Substorm impacts on inner magnetosphere convection

R. A. Greenwald[1], J. M. Ruohoniemi[1] , J. B. Baker[1] , and M. Lester[2], E. Talaat[3], R. Barnes[3]

[1] Department of Electrical and Computer Engineering
Virginia Tech
Blacksburg, VA, 24060, USA
ray.greenwald@vt.edu

[2] Department of Physics
University of Leicester
Leicester, LE1 7RH, UK

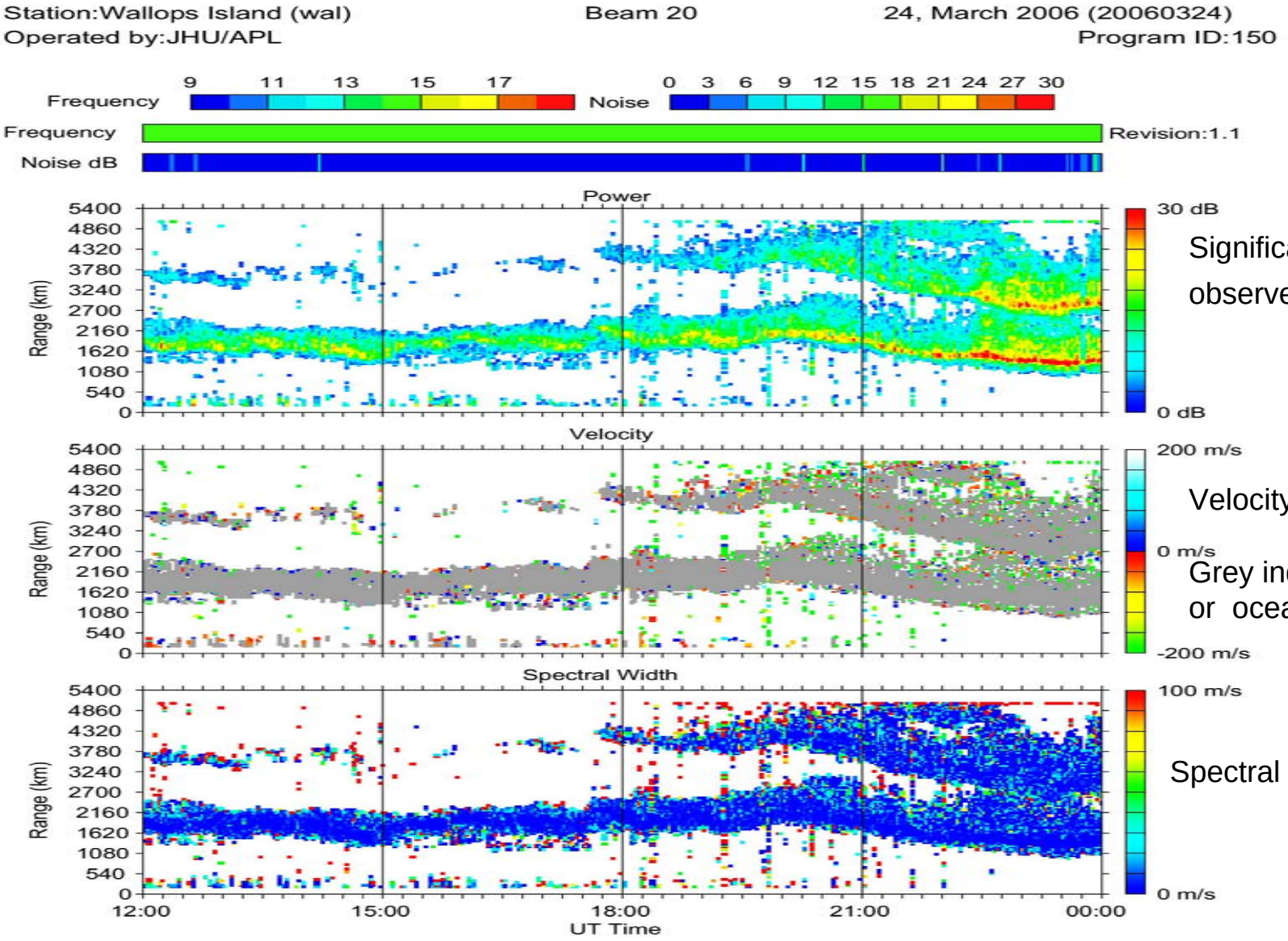
[3]JHU/APL
Laurel, MD 20723, USA

Questions???

- How do substorms affect inner magnetosphere convection?
  - Do substorms contribute to penetration electric fields?
  - What types of velocity changes occur?
  - What is the local time extent of the effects?
  - What are the time delays?
  - What is their duration?

- Effects most likely be observed in the nighttime ionosphere.
- We may need to differentiate ground scatter from low velocity ionospheric scatter.
- We examine two events identified with magnetic and/or optical data.

