


Volume

A green square containing a white icon of a bar chart with an upward-trending arrow, representing volume or growth.

Velocity

A blue square containing two white arrows pointing in opposite directions, representing velocity or speed.

Variety

An orange square containing a white icon of a square, a circle, and an upward-pointing triangle, representing variety or diversity. The entire square is circled in black.

Veracity

A grey square containing a white icon of a warning triangle, a square with question marks, and a circle, representing veracity or truth.

Does region of energized particles propagate earthward or tailward?

- Satellite data provide multi-point observations, yet no definite conclusion.

Reeves et al. [1996]

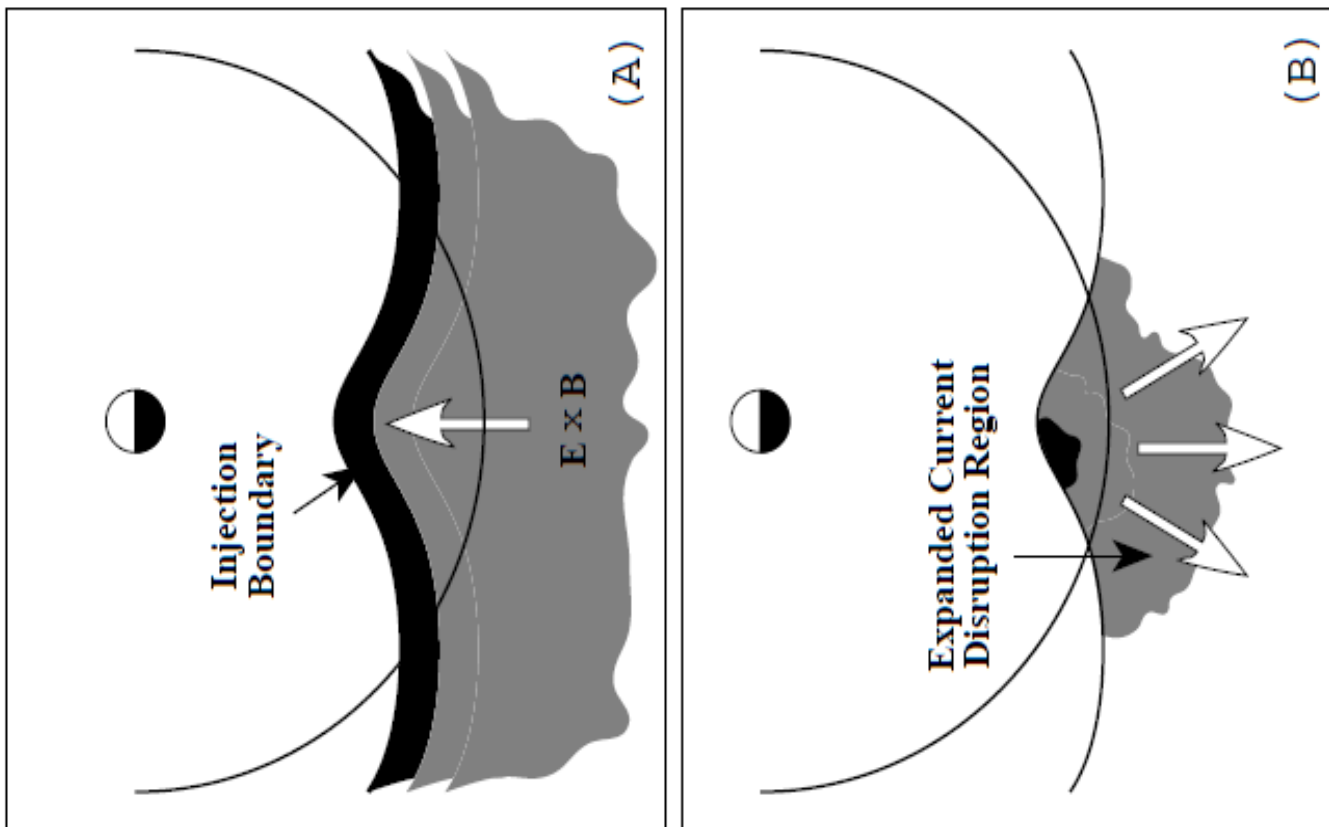
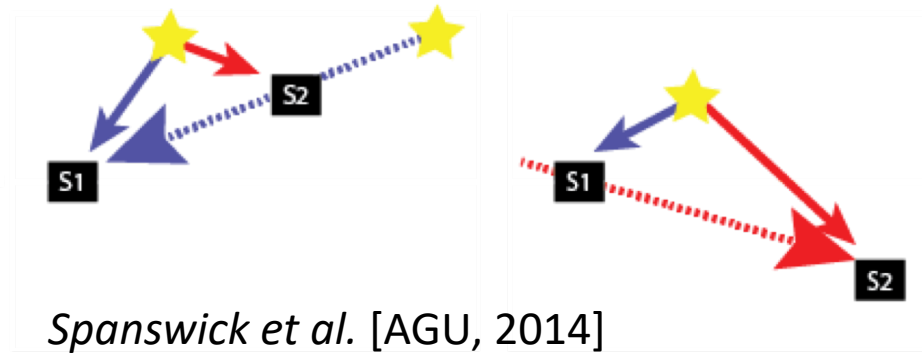
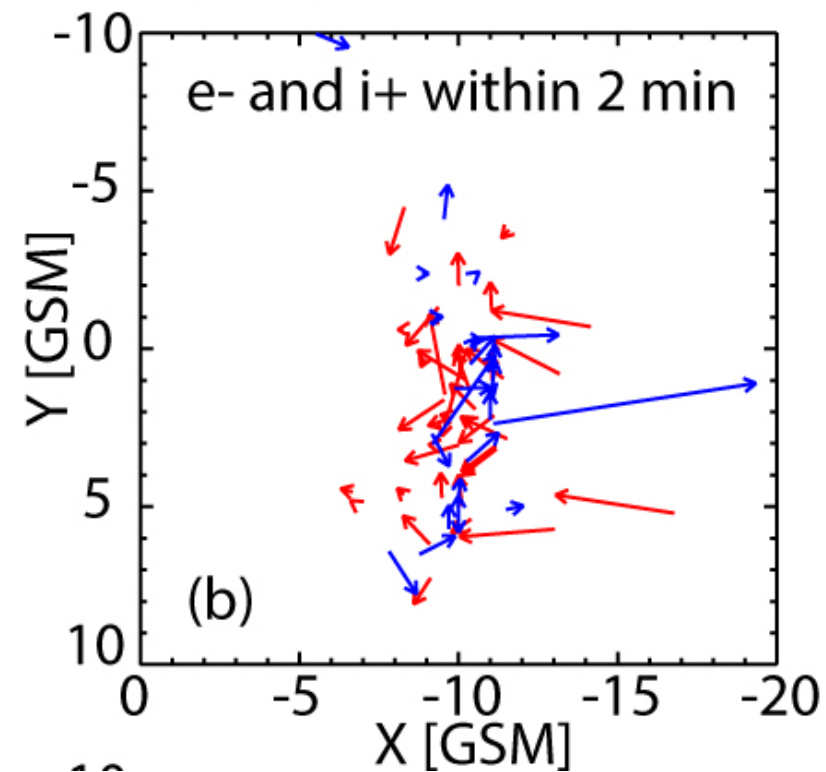
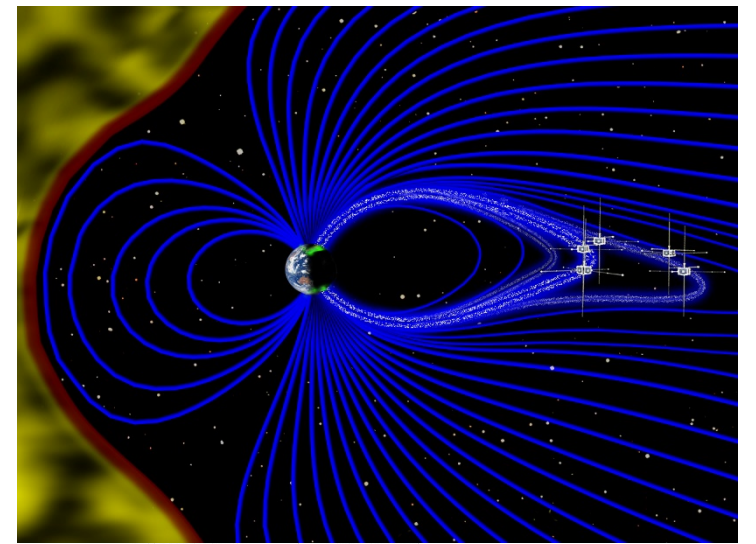
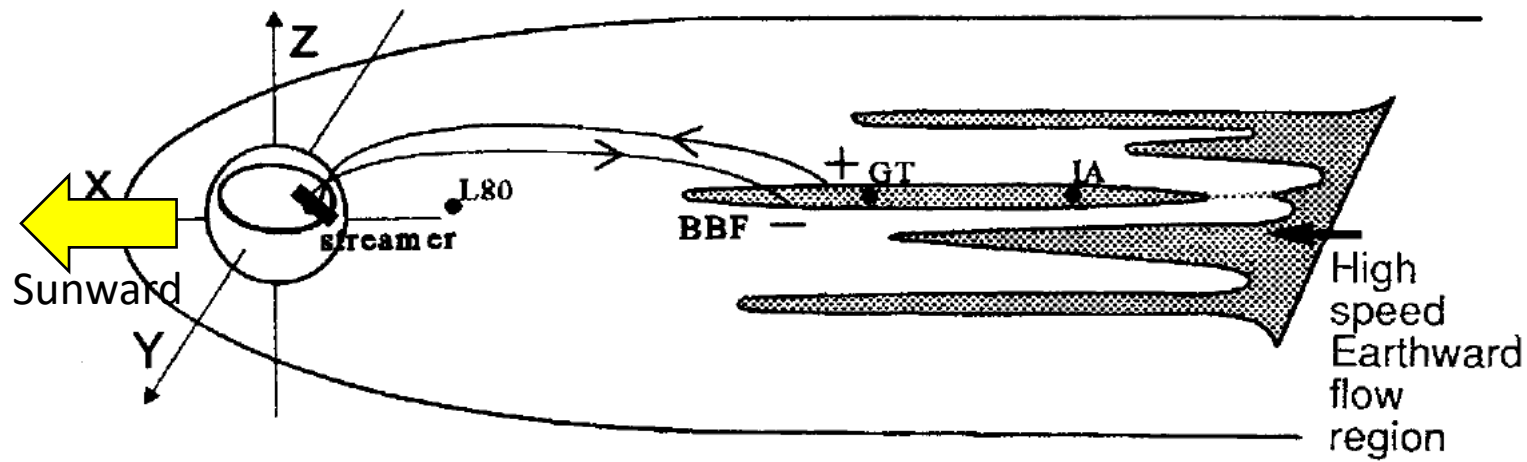


