Coupling of Dipolarization Front Flow Bursts to Substorm Magnetospheric and Ionospheric Expansion Phase Phenomena

L. Lyons, Y. Nishimura, T. Kikuchi, A. Runov, E. Donovan, V. Angelopoulos

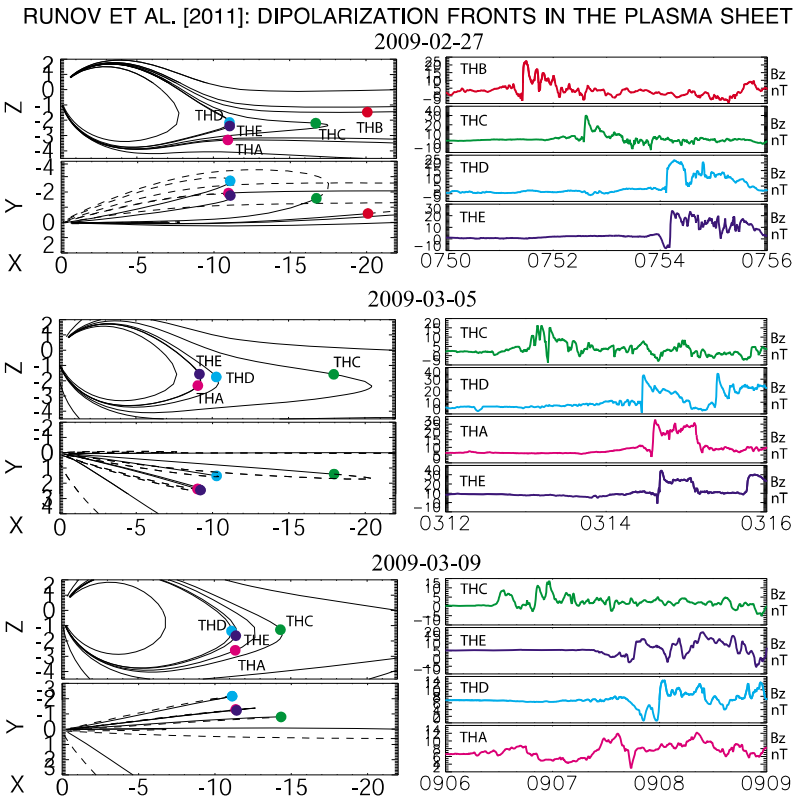


Figure 1. (left) THEMIS probe positions and T96 model [Tsyganenko, 1995] magnetic field lines in (XZ) and (XY) GSM planes for 27 February, 5 March, and 9 March 2009 events. (right) Z GSM component of the magnetic field versus UT.

from *Runov et al. [2011]*

THEMIS has revealed magnetotail **dipolarization fronts with large +ΔBz propagating Earthward** as coherent structures **[*Runov et al.*, 2009, 2011]**

- Have characteristic **signatures predicted by bubble models** of flow channels [*Chen and Wolf*, 1993; *Pontious and Wolf*, 1990]
  - Increase in earthward V and P_{mag} decrease in plasma n and P.

Question: *How are fronts related to well-known geomagnetic disturbances?*

- Streamer-flow channel association well known, but front associated changes much stronger than typical