The Quiescent State - Daytime



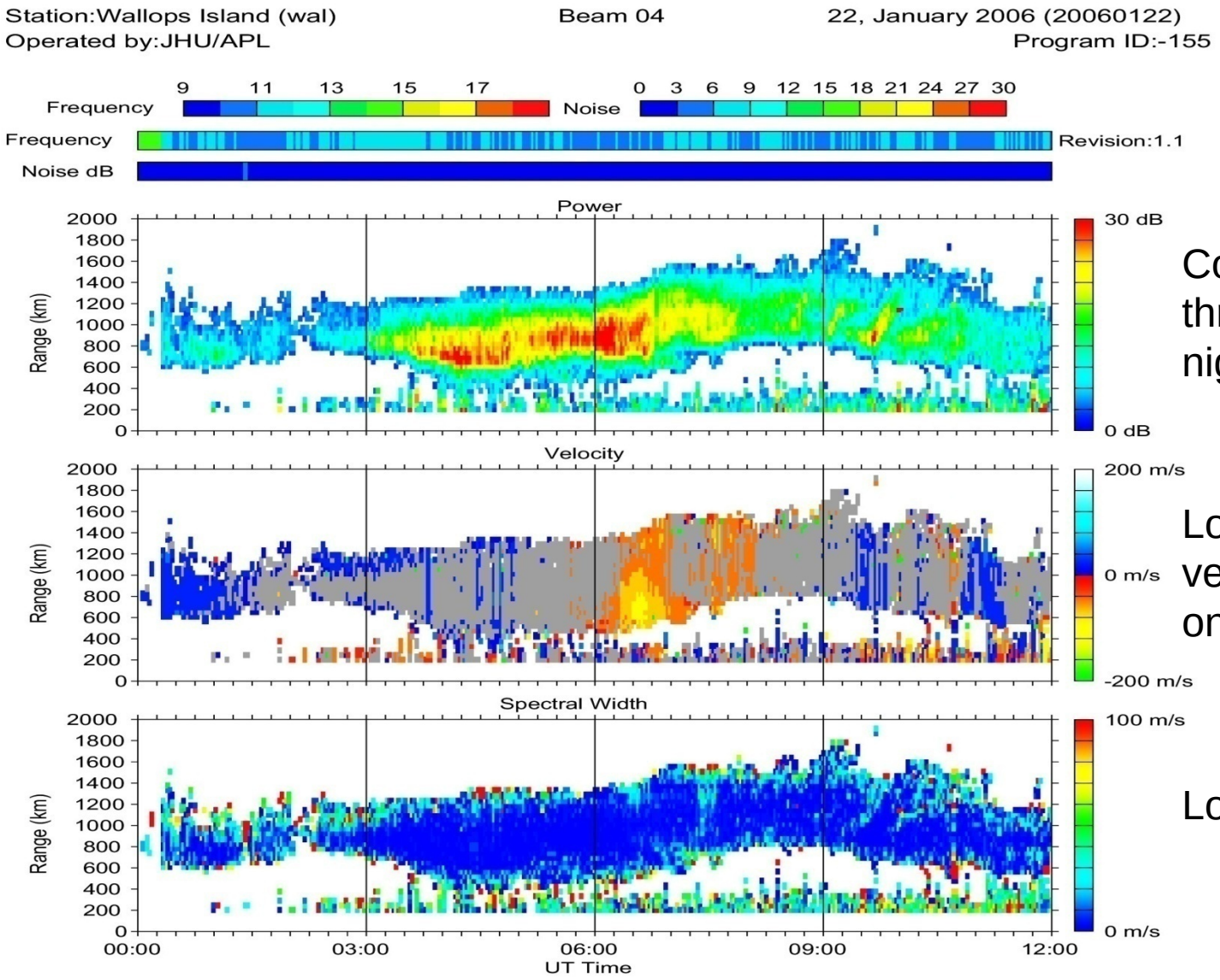
Significant backscatter observed to 5000 km

Velocity < 40 m/s

Grey indicates ground or ocean scatter

Spectral width < 30 m/s

The Quiescent State - Nighttime



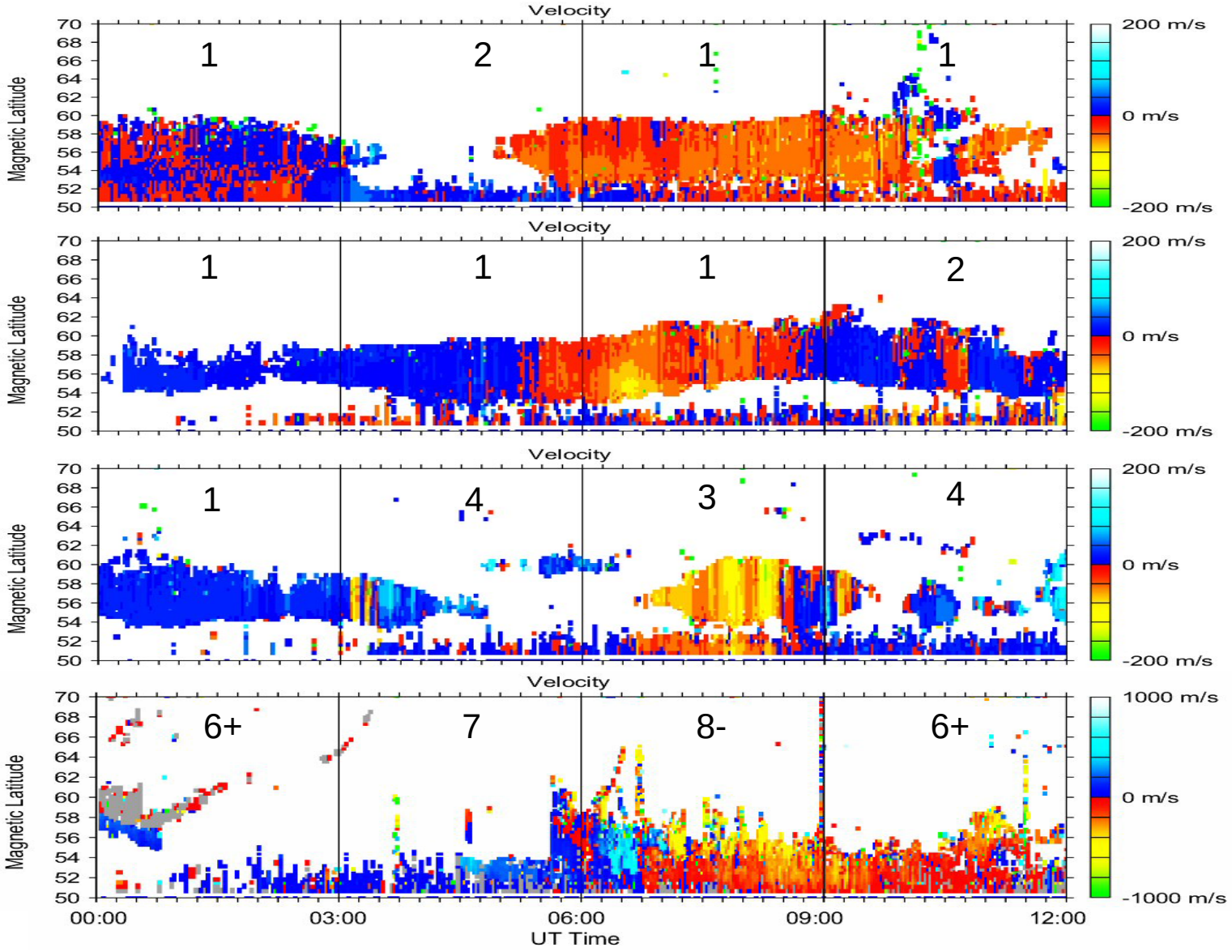
Continuous scatter throughout nighttime hours