Figure 1: Propagation of the substorm injection region predicted by (A) the Convection Surge model and (B) the Current Disruption model.

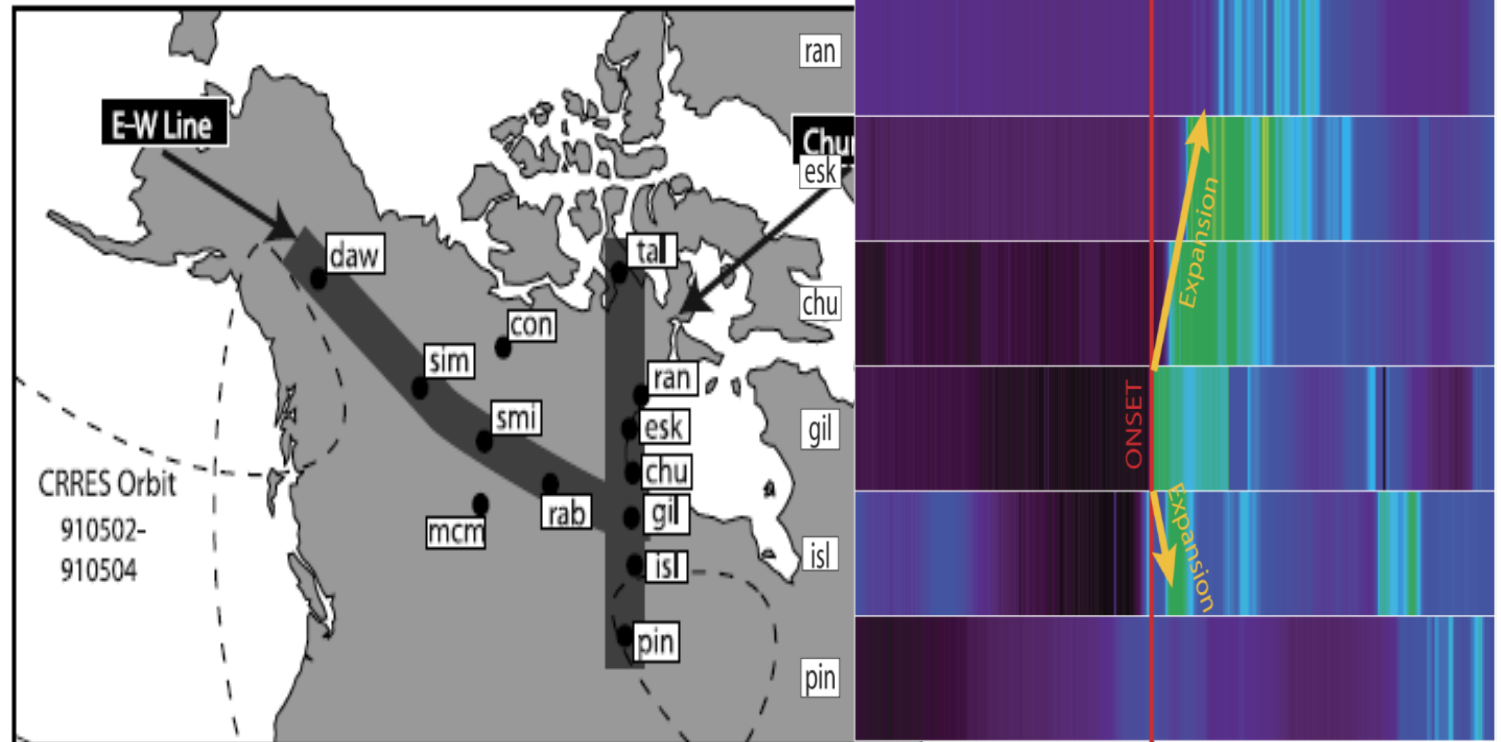


Spanswick et al. [AGU, 2014]