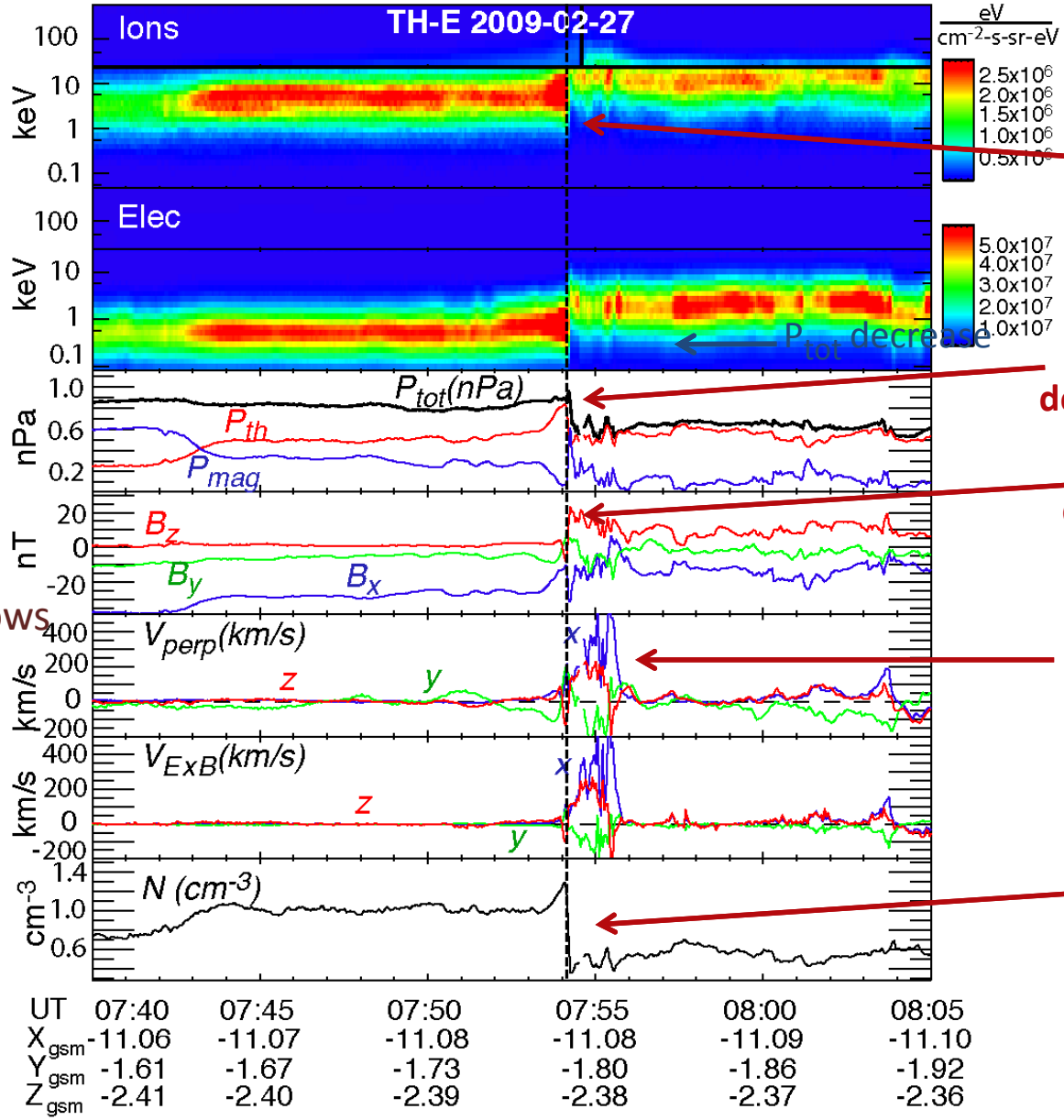
2009-02-27

THE

07:30-08:15UT

Large $PV^{5/3}$ decrease

(low entropy plasma flows in, replaces higher)



