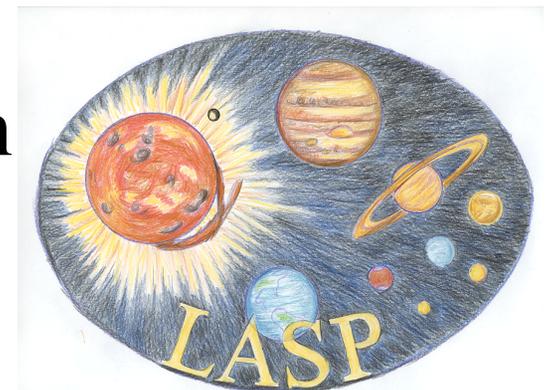


The Substorm at 05:45 on 10/13/01 Observed From the Ground, and the LANL, GOES, Polar and Cluster Satellites

W.K. Peterson, D.N. Baker, Y.-J Su, S. Eriksson,
X. Li, J.B. Sigwarth, J.D. Scudder, E. Donovan,
A. Korth, K.J. Trattner, J.A. Slavin, H. Remé,
M. Dunlop, M. André, H.J. Singer,
R.H.W. Friedel, G. Lu, R.L. McPherron
and C.T. Russell



Abstract

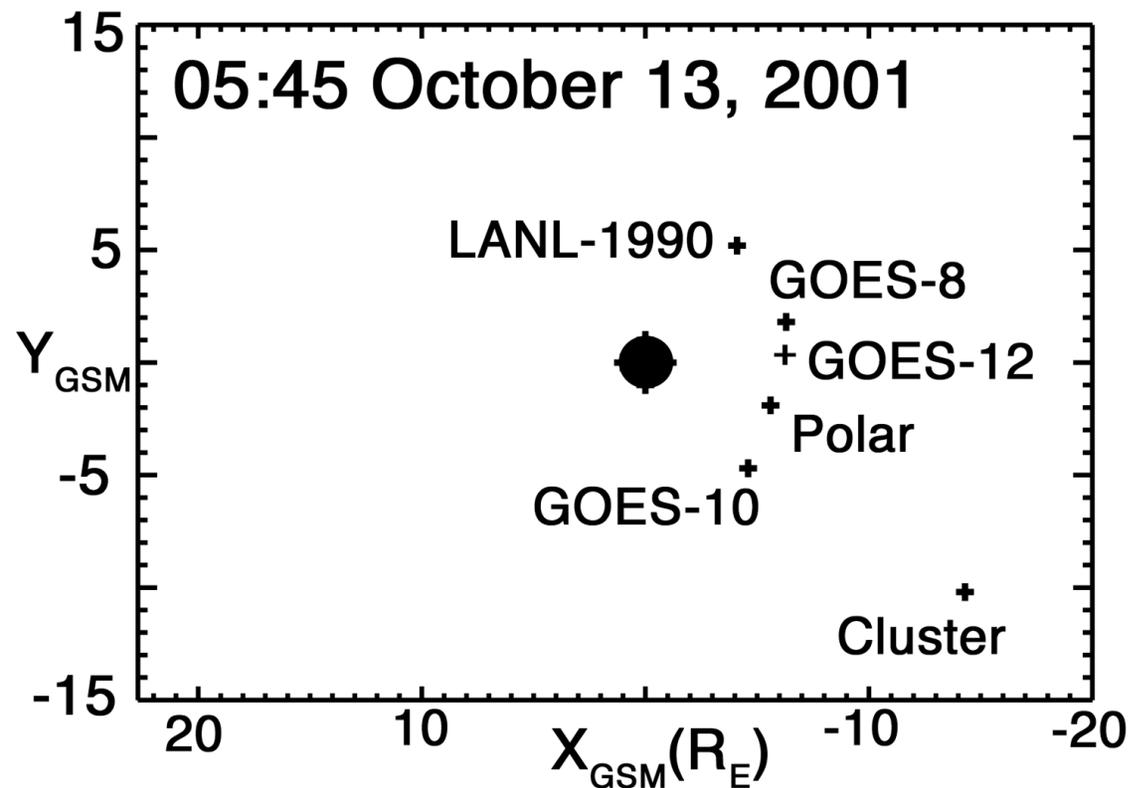
The substorm at ~05:45 was not the first, last, or most intense of those observed during the first half of October 13, 2001. However the configuration of platforms noted in the title was excellent for obtaining a comprehensive view of the initiation and evolution of a substorm. The combination of Canopus **ground magnetograms** and **Polar VIS images** identified onset at 05:45:02 +/- 00:00:22 west and south of Ft. Churchill, Canada. The closest satellite, **Polar, was located near geosynchronous altitude at 23:00 MLT.** Polar was sampling magnetic fields and plasmas characteristic of the outer plasma sheet before 05:45 UT and characteristic of the central plasma sheet after 05:45 UT. Polar magnetometer data from below the magnetic equator and GOES 12 magnetometer data from above the magnetic equator suggest that the main currents were flowing tailward of near-geosynchronous altitude. The **Cluster satellites were located at ~19 Re and ~21:00 MLT** on the dusk side of the magnetotail. A coherent dispersion feature in the plasma at several of the Cluster spacecraft was observed at ~05:36 UT, when the B_z (GSM) component on all four spacecraft began decreasing. The B_z component was negative on all four Cluster spacecraft from ~05:42 to ~05:55 UT. **We will present these observations and a time line of events derived from them. We will discuss how these observations agree and disagree with current ideas of the initiation and global evolution of substorms.**

Why Choose This Event?

Cluster and **Polar** were located in the magnetotail and **clear optical, magnetic, and particle signatures of substorm onset were observed at ~05:45**

There are good supporting data from

- Canopus,
- GOES - 8/- 10/12 and
- LANL- 1990.