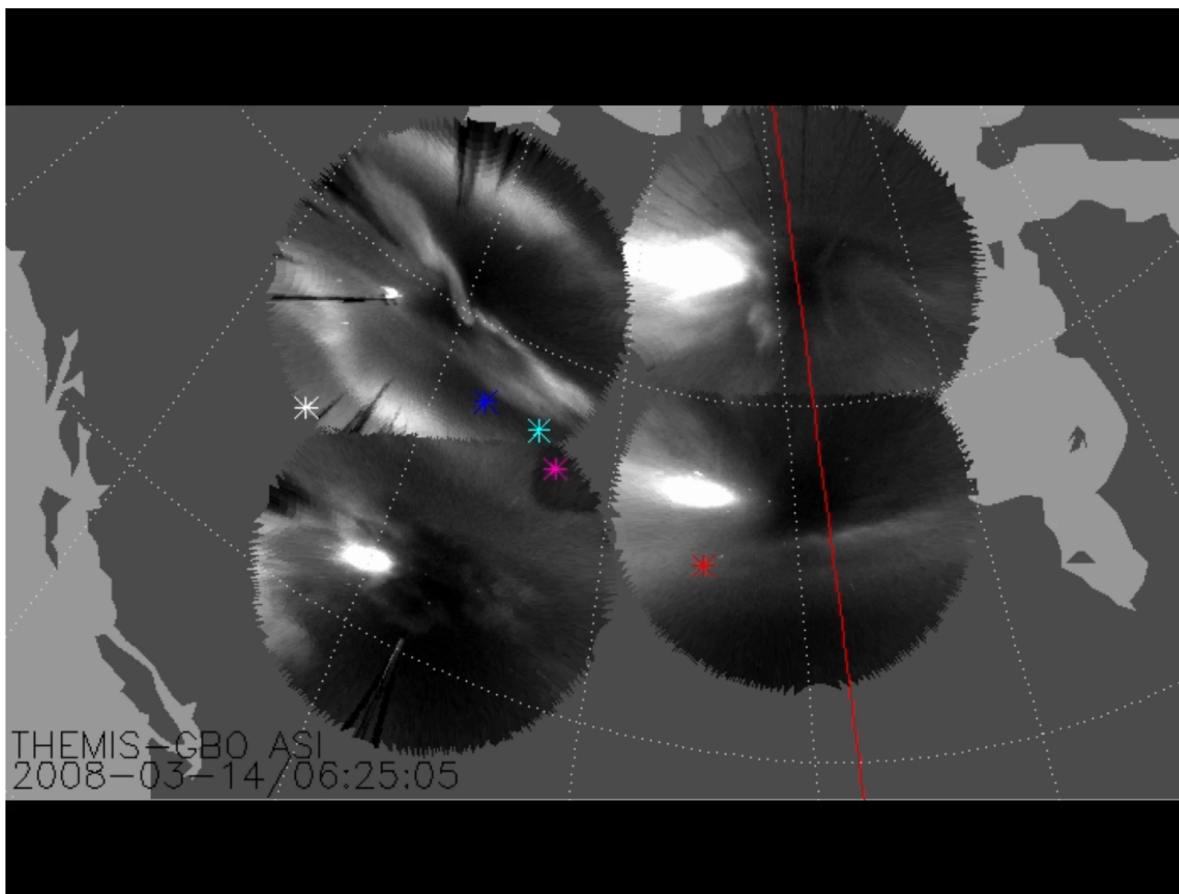
Does region of energized particles propagate earthward or tailward?

- Riometer data suggested mostly poleward/tailward propagation.
- But how do we explain the earthward transport in space?