Particle energization

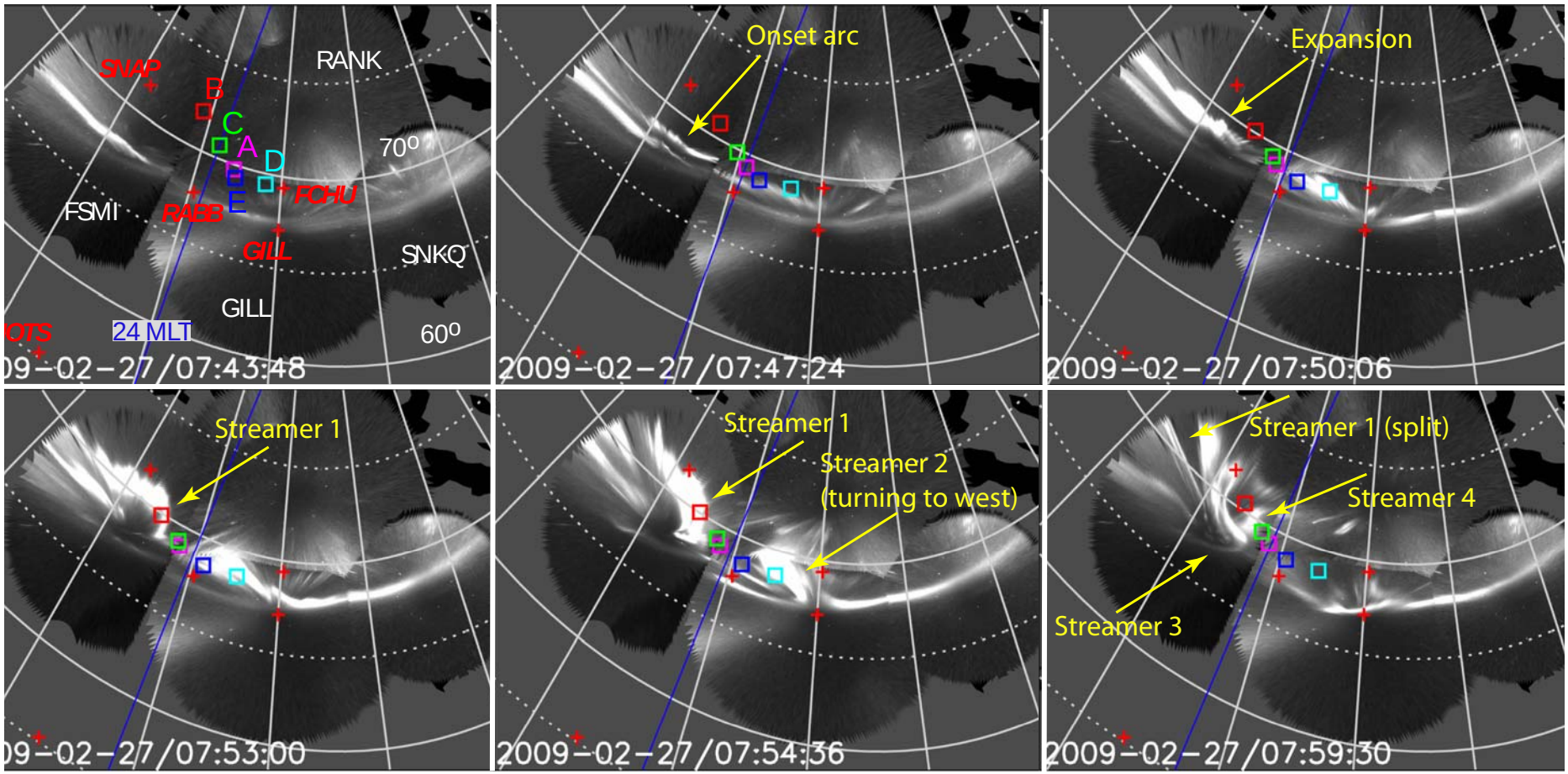
P_{tot} decrease

Sharp dipolarization

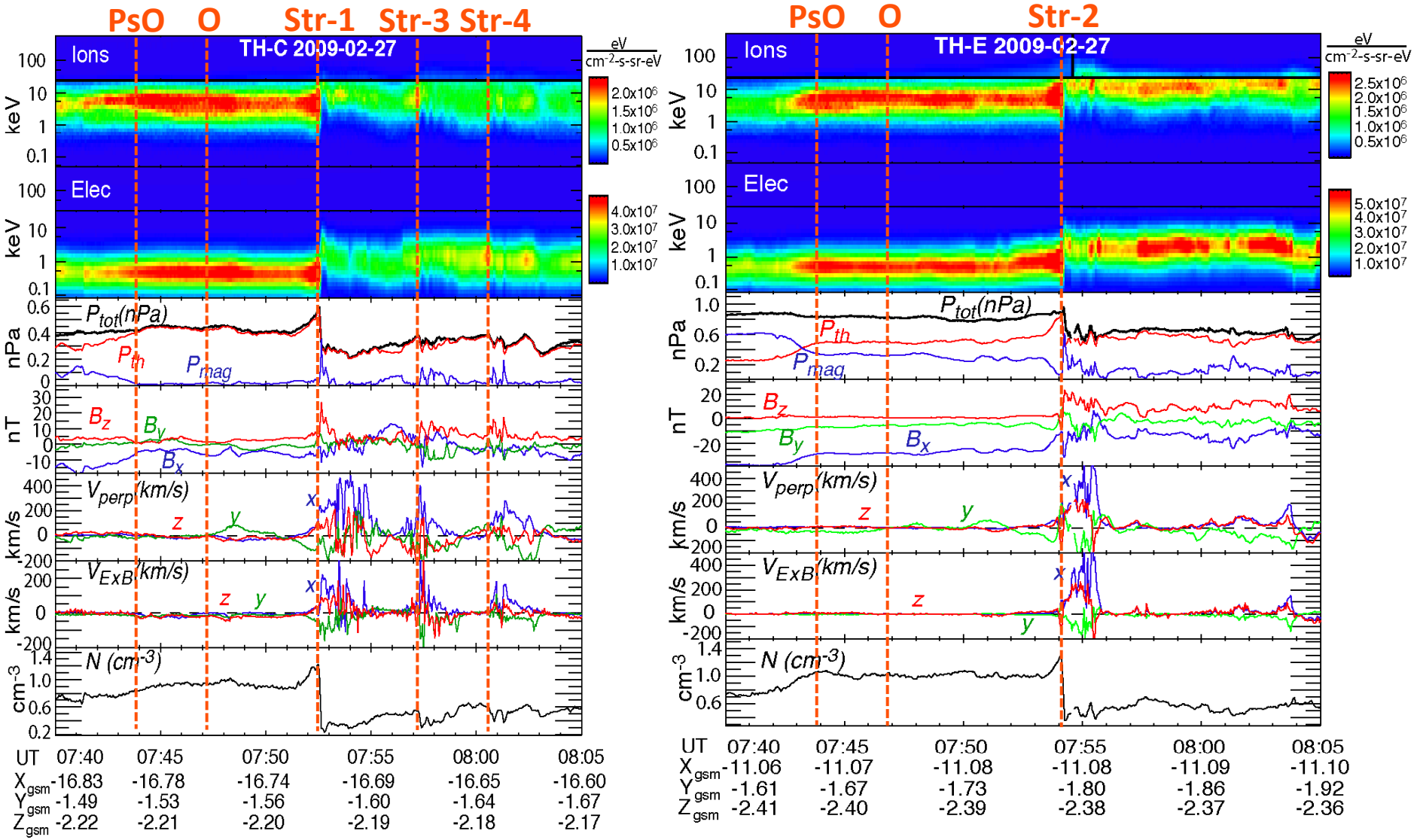
Strong earthward flow