What is Interesting and/or Unique About This Event?

Onset time and location are determined to within 27 seconds and 5° longitude

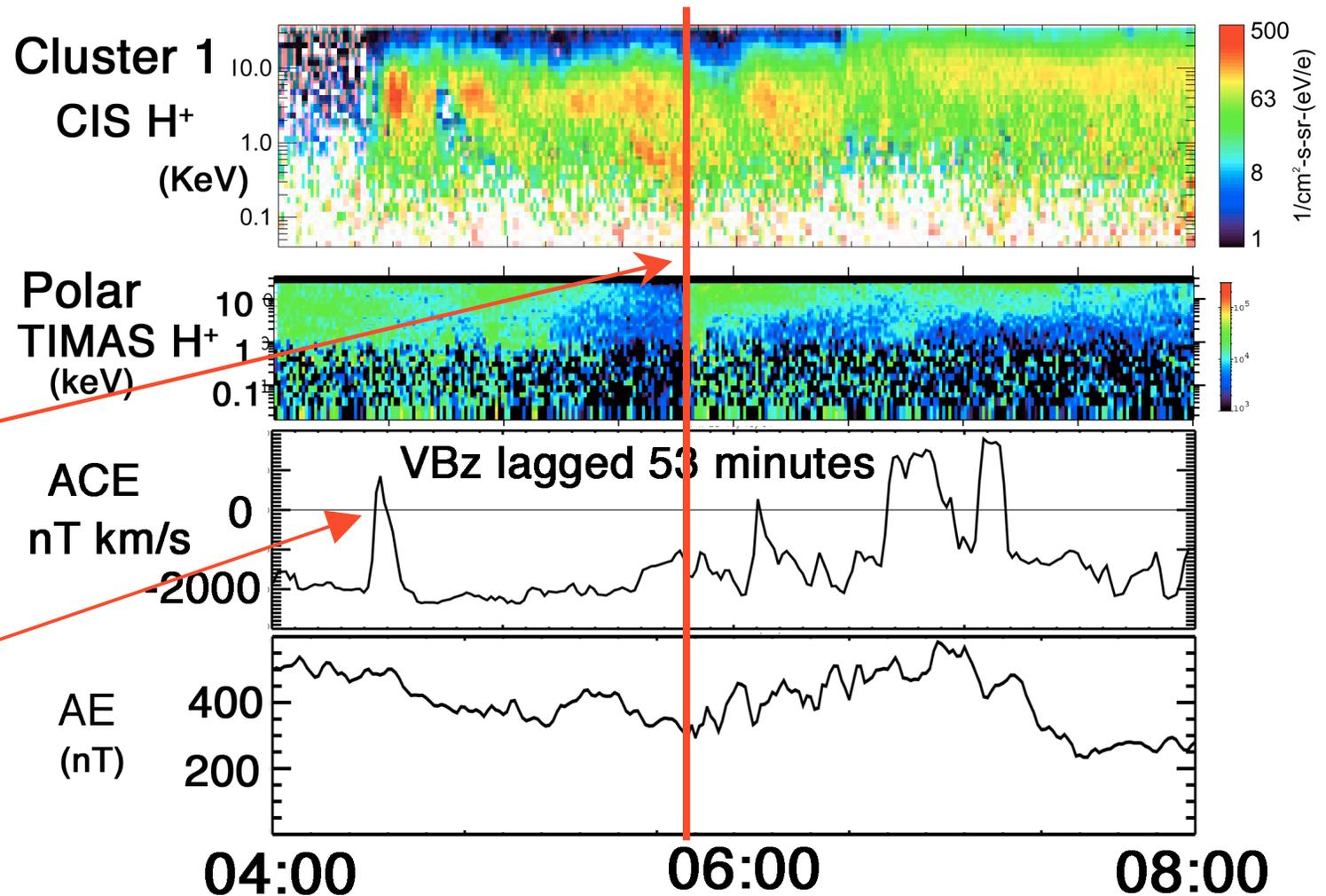
Polar is near the midnight equator at nearly Geosynchronous Orbit.

- Polar and other satellites near geosynchronous orbit observe the temporal evolution of magnetosphere reconfiguration at a wide range of MLT

Cluster observes a series of “Flaps” in the tail, including an interval of Bz Southward near the time of the substorm onset (~05:45)

Geophysical Context on 10/13/ 2001

The IMF was Southward before the substorm onset at ~05:45 except for a brief interval at ~04:20



- The first (larger substorm (Not shown above ~03:00) had an $A_E \sim 500$ nT.
- The A_E History for the 05:45 small substorm is confusing: There is a gradual increase in magnitude and fluctuations after onset.

Optical Onset Determined by Polar/VIS is Between 05:44:41 and 05:45:35

Polar/VIS views the
aurora edge on.