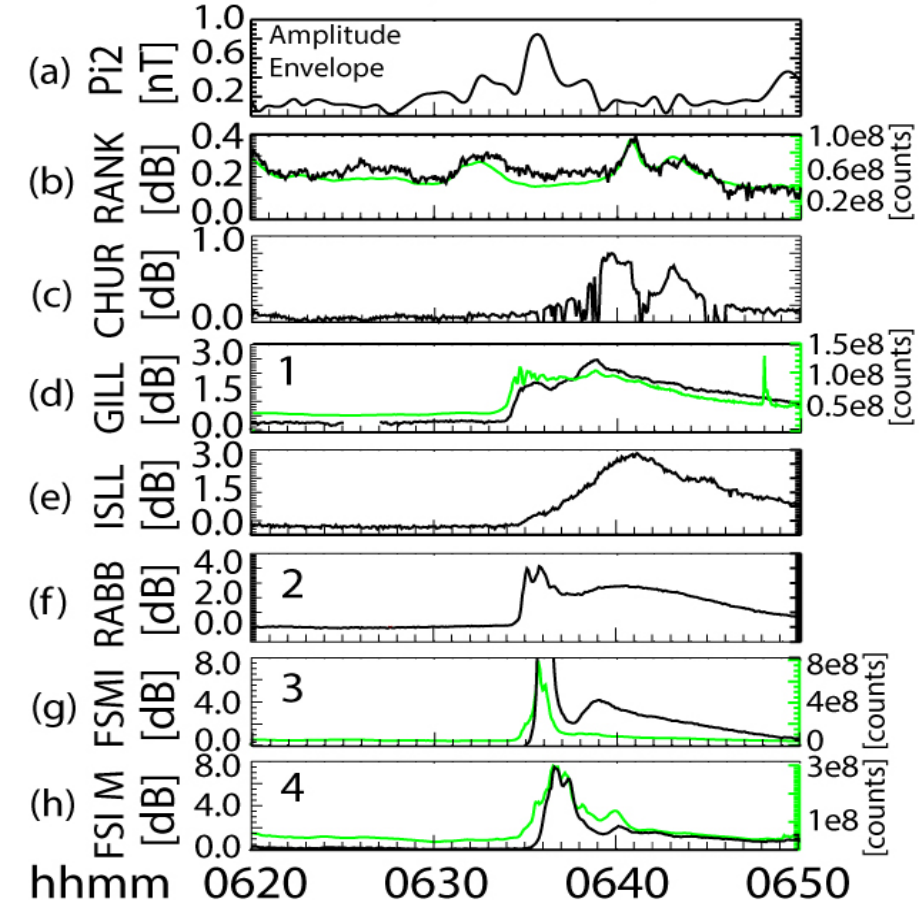


Does region of energized particles propagate earthward or tailward?

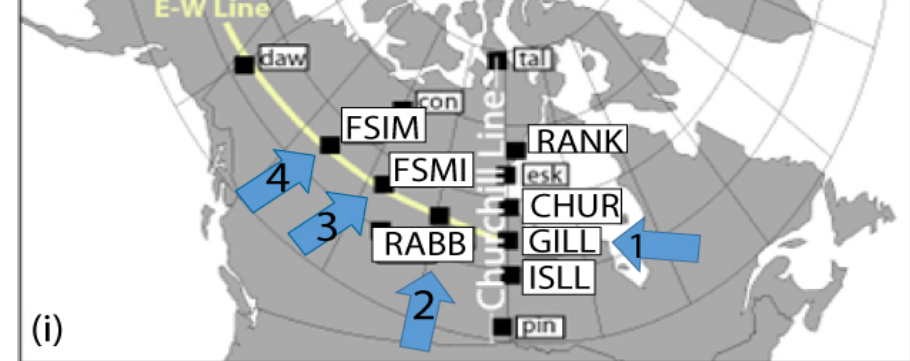
- Ground-based data provide a 2D image upon which to put the spacecraft data into context



Ground Data: Pi2, Riometer, ASI Counts



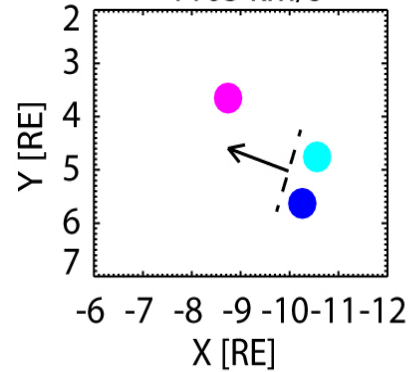
NORSTAR Riometer/ THEMIS All-Sky-Imagers



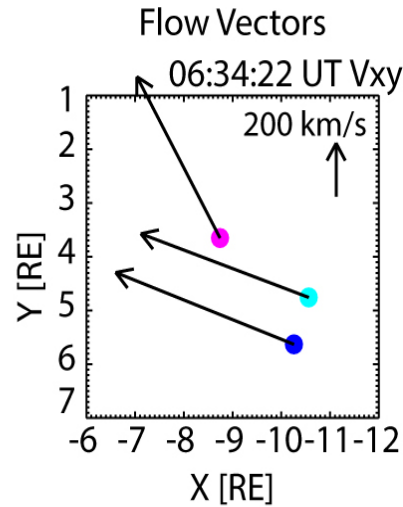
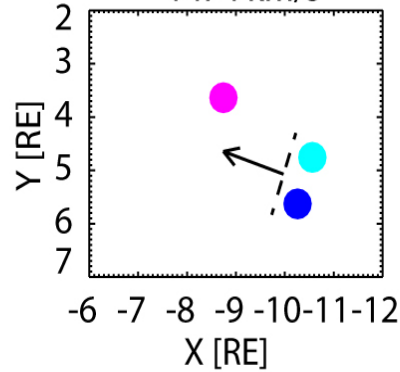
An Interpretation