Low Doppler velocities except for one brief period

Low spectral widths

Nighttime Scatter

Ground-Scatter Flag Off



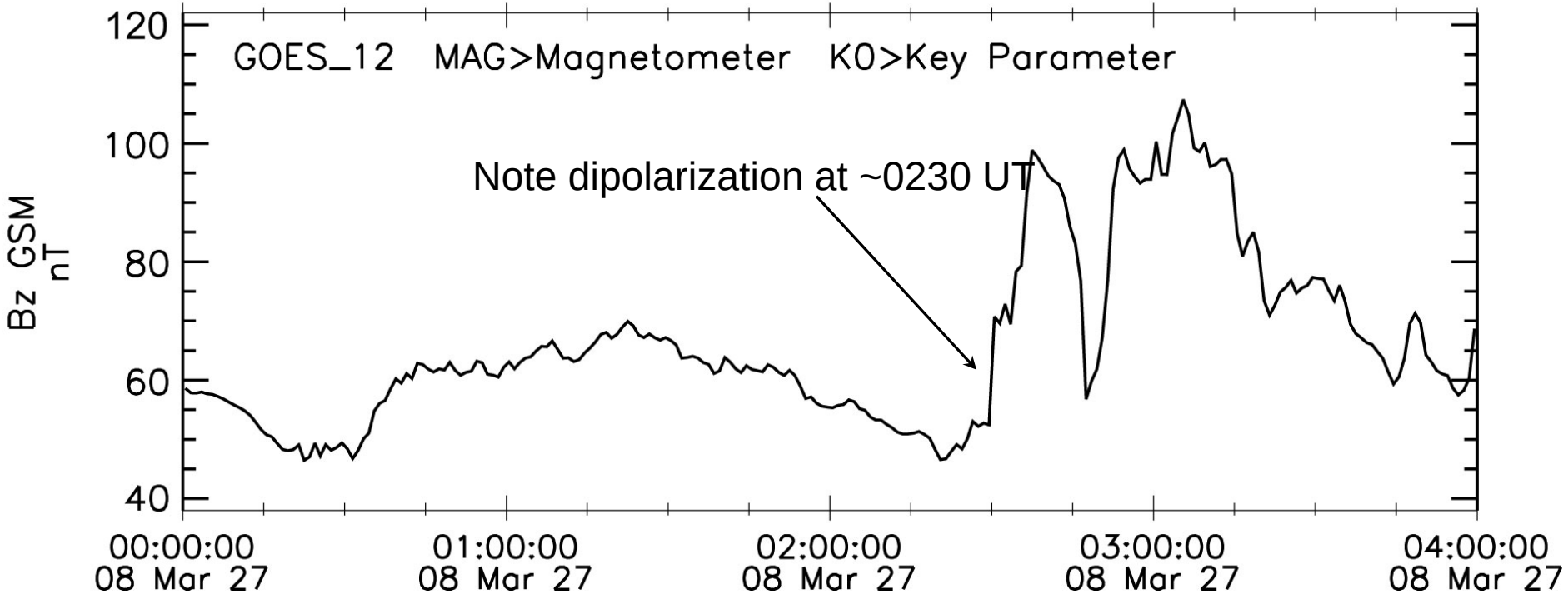
Jan 21, 2006
Beam 4

Jan 22, 2006