Sharp N decrease

Onset 0746:48 (psuedo 0743:54)



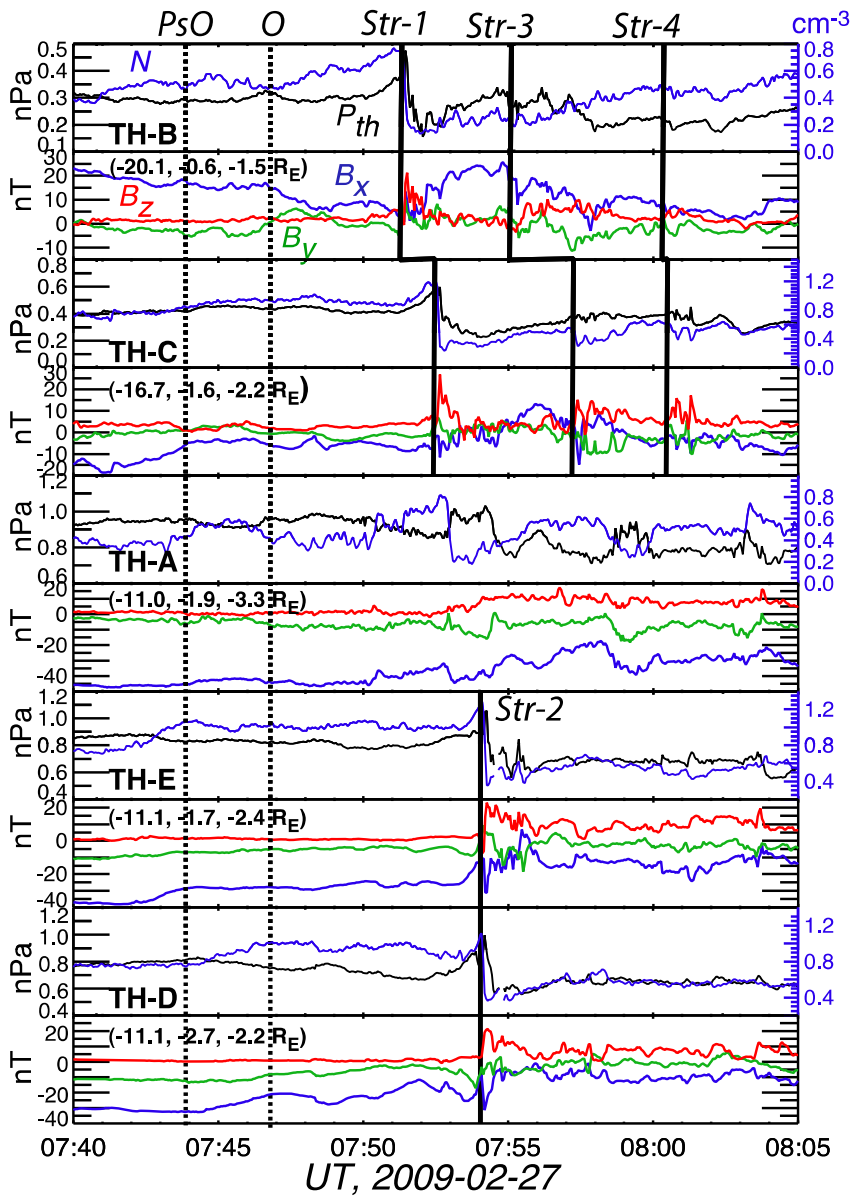
Streamers 1,3,4 near THEMIS B, C, Streamer 2 near E, D