Gabrielse et al., Under Review

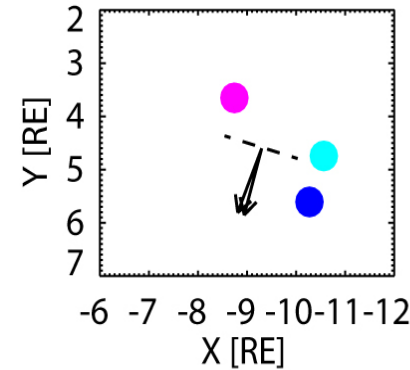
Electron injection boundary
($>11.6\text{keV}$ First increase)
 $N=0.94, -0.33$
1105 km/s



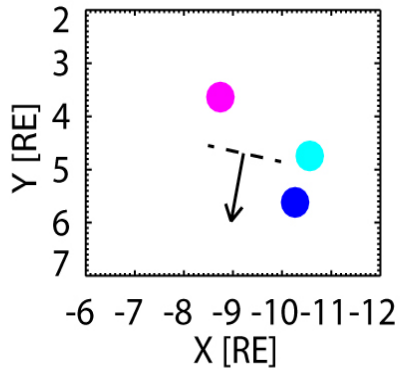
Ion injection boundary
(First increase)
 $N=0.94, -0.33$
1474 km/s



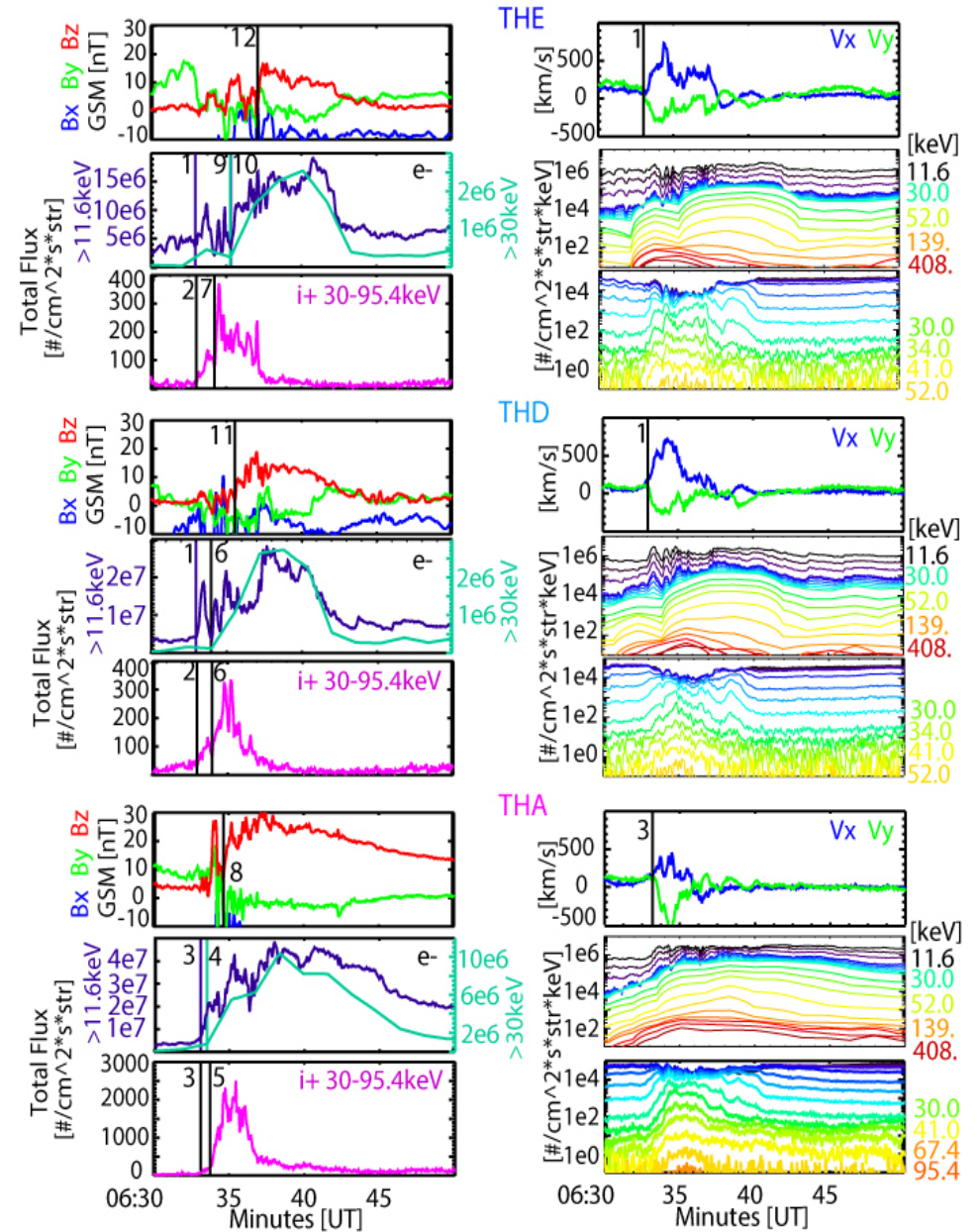
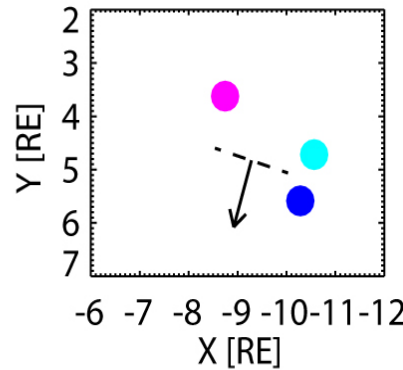
Electron injection boundary
 $>11.6\text{keV}$: $>30\text{keV}$:
 $N=0.27, 0.96$ $N=0.38, 0.93$
71.6 km/s 74.4 km/s