Power has been
integrated along
GCM meridians
in successive
images

**Onset is West
and South
of Churchill**

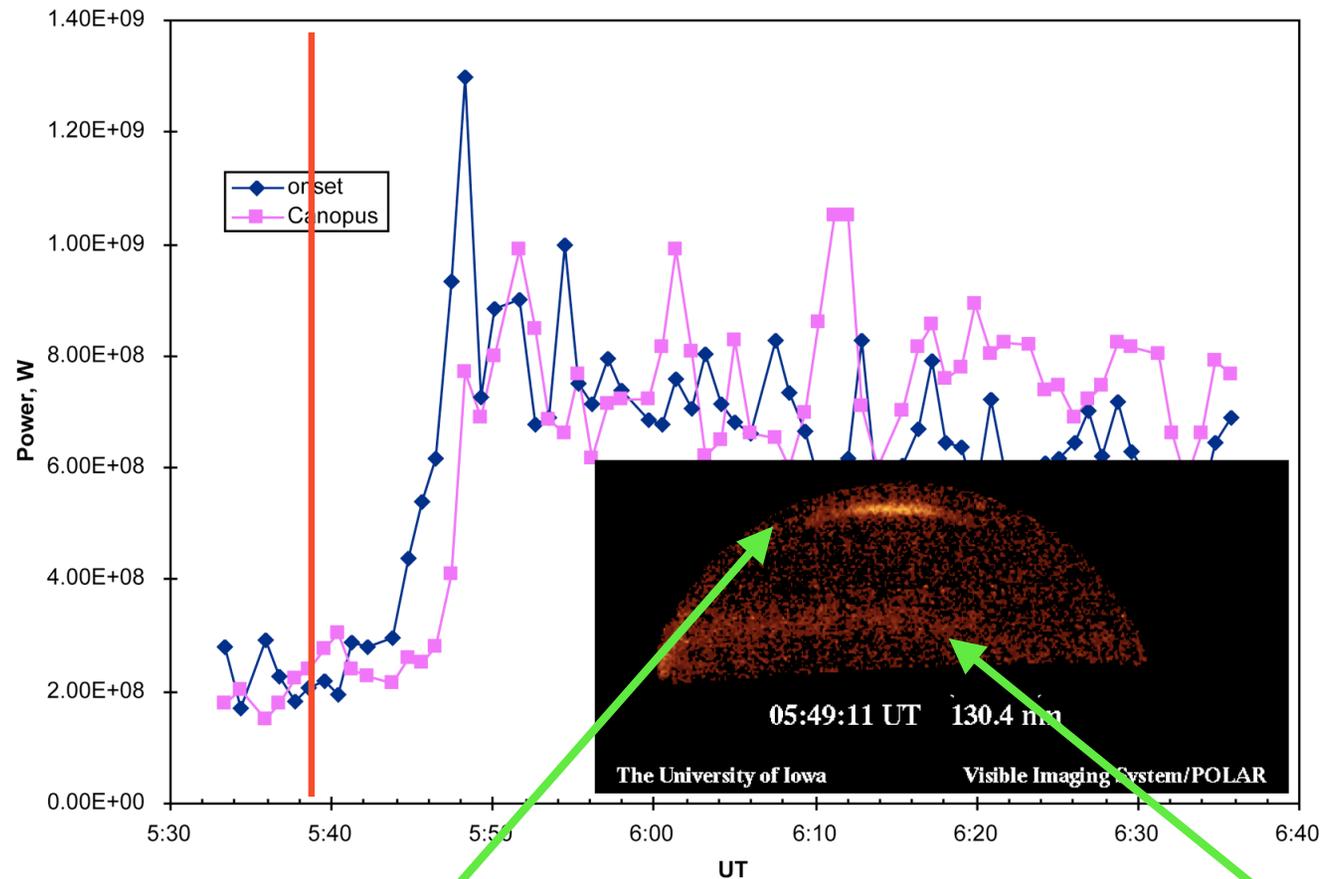
Geographic
51° N 104° W

Geomagnetic
60° N 44° W

Longitude +/- 5°

Latitude +/- 20°

Auroral Precipitating Electron Power
October 13, 2001 (286)

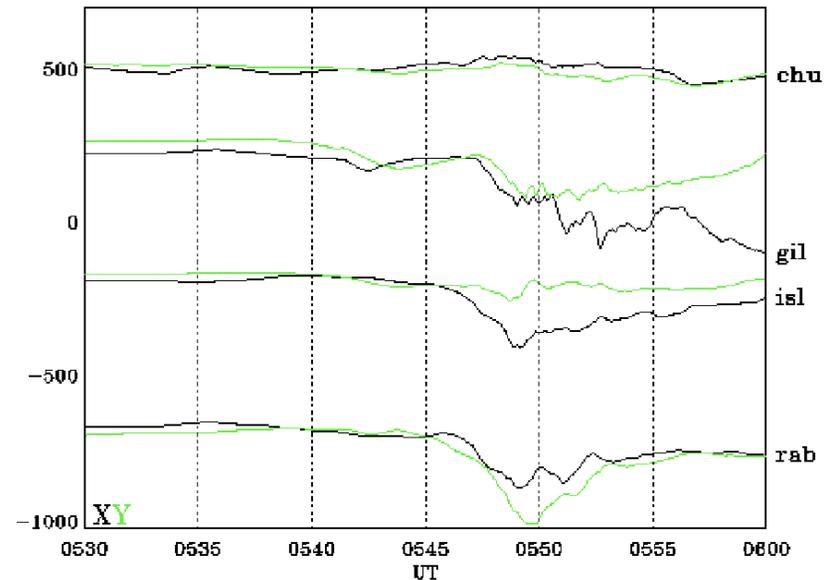
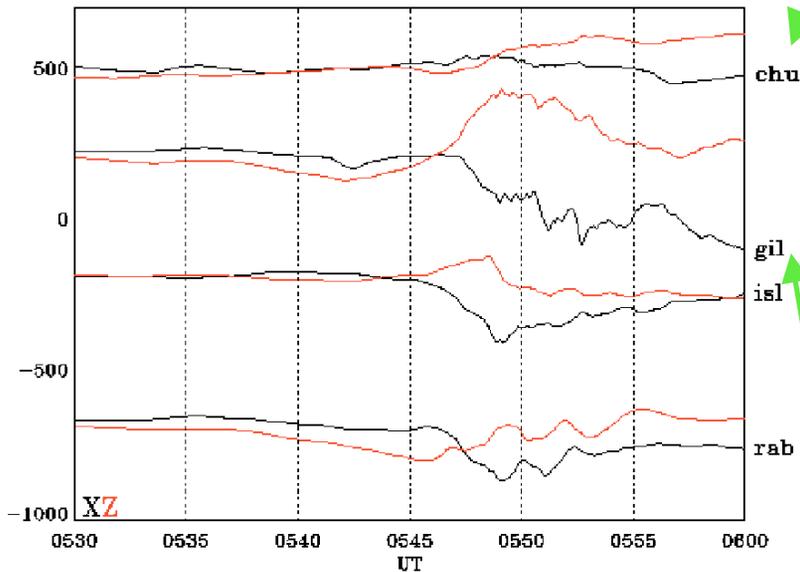