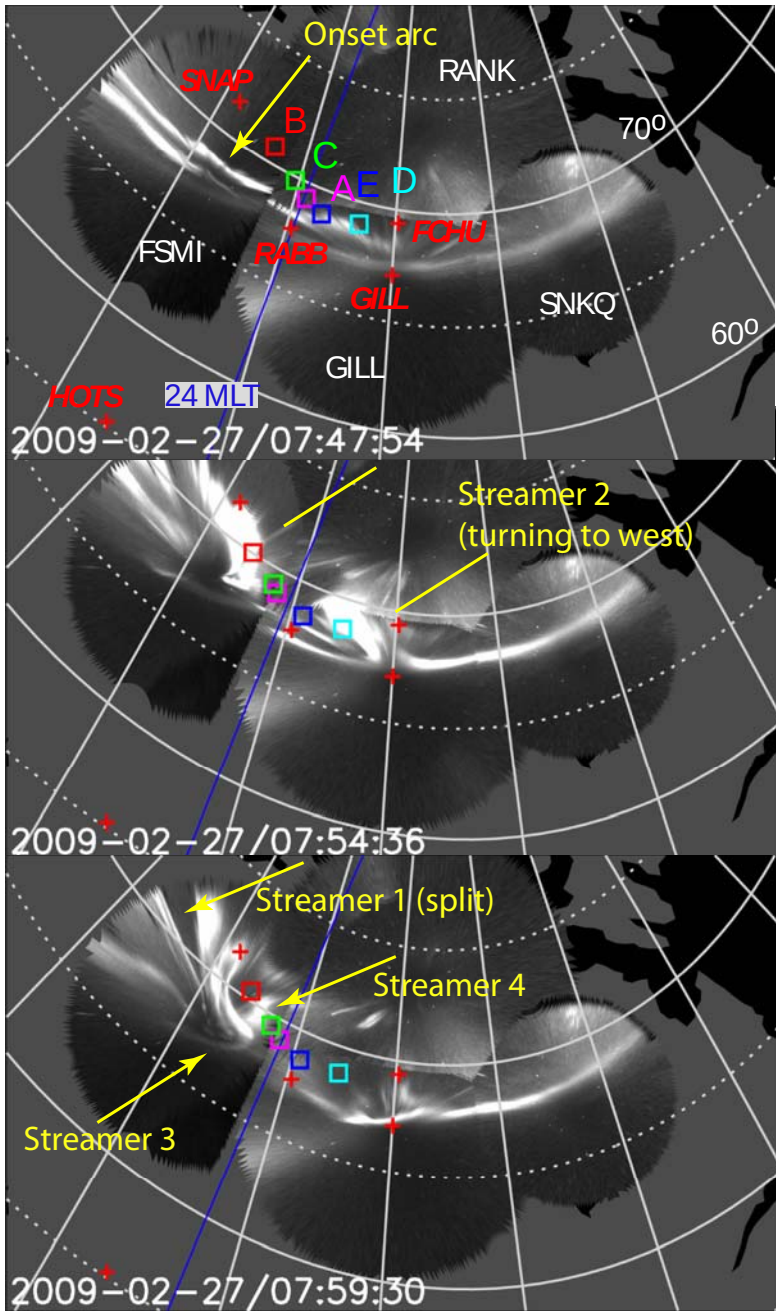


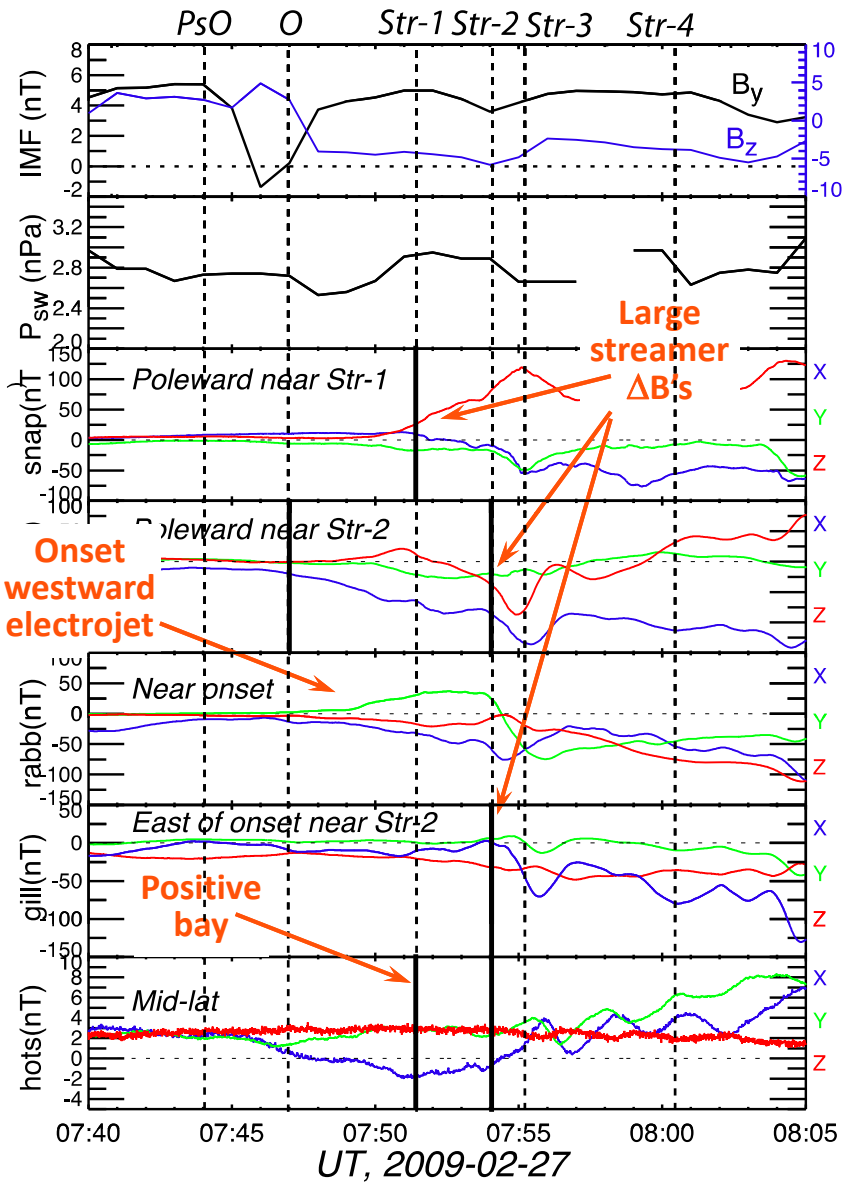
Onset: Nothing much – only some modest V_y

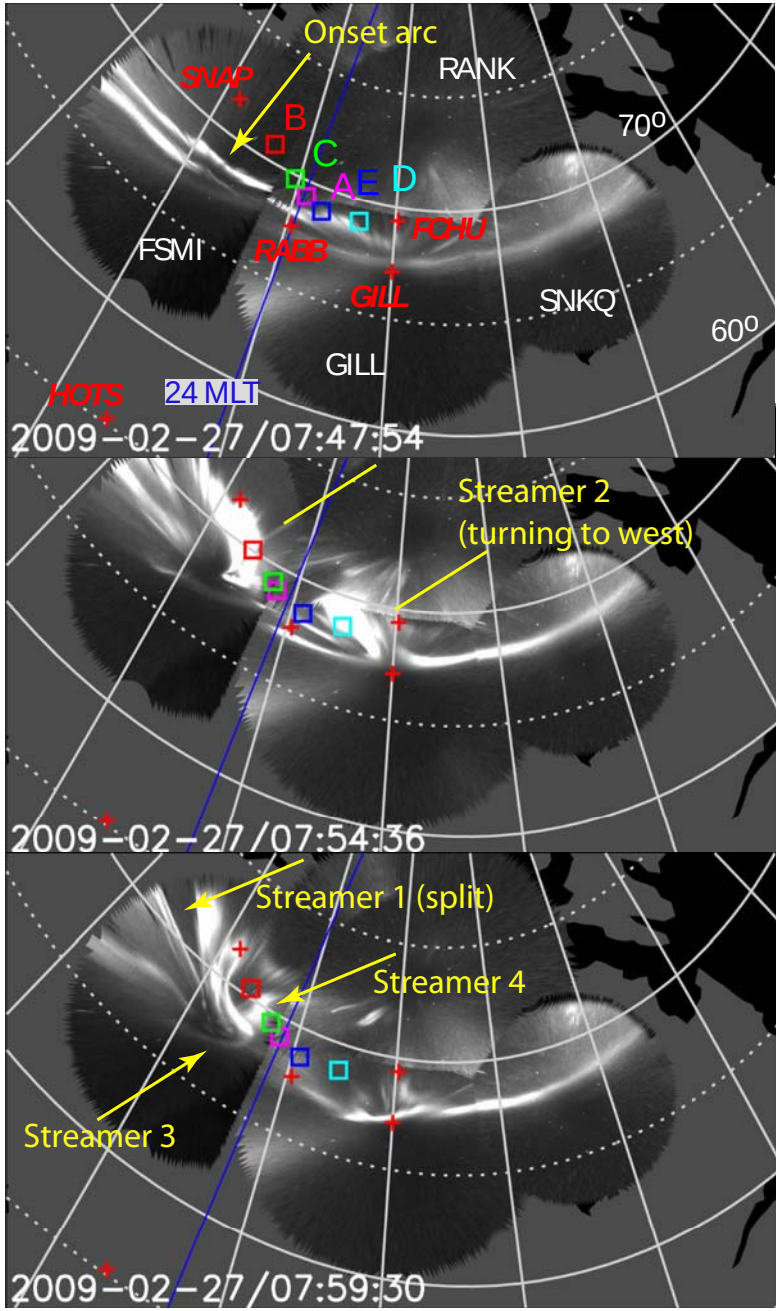
Streamers: Strong dipolarization (fronts), flows

Suggests: *Largest mid and inner plasma sheet substorm effects can be longitudinally localized and due to flow channels/streamers*


PsO
O
Str-1
Str-3
Str-4
cm-3
N
Pth
TH-B
(-20.1, -0.6, -1.5 RE)
Bx
Bz
By
TH-C
(-16.7, -1.6, -2.2 RE)
TH-A
(-11.0, -1.9, -3.3 RE)
Str-2
TH-E
(-11.1, -1.7, -2.4 RE)
TH-D
(-11.1, -2.7, -2.2 RE)
nPa
nT
07:40
07:45
07:50
07:55
08:00
08:05
UT, 2009-02-27