Ion injection boundary
(Sustained increase)
 $N=0.19, 0.98$
389 km/s



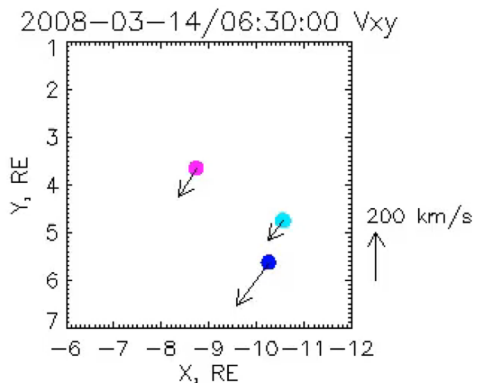
B_z Boundary
(Sustained increase)
 $N=0.28, 0.96$
64.6 km/s



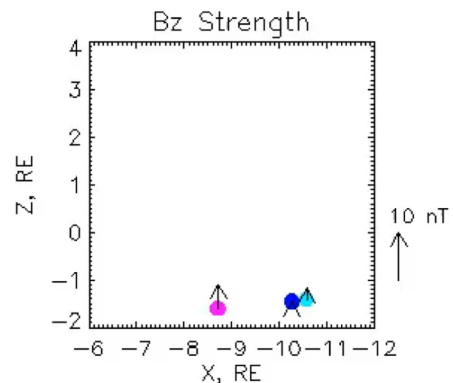
An Interpretation

Gabrielse et al., Under Review

Velocity Vectors

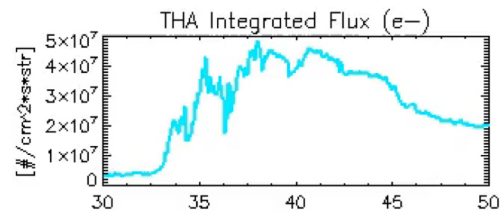
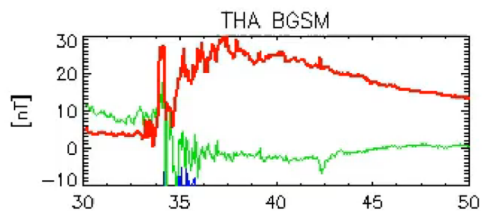


Bz Magnitude



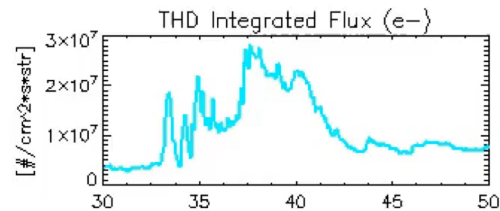
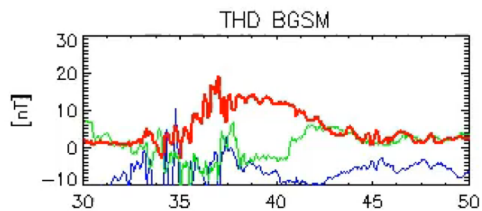
THA
(inner)

