

Correlation between Pi1B micropulsations and poleward boundary intensifications

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Introduction

- Pi1B associated with substorm onset in time and space [Milling et al., 2008]
- Pi1B linked to Alfvénic aurora [Lessard et al., 2006, 2011]
- PBIs often precede substorms [Nishimura et al., 2010; Lyons et al., 2010]
- But not all PBIs are substorm related [e.g., de la Beaujardière et al., 1994]
- PBI location likely maps to tail reconnection site
- Fast flows associated with both substorms [Baumjohann et al., 1990] and PBIs [Lyons et al., 1999; Zesta et al., 2011]
- Pi1B-like waves seen in fast flows [Lessard et al., 2008]

Q: Are Pi1B and PBIs related?

Substorm-Related PBI: 5 March 2008

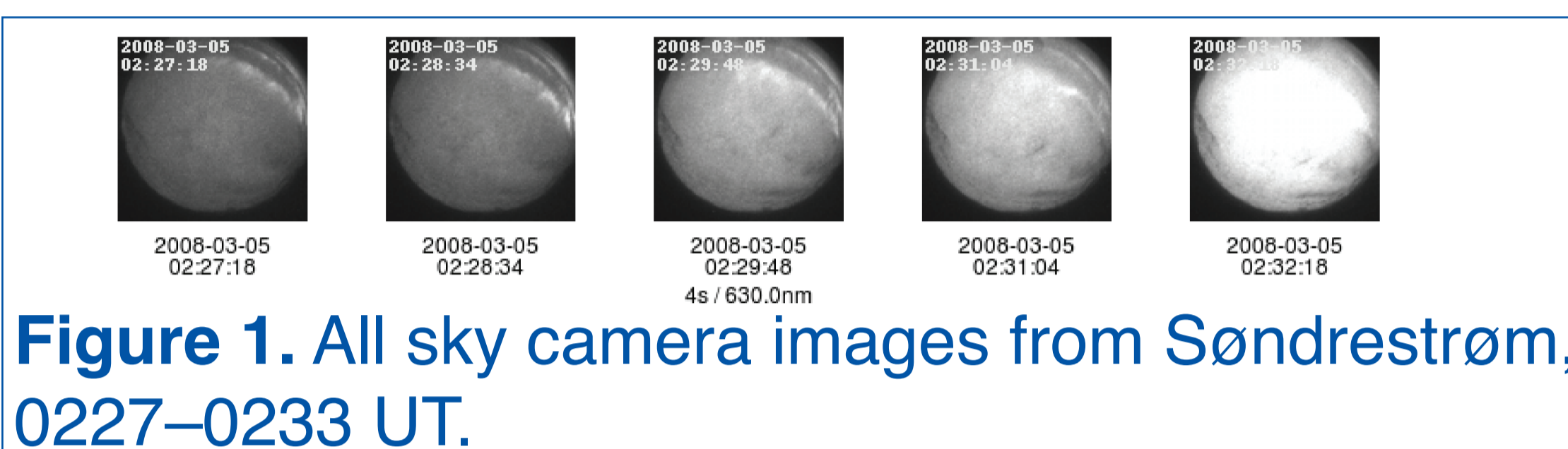


Figure 1. All sky camera images from Søndrestrøm, 0227–0233 UT.

- Substorm onset ~0200 UT
 - PBIs at ~0225, 0232 UT (Figure 1)
 - Pi1B seen at same times as substorm onset, PBIs (Figure 2)
 - PBI is in recovery phase
- See also Zesta et al. [2011]