Aurora

Equatorial Airglow

CANOPUS array puts Onset Latitude South and West of Churchill

Churchill 58° 45' N 94° 40' W

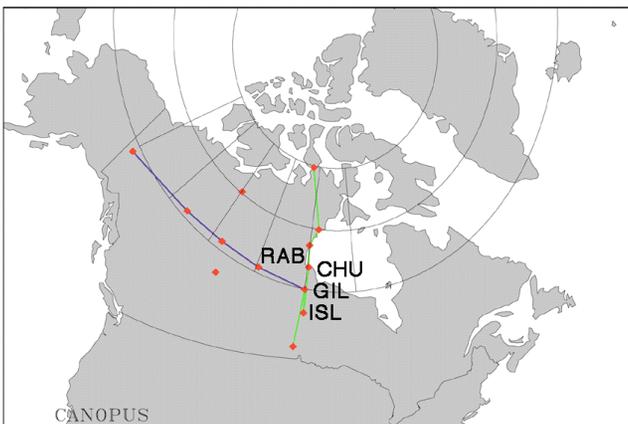


Gillam 56° 24' N 94° 42' W

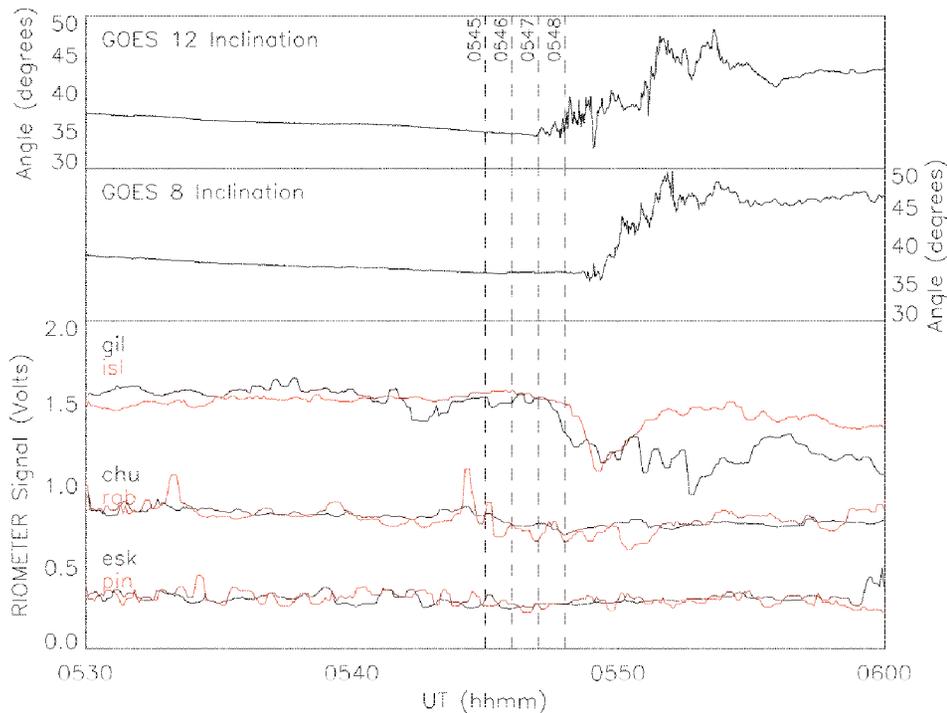
Onset is therefore at **05:45:08 +/- 00:00:27**

Longitude 104° +/- 5° W

South of 58°

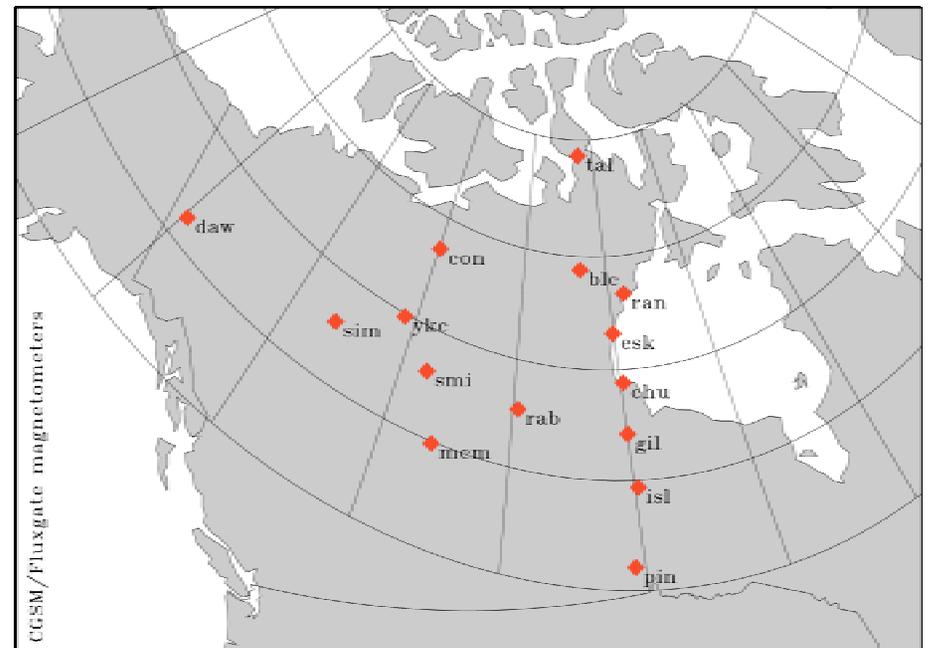


Canopus Riometers put onset near the latitude of Gillam (56° N)