Beam 4

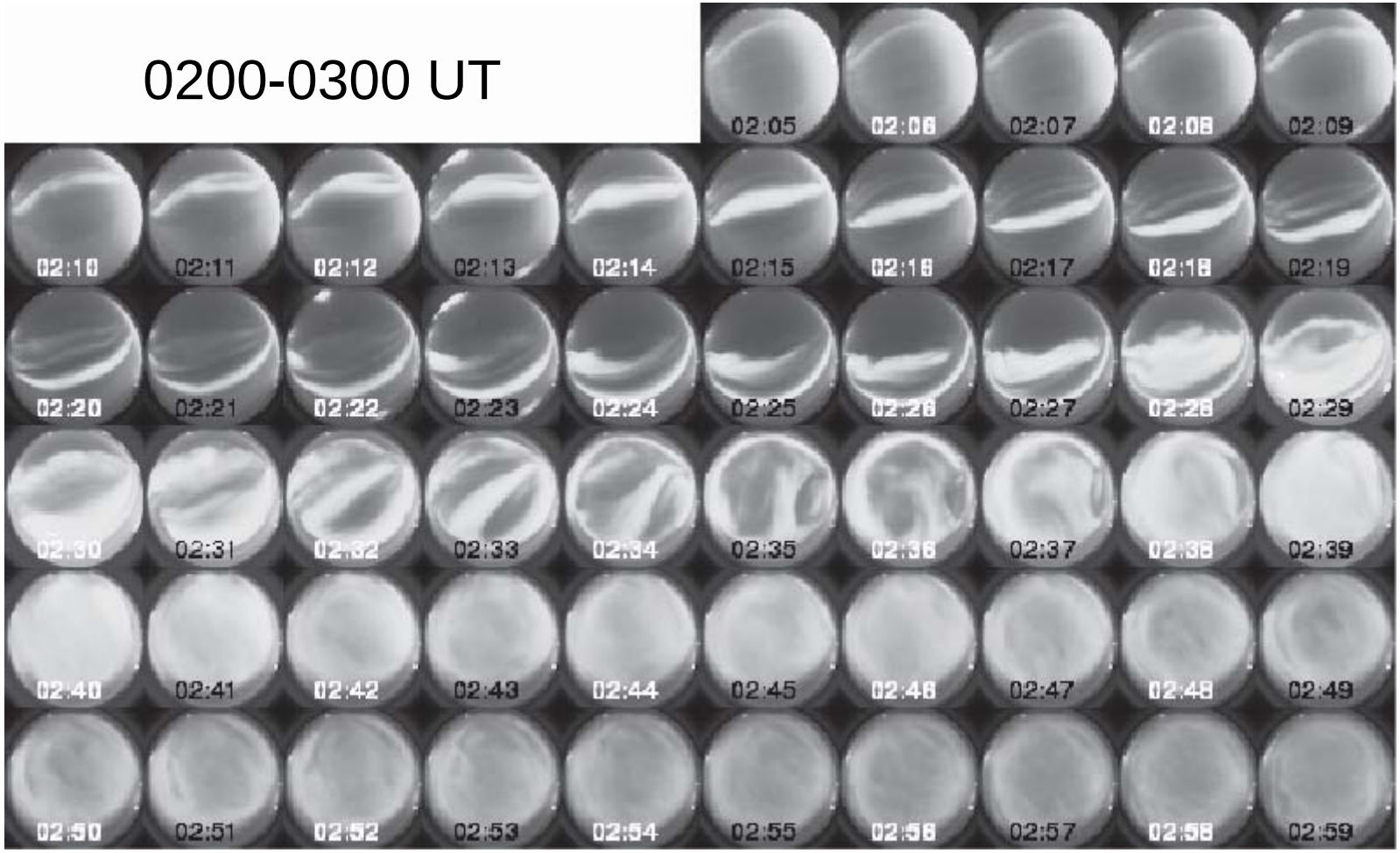
Jan 23, 2006
Beam 4

Sept 11, 2005
Beam 1

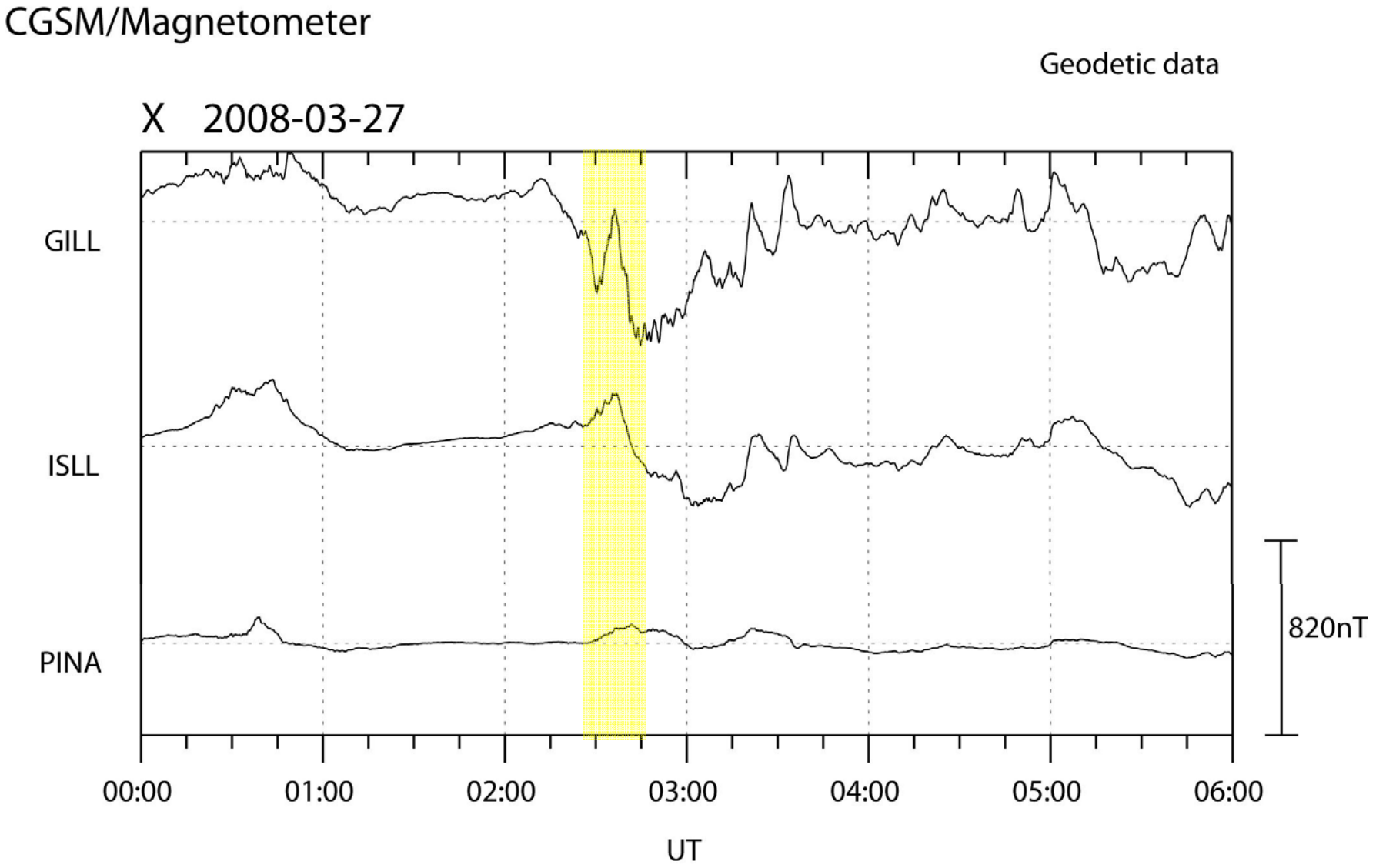
Case 1: March 27, 2008
GOES 12 Magnetometer Data