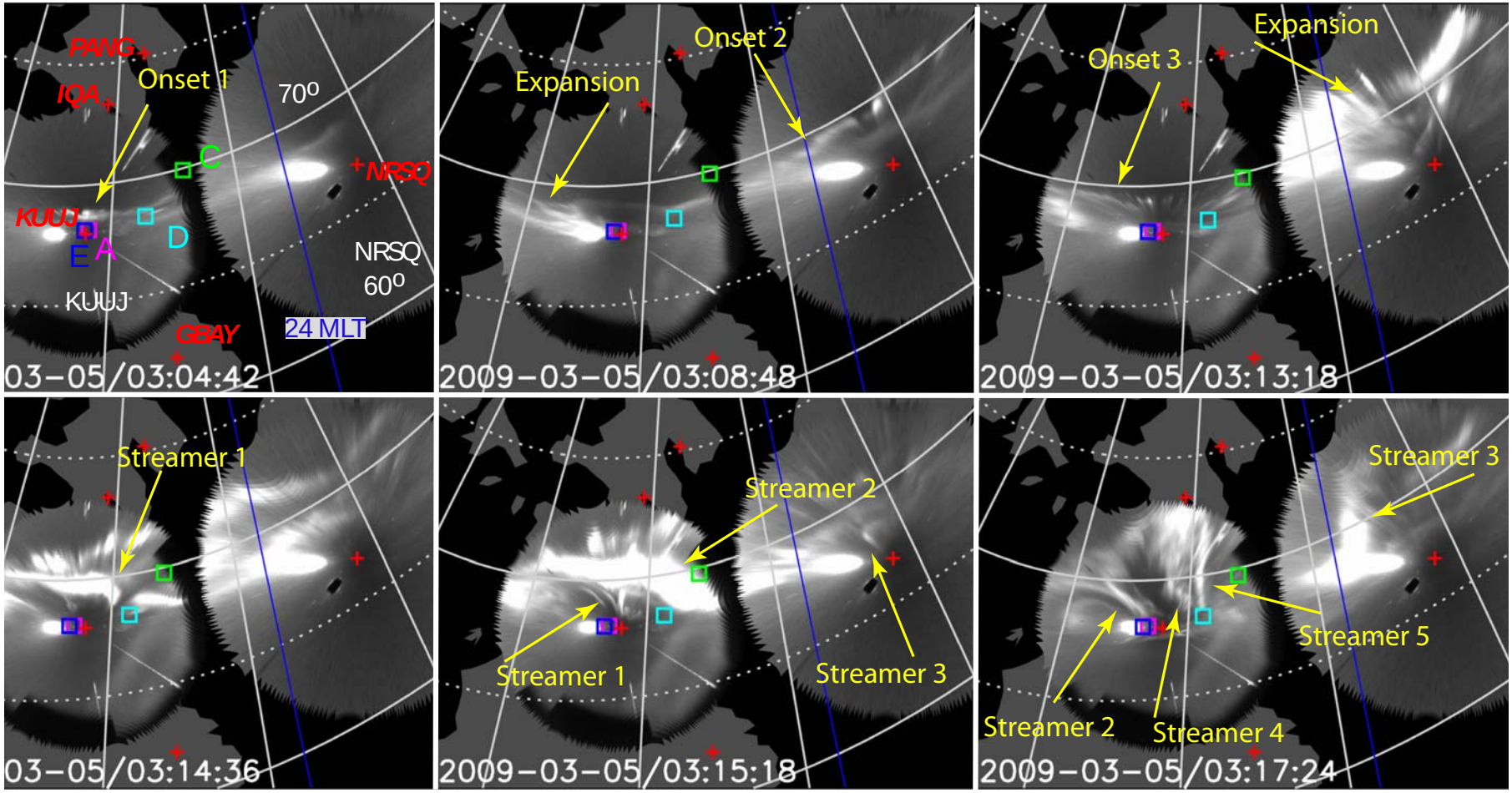

Onset arc
SNAP
RANK
70°
B
C
AE
D
FCHU
FSMI
RABB
GILL
SNKQ
60°
GILL
HOTS
24 MLT
2009-02-27/07:47:54
Streamer 2
(turning to west)
2009-02-27/07:54:36
Streamer 1 (split)
Streamer 4
Streamer 3
2009-02-27/07:59:30