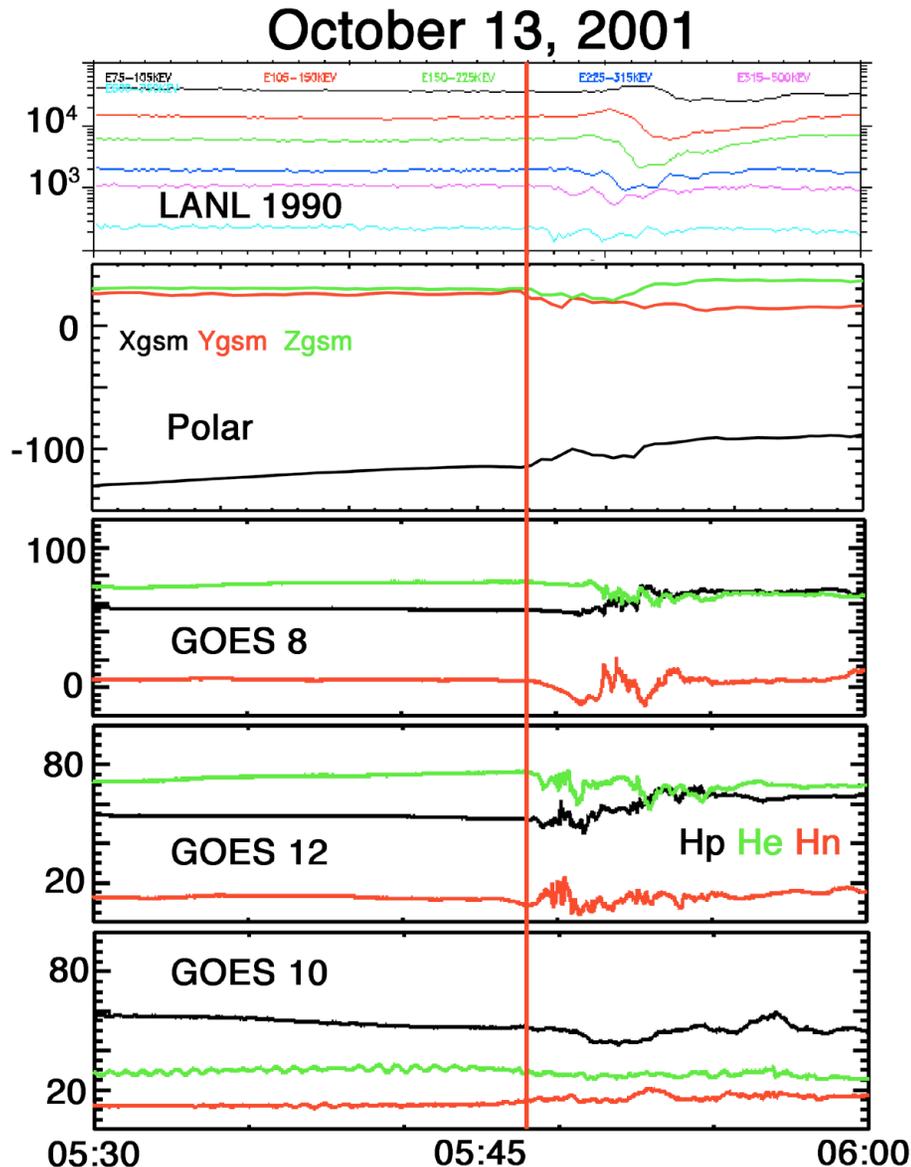
Absorption seen at Gillam (gil) and Island Lake (isl), but NOT Churchill (chu), Rabbit Lake (rab), Eskimo Pt. (esk) or Pinnowa (pin)

Onset of absorption first seen at Gillam ~ 05:47. This implies that strong ionization occurred Westward and perhaps Northward of Gillam.



Near Geosynchronous Observations

Line is at 05:46:10 (onset **05:45:08**)



Polar detects onset first followed by GOES 12 and LANL

All Geosynchronous observations of onset are AFTER detection of the optical signature