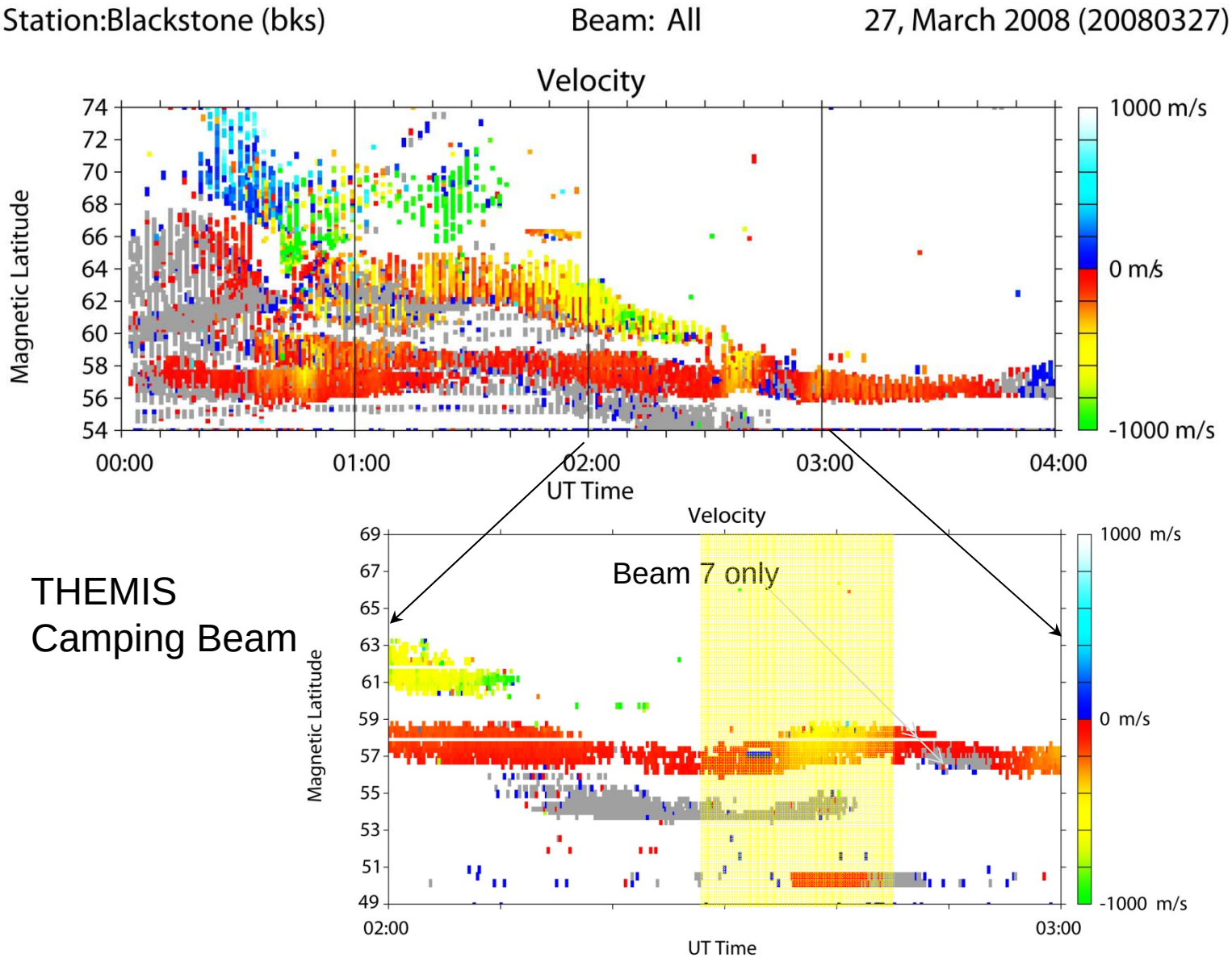
Case 1: Gillam All-Sky Camera Images



Case 1: Churchill Chain Magnetometers

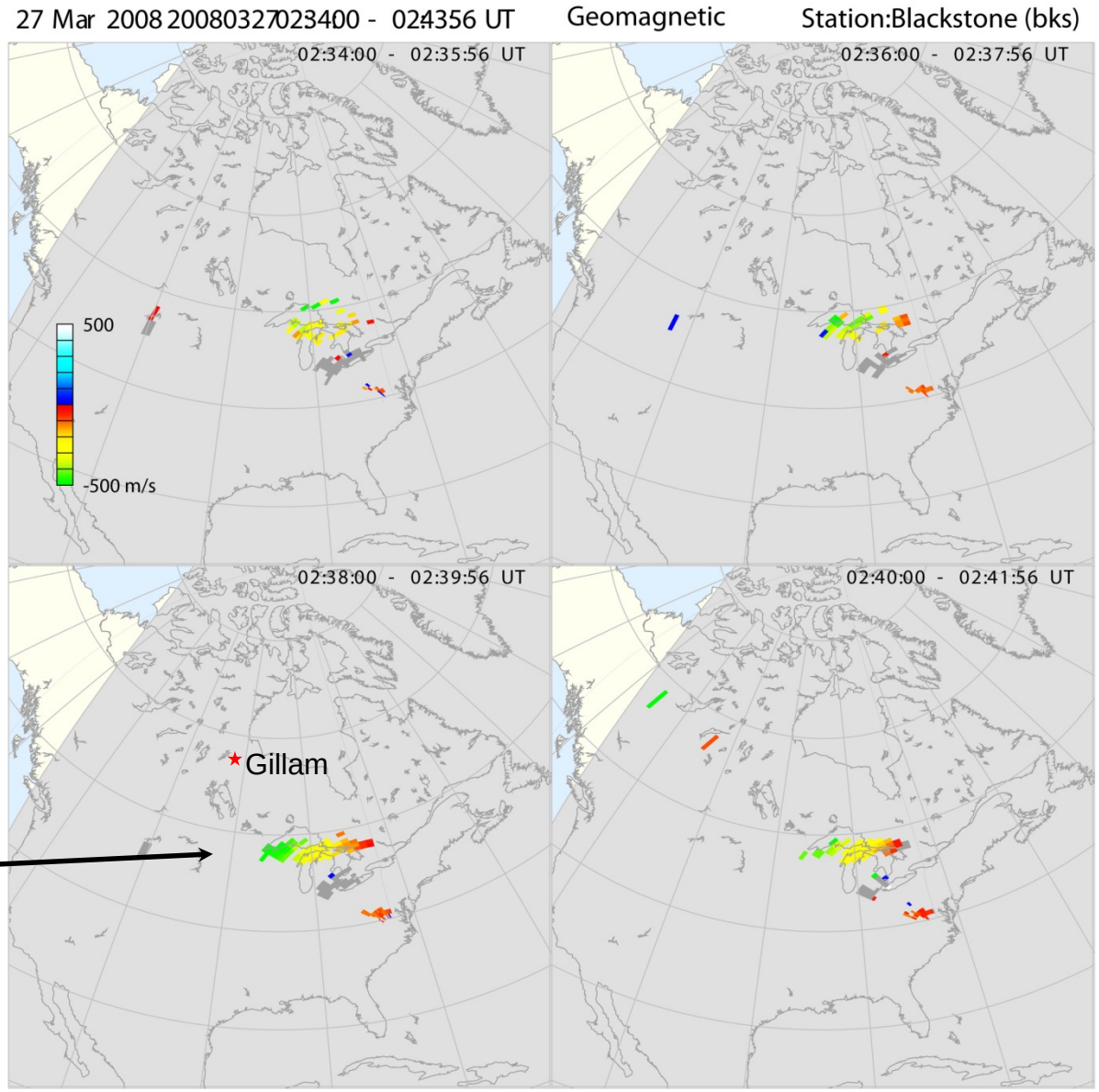


Blackstone Nighttime Observations During Minor Storm (Kp=5)