Bz



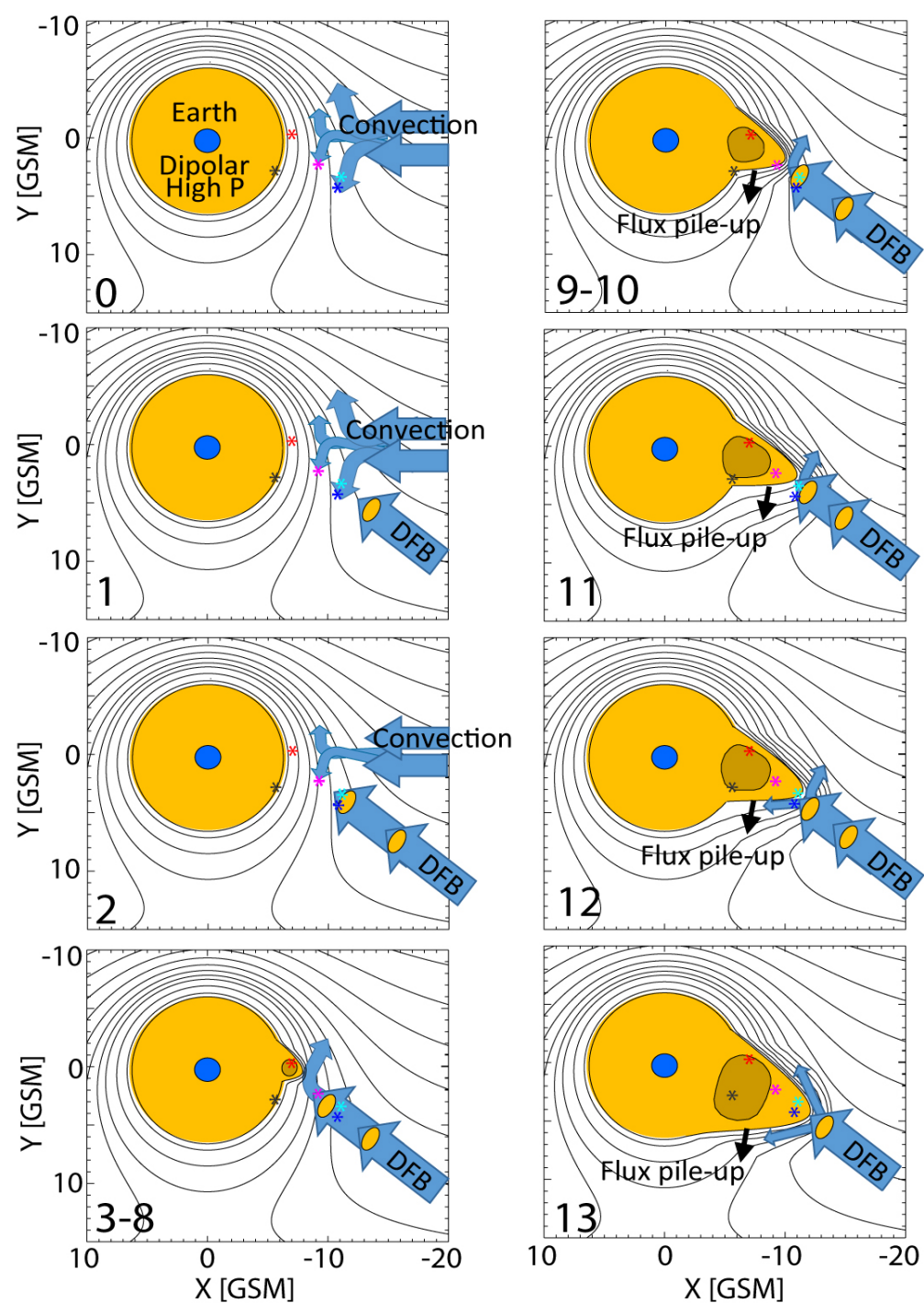
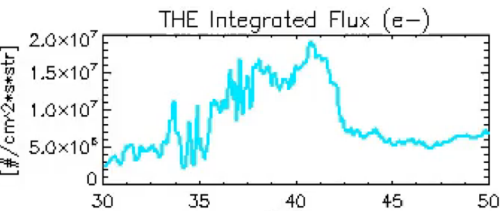
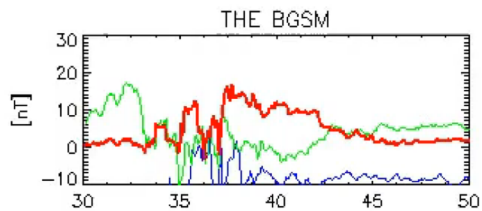
THD
(outer)

Bz



THE
(outer)

Bz



Next Generation CEDAR Science Questions

- What are the powerful use cases for applying data science in geospace?
- What are the immediate next steps to embrace data science approaches in geospace?

I advocate for embracing data variety, using a combination of in-situ and ground-based observations.