LANL 1990 38° W

GOES 8 75° W

GOES 12 90° W

CANOPUS 95° W geographic

**Optical onset ~104° W
geographic**

Polar 109° W

GOES 10 135° W

Overview of Polar and Cluster Observations

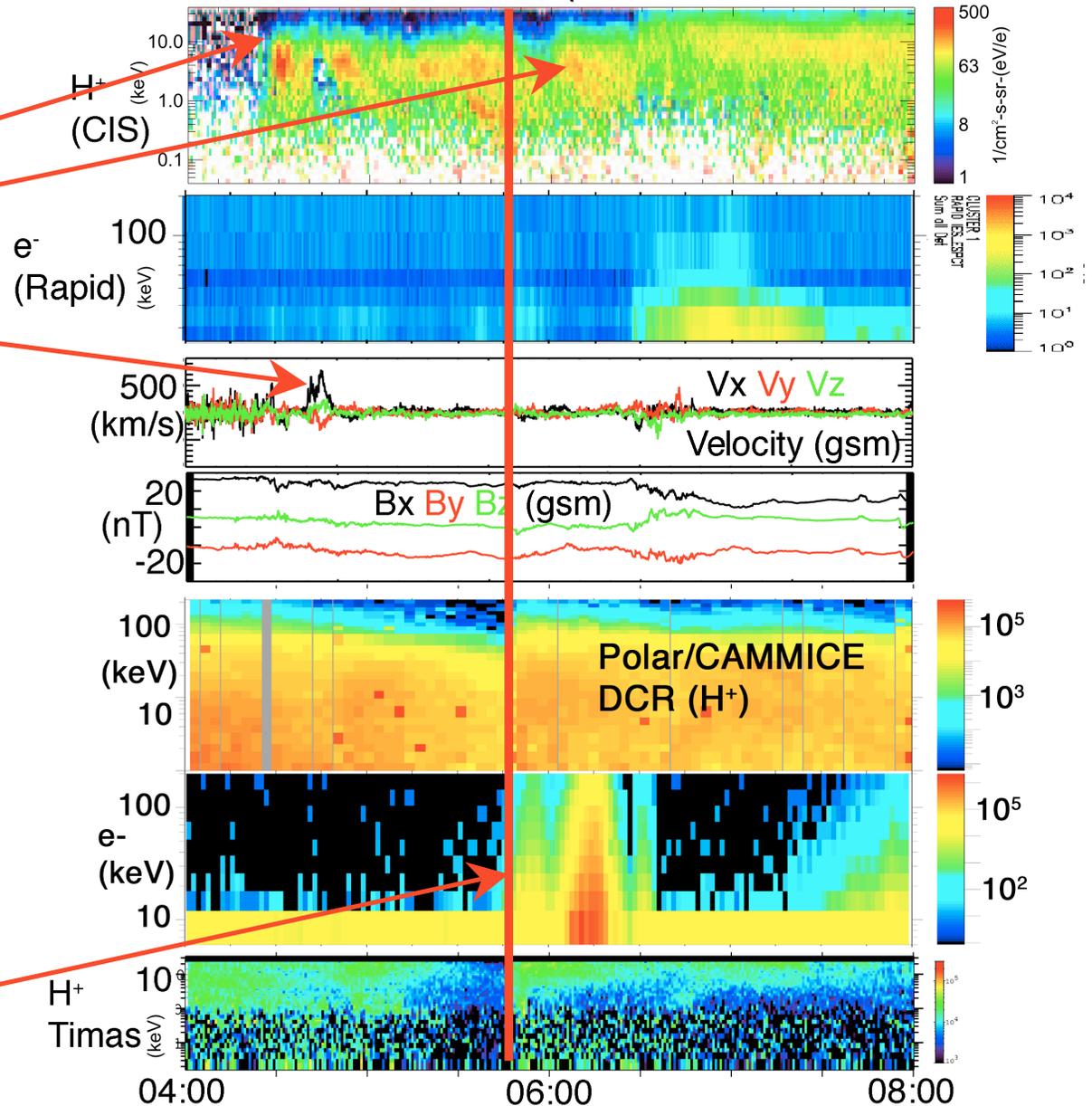
• Cluster

- ~19 Re dusk side
- Enters PSBL ~04:20
- Enters PS ~06:20
- Strong Convective Earthward flow ~05:00
- Brief interval of $B_z < 0$ ~05:45
- **Intensifications of energetic electrons ~05:45 and ~06:45**

• Polar

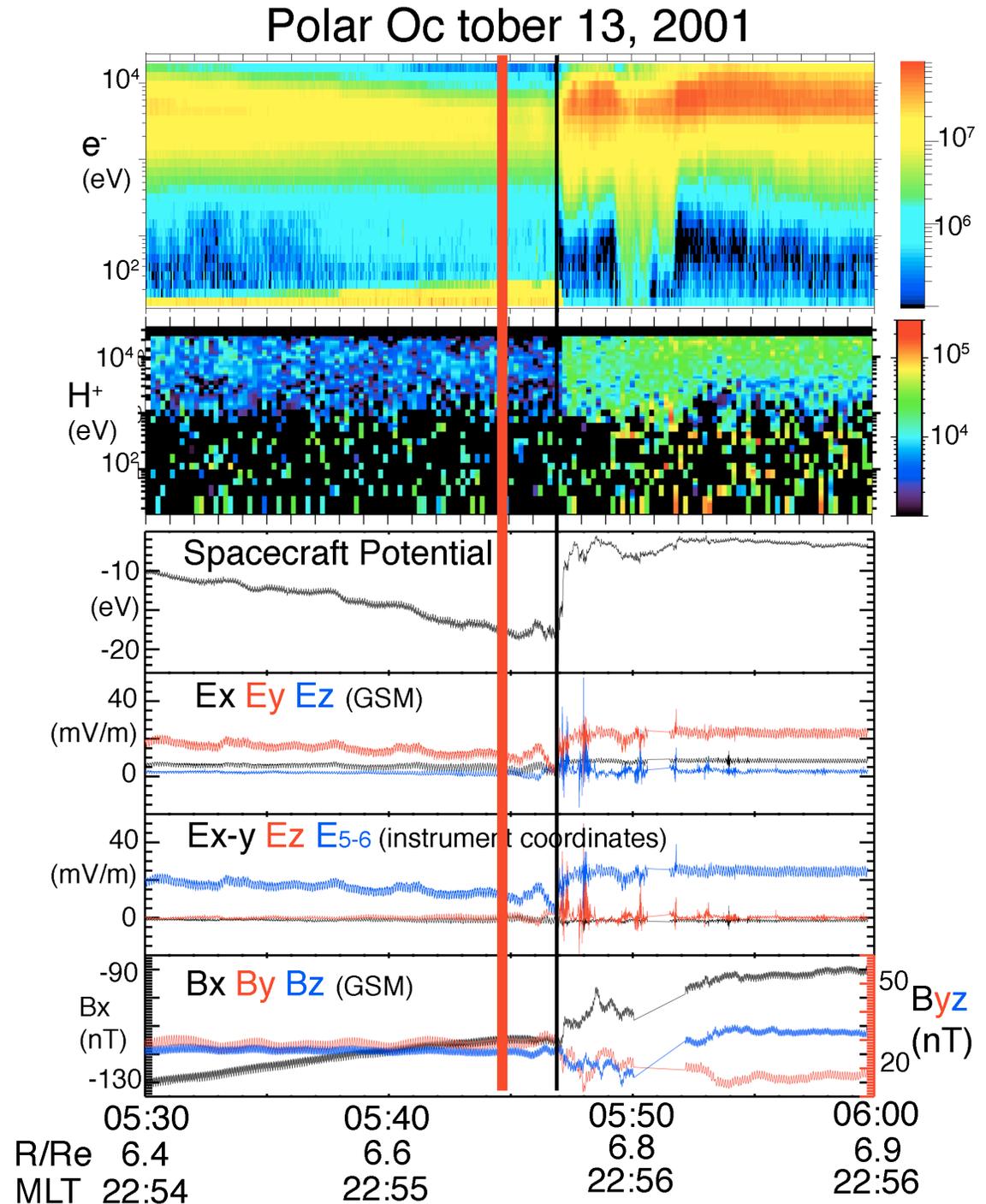
- 6.7 Re midnight
- **Signature of magnetospheric reconfiguration ~05:47**