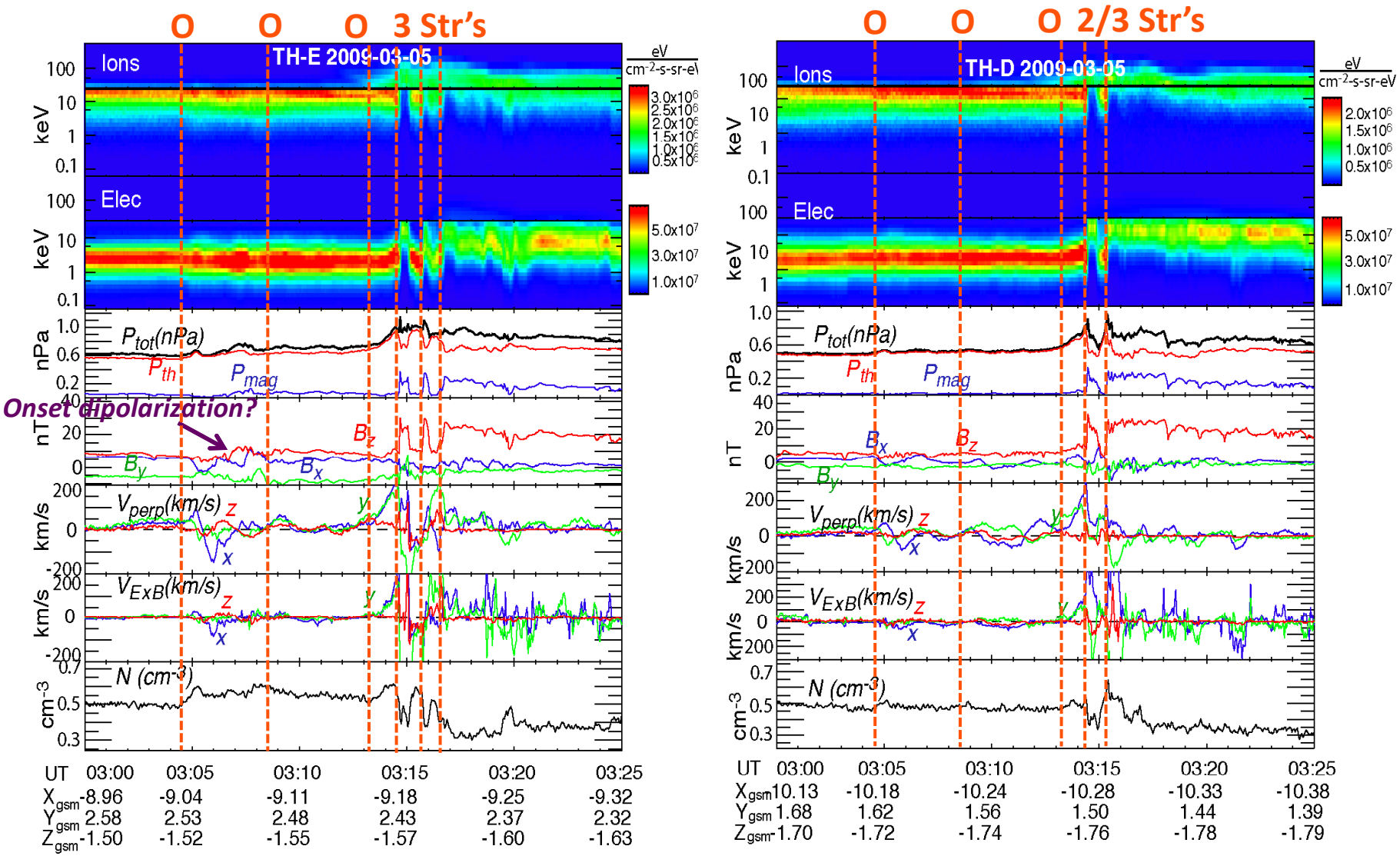


Suggests: *In addition to mid and inner plasma sheet substorm, largest auroral ΔB and mid-lat. positive bay due to flow channels/streamers*

Onsets 0304:18; 0308:30; 0313:12 (1st and 3rd near THEMIS E, A, D)



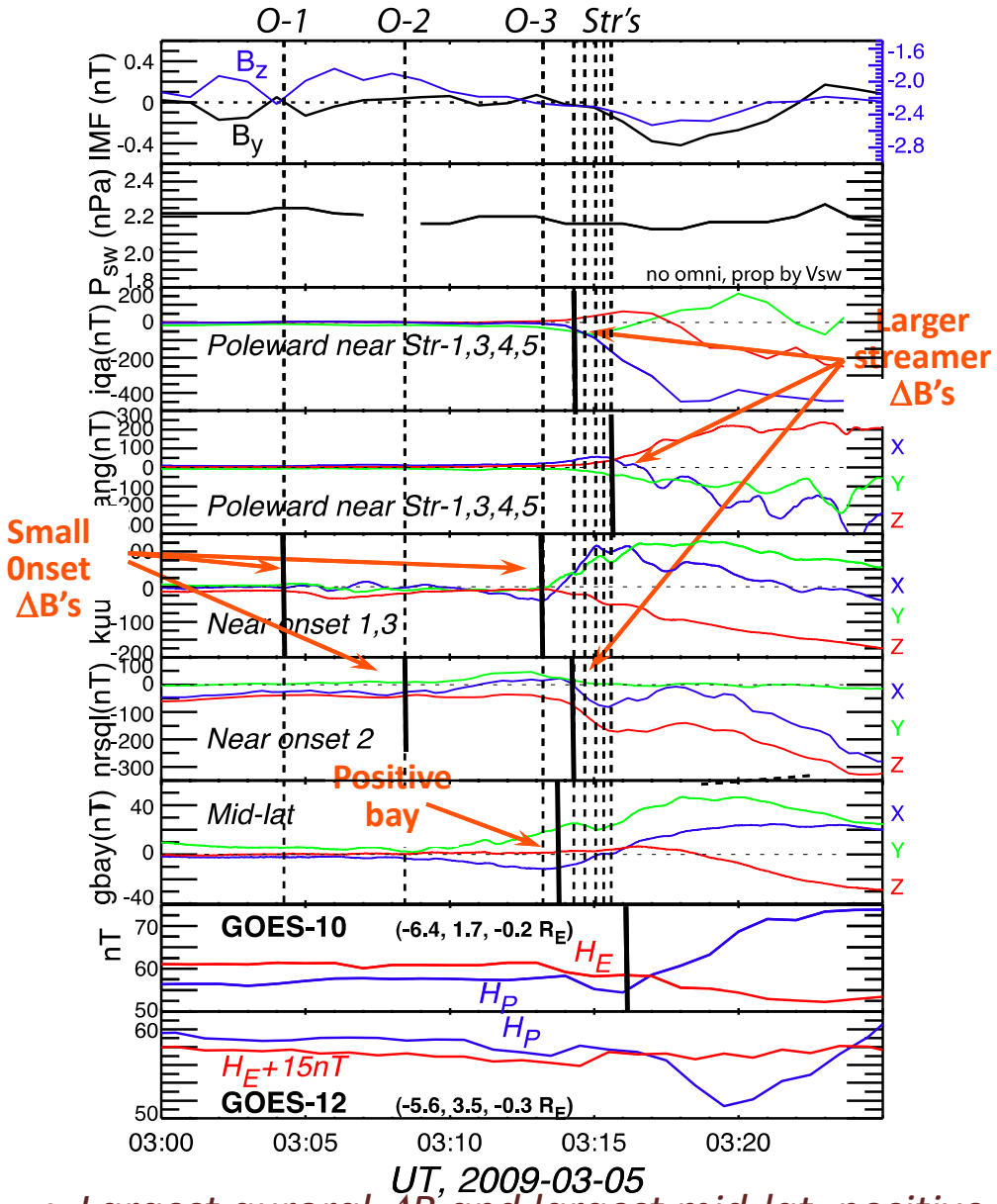
Streamers 1,2,4,5 near THEMIS D, E (2 reaches near G10, 0317); Streamer 3 near NRSQ