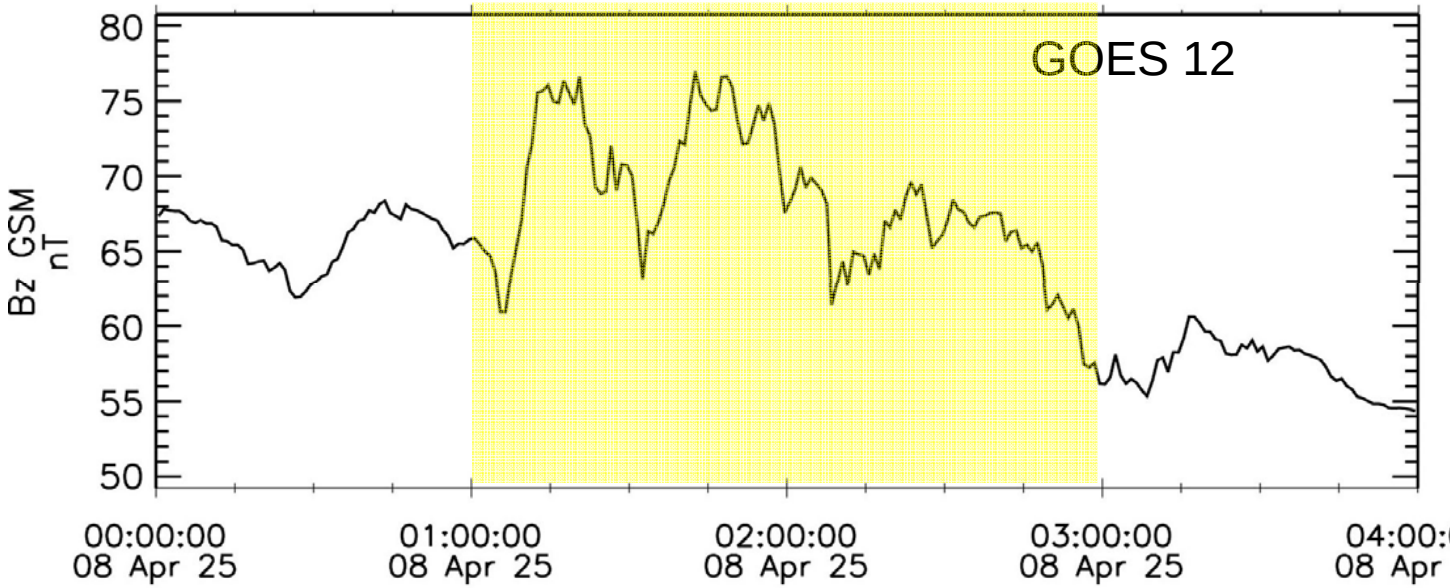
THEMIS
Camping Beam

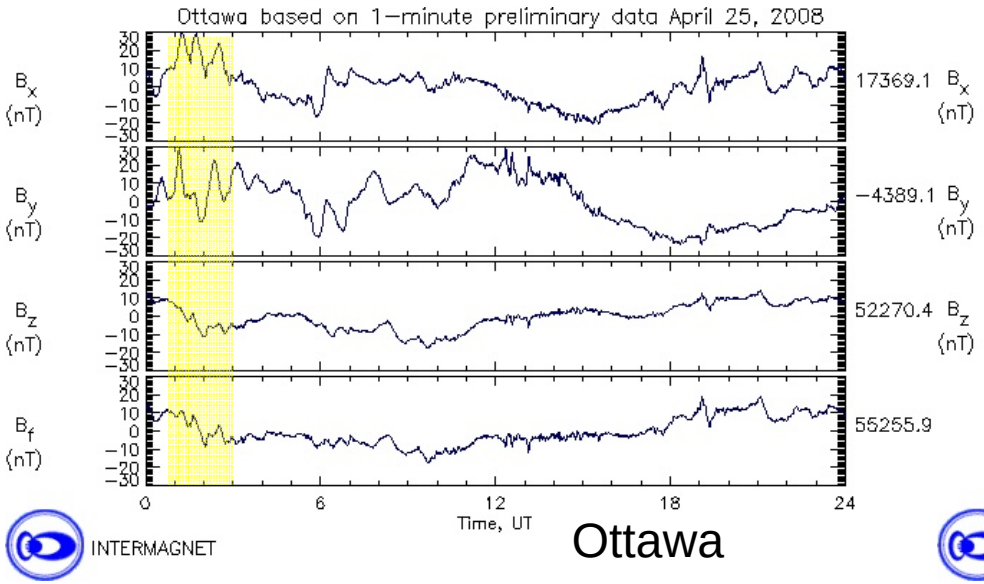
Sequence of Four Scans of Blackstone Radar