October 13, 2001 (Cluster 1 and Polar)



Polar 05:30 to 06:00

- **Red line is at 05:45**
- **Black line at 05:47**
- Polar is at $6.7 R_E$ and near 23:00 MLT at onset
- **There are precursor E and B signatures at ~05:45 prior to the ion/electron boundary**
 - These signatures have been discussed by Toivanen et al.
- **The first Kinetic (small scale) Alfvén waves occur ~05:47 at the same time as the ion/electron boundary**



Cluster 05:30 to 06:00 (1/2)

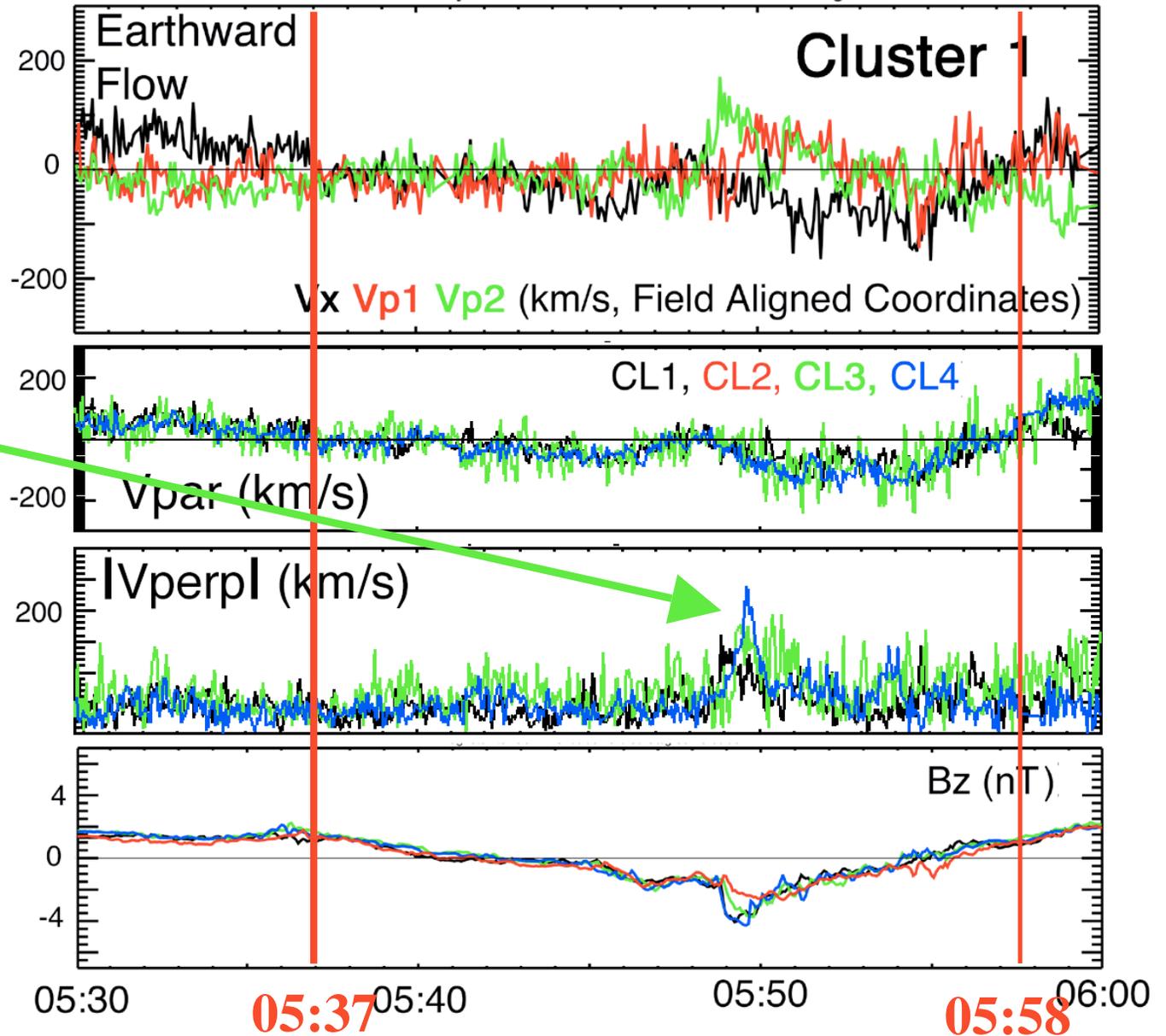
Plasma flow is:

