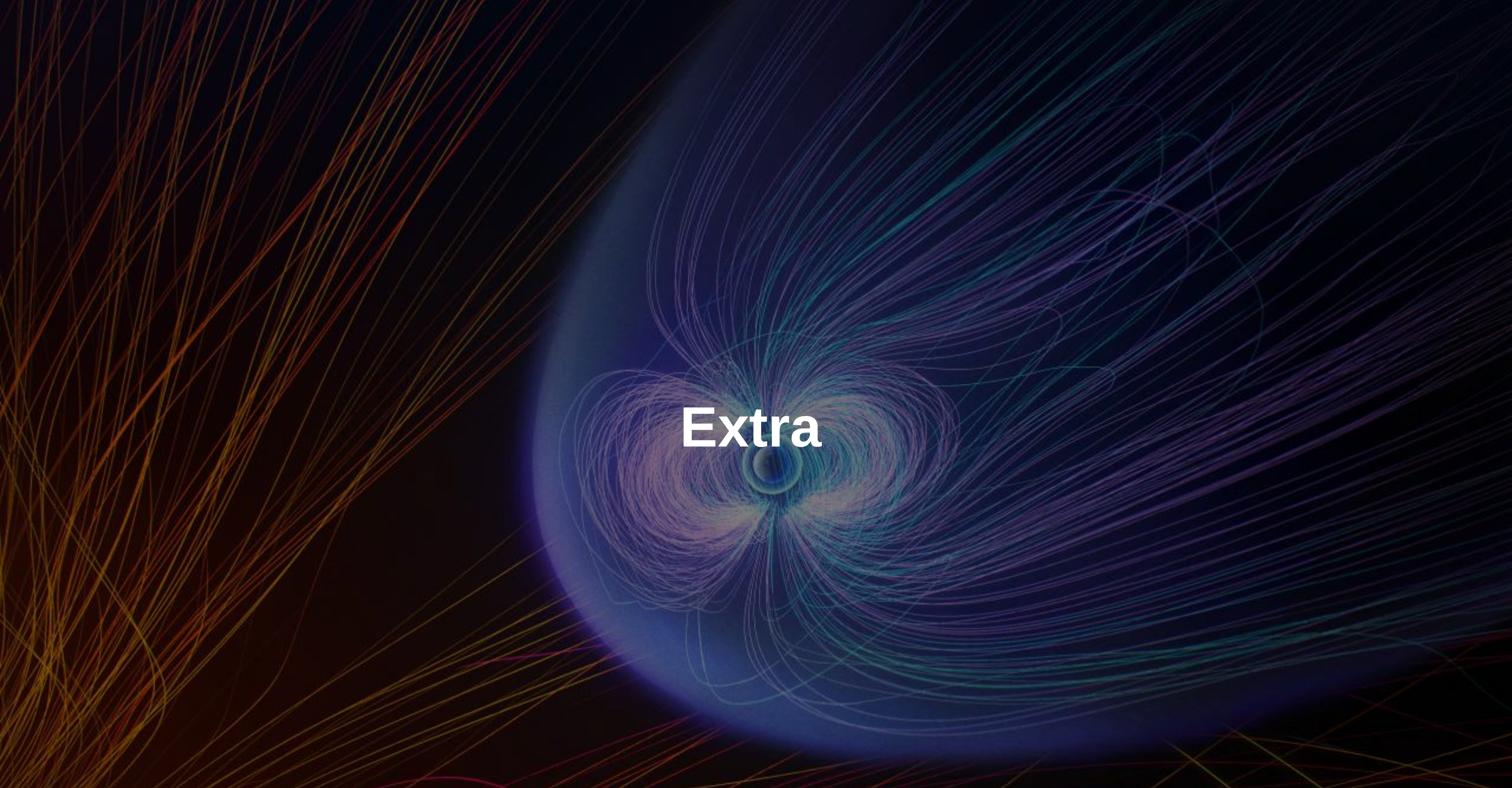
However, recent simulation and observation efforts have showed us that :

(a) During the **initial buildup of the ring current at least 50% of the net transport below 6 R_E is due to plasma sheet bubbles (Sciola+ 2023).**
(b) During storms **dawnside BBFs create multiscale enhancement of the dawnside AEJ and cause large dB/dt** (Kareem+2023).
(c) Stormtime convection is associated to more **dipolar field at dusk** and **faster flow at dawn (Raptis+2024).**
(d) BBFs contribution to magnetic flux transport is elevated during storms, accounting for 30-50% (Ongoing).
(e) BBFs are more frequent during storms, and are more frequent at dawn during the main phase and at dusk during quiet/recovery times (Ongoing).

See also Anusree Devanandan's Poster: **SM13A-2769** and Joel Tibbetts Poster: **SM13A-2772**

*See Decadal mission recommendation: "Links"

Extra



Modeling ENA Imaging with MAGE

- Observing system simulation experiment (OSSE) for energetic neutral atom (ENA) imagers based on MAGE
- Customizable to different imager characteristics and geometries (e.g., TWINS, IMAGE/MENA)
  - ➔ Enables data-model comparisons with existing missions
- Motivating question: By taking MAGE data as "ground truth," what would an ENA imager be able to resolve in terms of mesoscale features?
  - ➔ Can inform future mission design requirements

MAGE MHD input

Synthetic ENA flux output