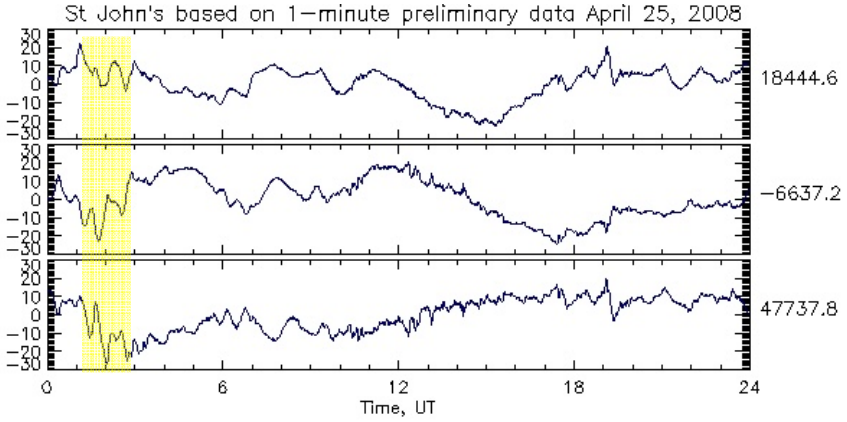
Note rapid onset of enhanced flow

Case 2: Magnetic Observations on April 25, 2008 Kp=3





Ottawa

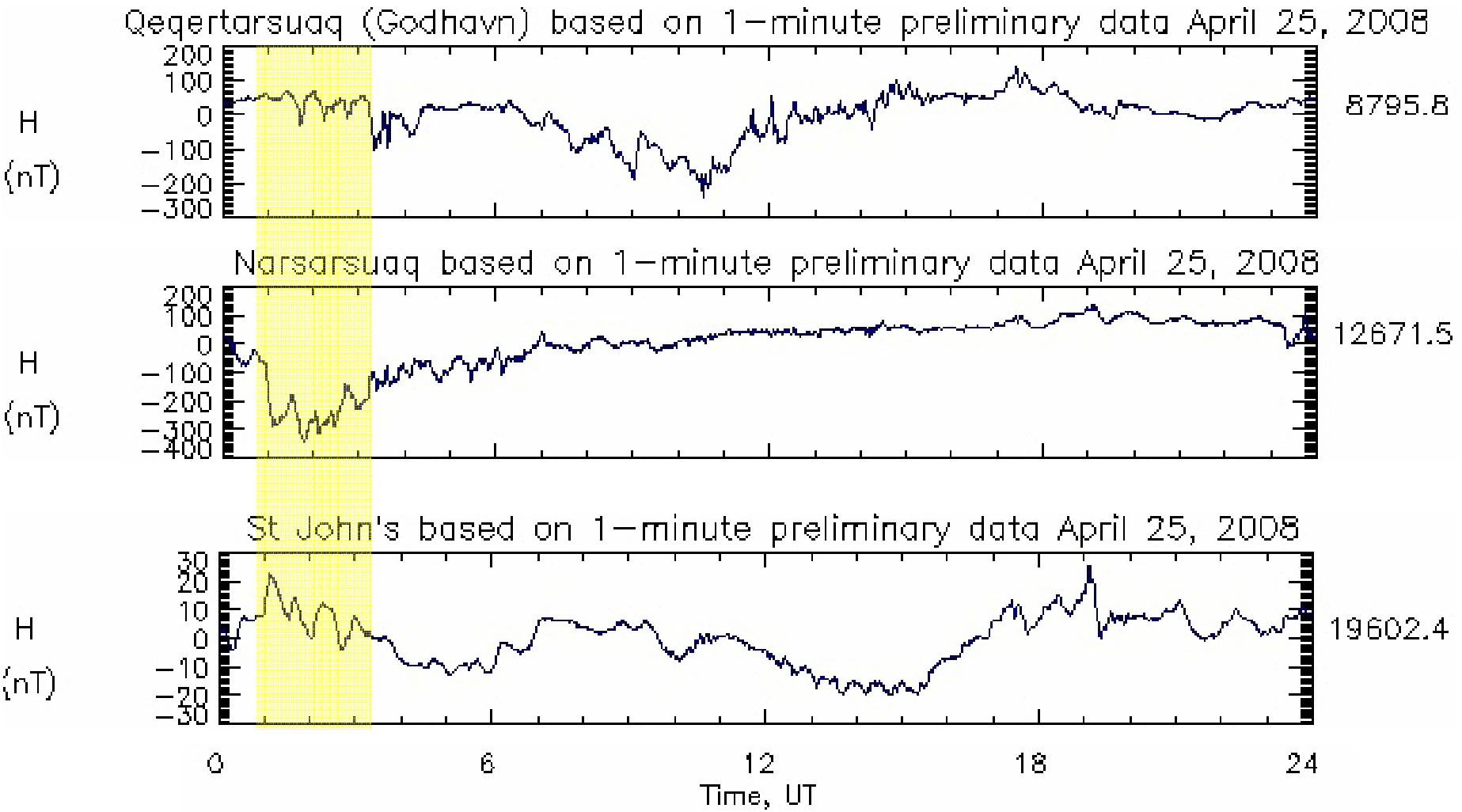


St. John

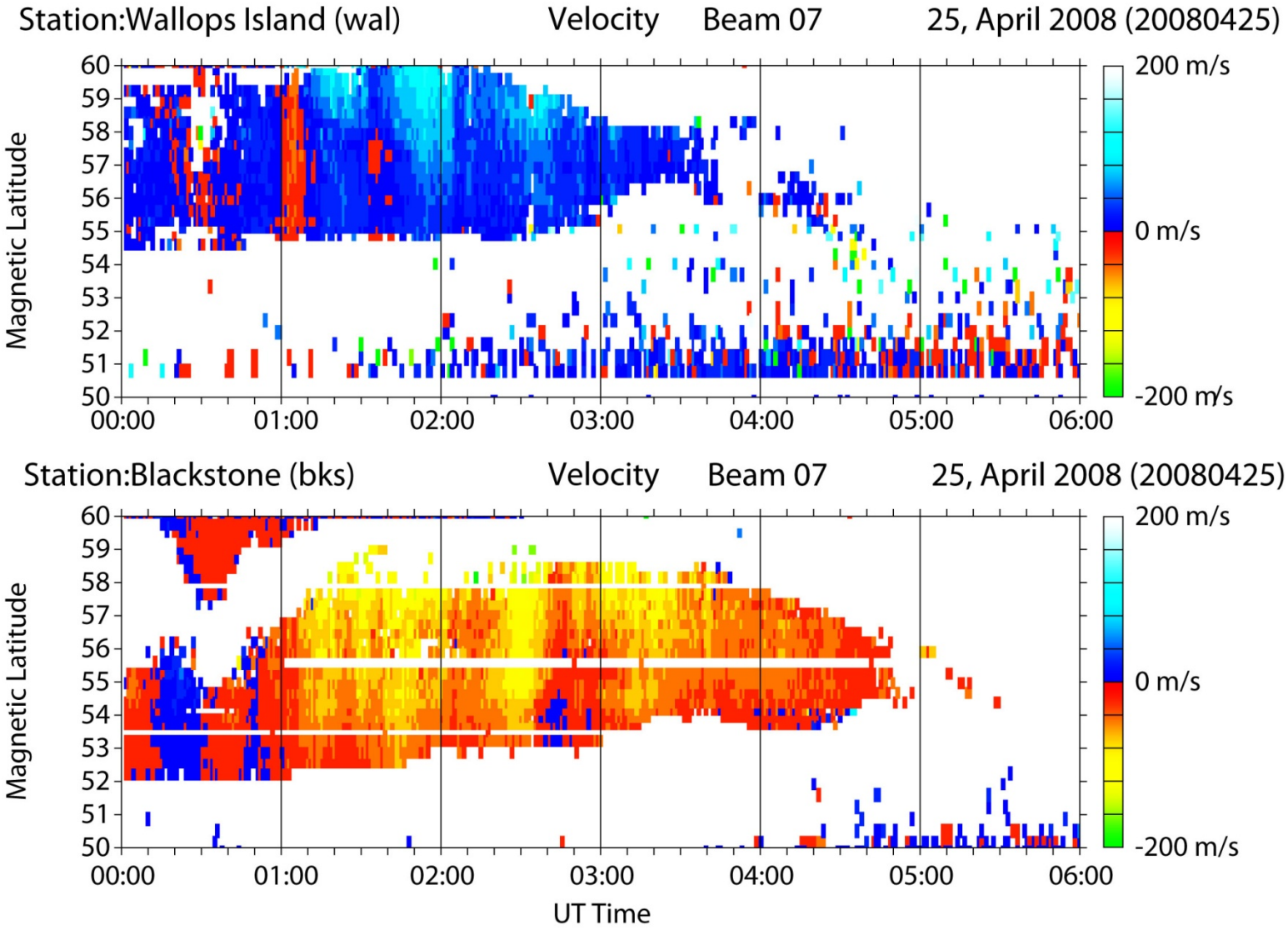
INTERMAGNET

INTERMAGNET

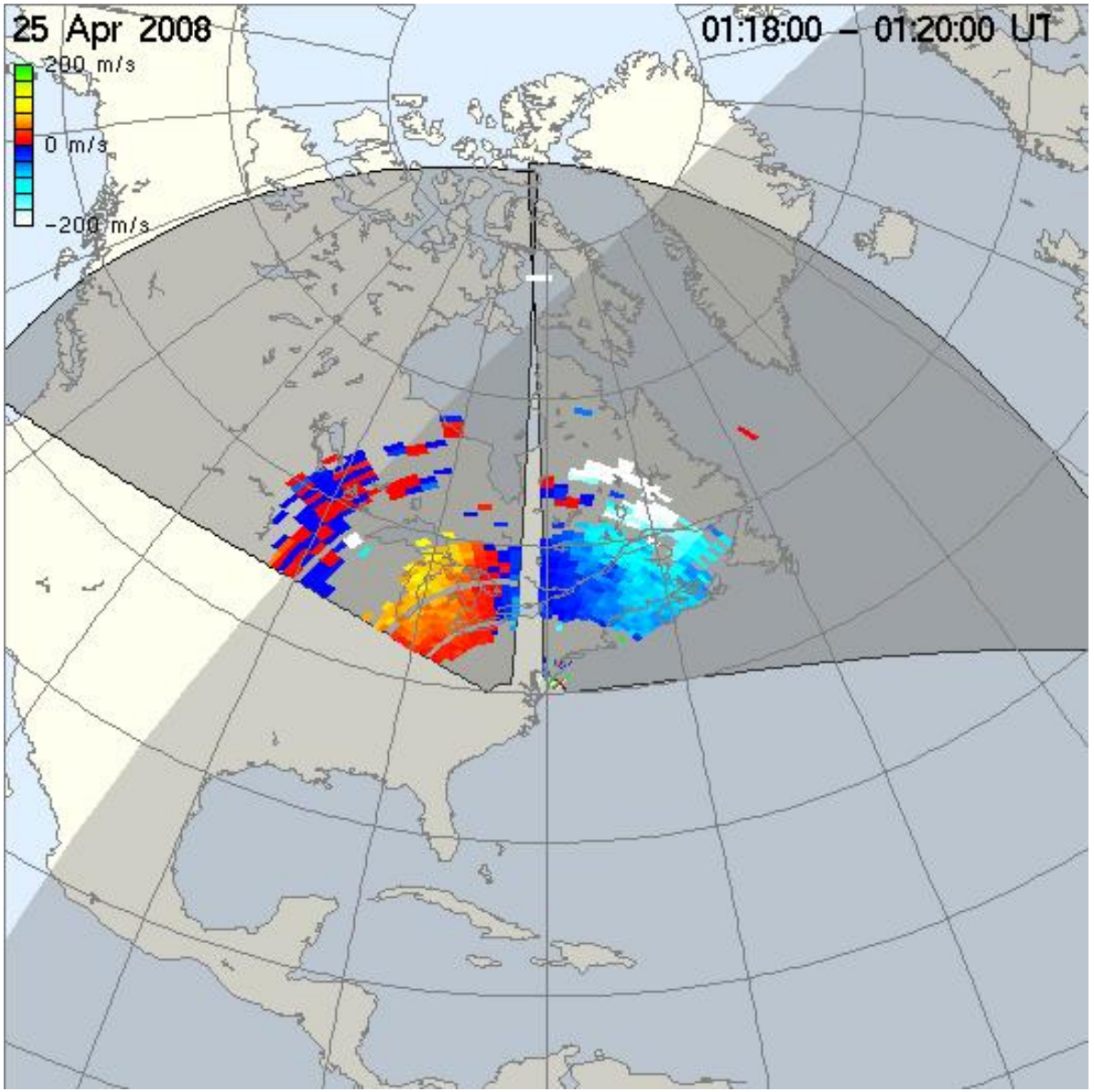
Case 2: Magnetic Data From Greenland Chain

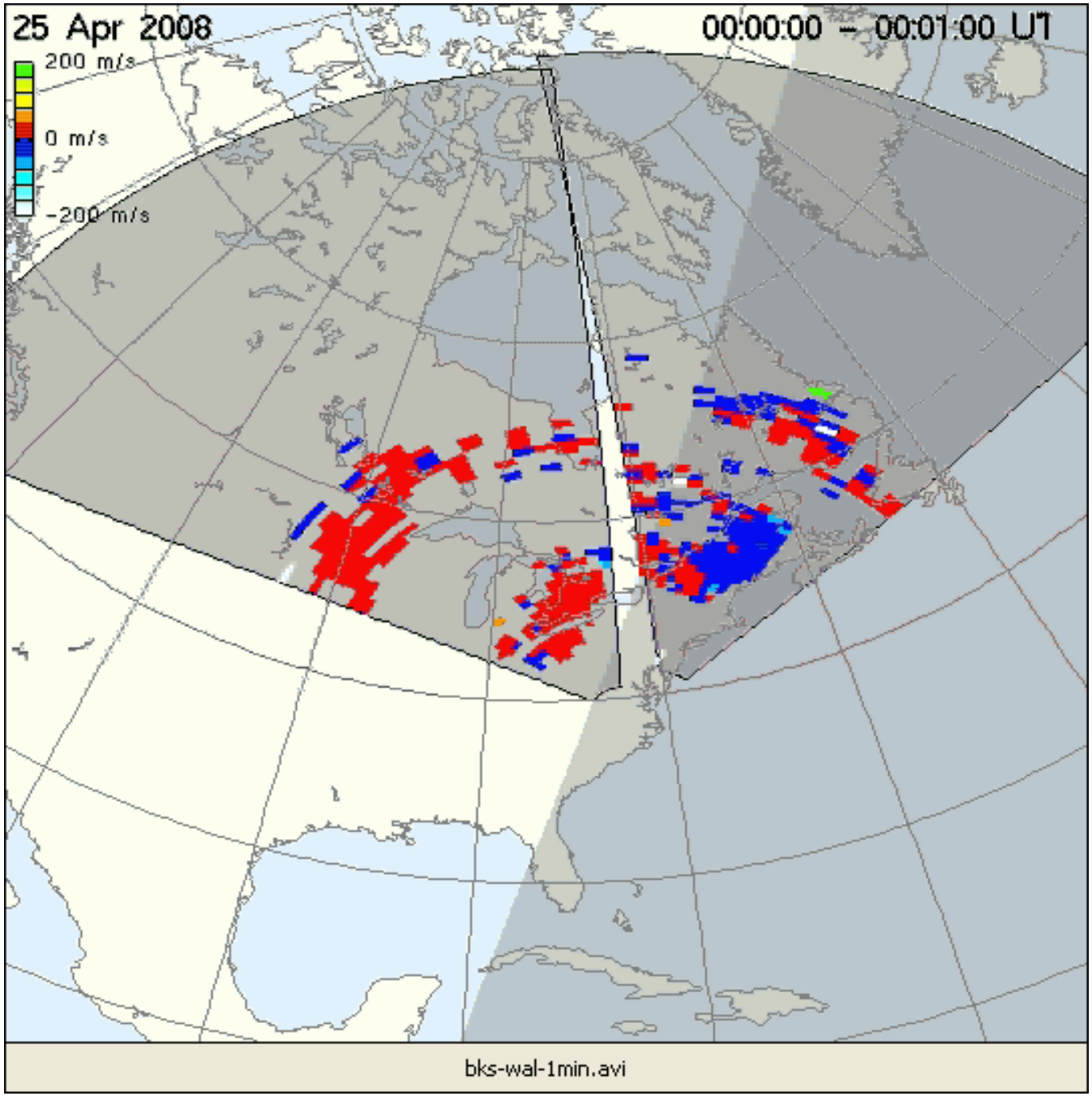


Wallops and Blackstone Time Series
April 25, 2008



Blackstone/Wallops View of Plasma Flow Bursts Across North America




25 Apr 2008
00:00:00 - 00:01:00 UT
200 m/s
0 m/s
-200 m/s
bks-wal-1min.avi

Summary

- We have examined two substorms identified by their magnetic and optical signatures.
- The Wallops and Blackstone radars observe enhanced plasma flows in the nighttime subauroral ionosphere ~5-10 minutes after substorm onset.
- Enhanced flows endured throughout the expansion phase.
- Substorm injections presumably modify pressure gradients in inner magnetosphere leading to inner magnetosphere electric fields and plasma convection.
- These transient flow enhancements are a common feature of subauroral plasma convection and occur over a wide range of magnetospheric disturbance levels.