Mostly field aligned
before $\sim 05:37$
and after $\sim 05:58$

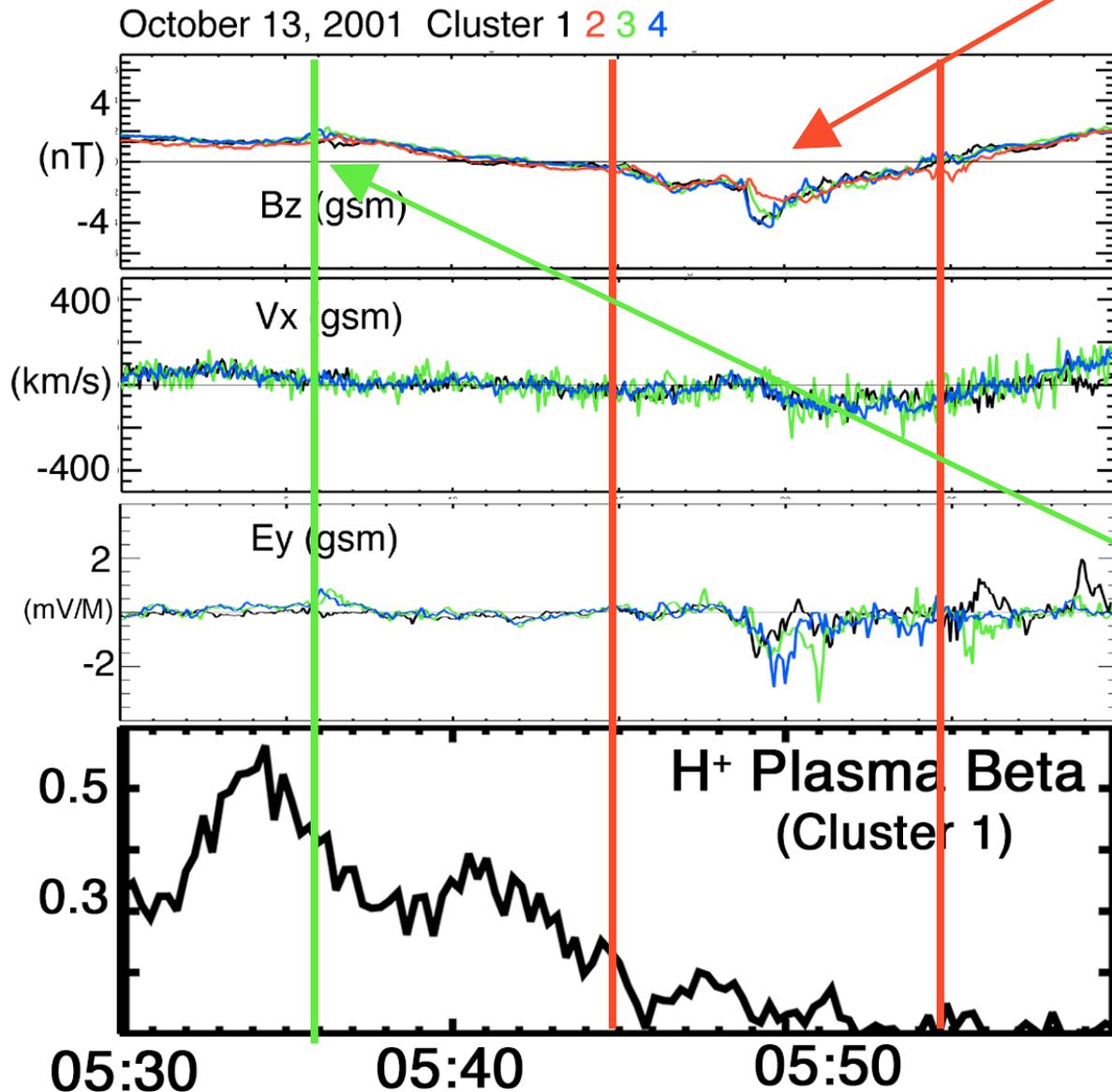
Mostly convective
from $\sim 05:49$ to
 $\sim 05:51$

Field aligned flow is
mostly tailward
from $\sim 05:37$ to
 $\sim 05:58$.

Cluster 3 and 4
show similar
features



Cluster 1, 2, 3, and 4



**Bz (gsm) is negative from
~05:45 to 05:55**

Bx ~+22 nT (not shown)

By ~ -18 nT (not shown)

**Ey (gsm) is negative at
~05:50**

**Ey x Bz => Earthward
Convective Flow at
~05:50**

**Is the Feature in Ey
and Bz at ~05:36
related to a plasmoid
passing downward
of Cluster or a
change in the IMF?**

Is the Feature in Ey and Bz at ~05:36 related to **A) a plasmoid passing dawnward of Cluster or B) a change in the IMF or SW pressure?**

We can't tell from the available data.

A. The Cluster Spacecraft remain in the northern lobes with a more or less constant Bx magnitude.

B. A search of the ACE, WIND, and GEOTAIL IMF clock angle and SW dynamic pressure for the appropriate times, shows no strong features that could be correlated with the feature.

C. Decreasing \square and Bz at Cluster suggests SC moving away from the plasma sheet.

CONCLUSIONS

- The 05:45 substorm is not a simple isolated substorm
- **We have identified onset time to within +/- 27s**
- **We have identified onset Longitude to within +/- 5° using Polar VIS**
- We have documented the propagation delays of the substorm current wedge at 5 geosynchronous platforms centered on optical onset.
- We have not been able to correlate interesting, large-scale, features in the cluster particle and fields data with either the 05:45 substorm or changes in the IMF direction of SW dynamic pressure.
- Earthward convective flow (the passage of a plasmoid?) at cluster is observed at ~05:50, 5 minutes after substorm onset.