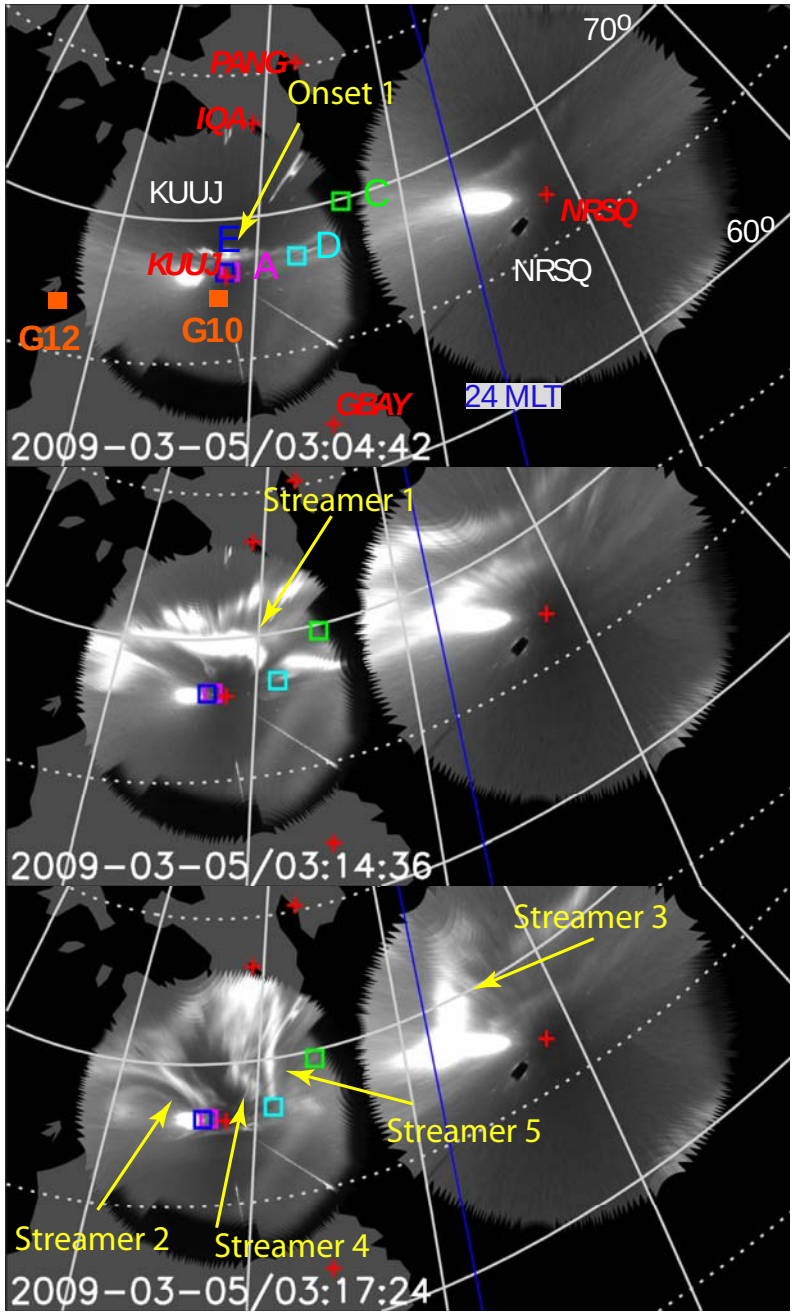


Onset 1 and 3 near D, E: Weak dipolarization and modest V_x, V_y

Streamers near D, E: Strong dipolarization (fronts), flows

Suggests: *Largest mid and inner plasma sheet substorm effects can be longitudinally localized and due to flow channels/streamers*





- *Largest auroral ΔB and largest mid-lat. positive bay due to flow channels/streamers*
- *GOES-10 dipolarization also*

Summary

1. **Examined activity during periods** having strong dipolarizations classified as dipolarization fronts [*Runov et al.,* 2009, 2011]
   - **6 events identified** having good conjugate coverage by THEMIS ASIs
2. Found **Dipolarization fronts** to be associated with equatorward moving streamers originating after substorm onset
   - As is well known, streamers form repetitively during expansion phase
   - Suggests that longitudinally narrow flow bursts accompanied by dipolarization can form several times during an expansion phase.
3. **Contrary to expectations**
   - Largest expansion phase flows and dipolarization associated with streamers, rather than onset instability
   - Mid-latitude positive bays and largest auroral oval ΔB's delayed by a few minutes from the auroral substorm onset, and instead coincided with streamer initiation
4. **If above results are found to be general,** it would suggest that
   - Multiple flow bursts fundamental element of magnetosphere-ionosphere convection during substorm expansion phase, and are major contributor to substorm dipolarizations, auroral zone magnetic bays, mid-latitude positive bays