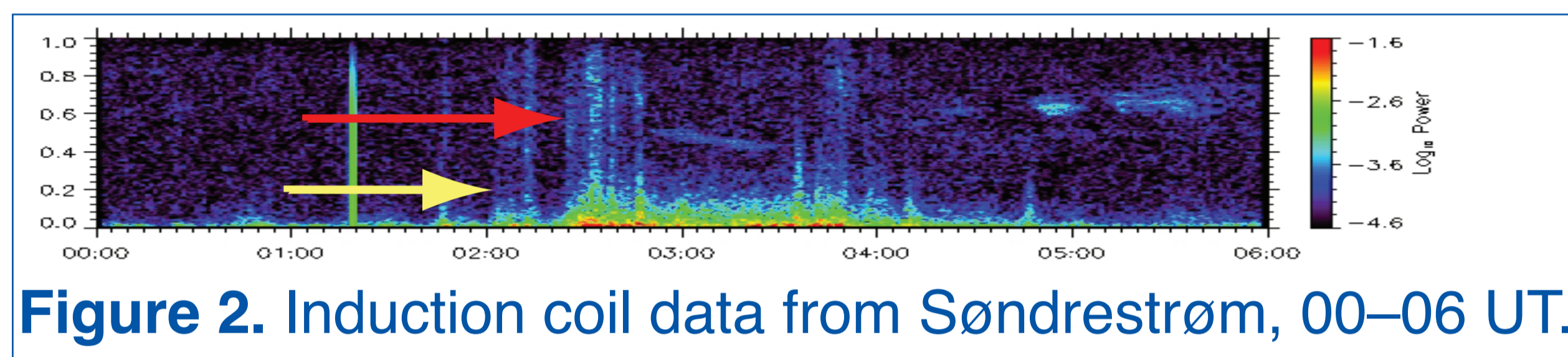


Figure 2. Induction coil data from Søndrestrøm, 00–06 UT.

Non-Substorm PBI: 20 November 2001

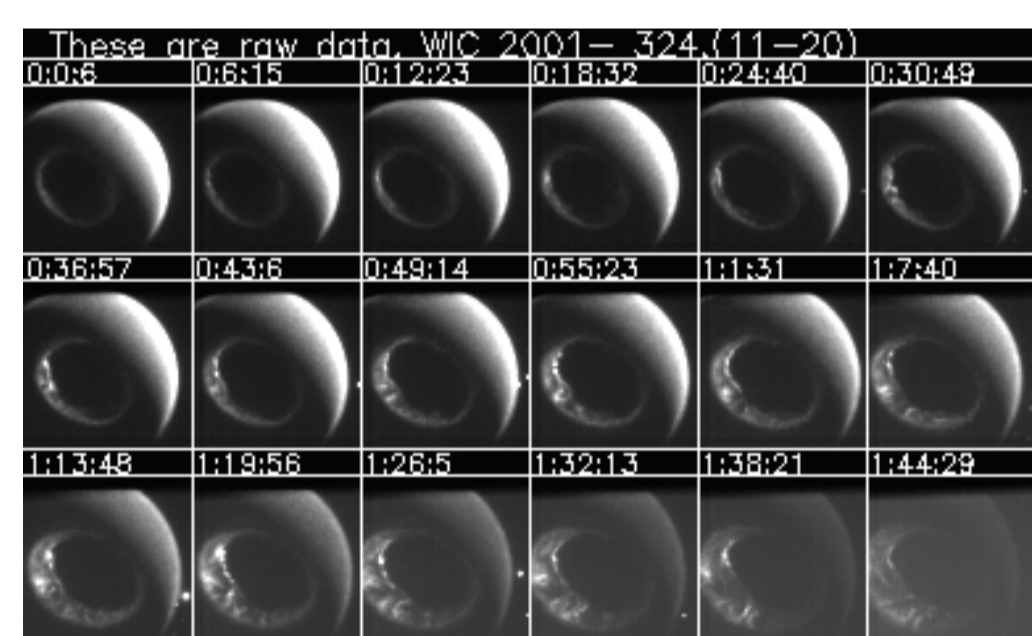


Figure 3. IMAGE/WIC global auroral images, 0000–0145 UT.

- PBI observed at 0030 UT (Figure 3)
 - Pi1B observed to start at same time (Figure 4)
 - FAST overflight of subsequent PBI (~0148) suggests auroral precipitation in transition between Alfvénic and inverted-V type (Figure 5)
- see also Semeter et al. [2005]

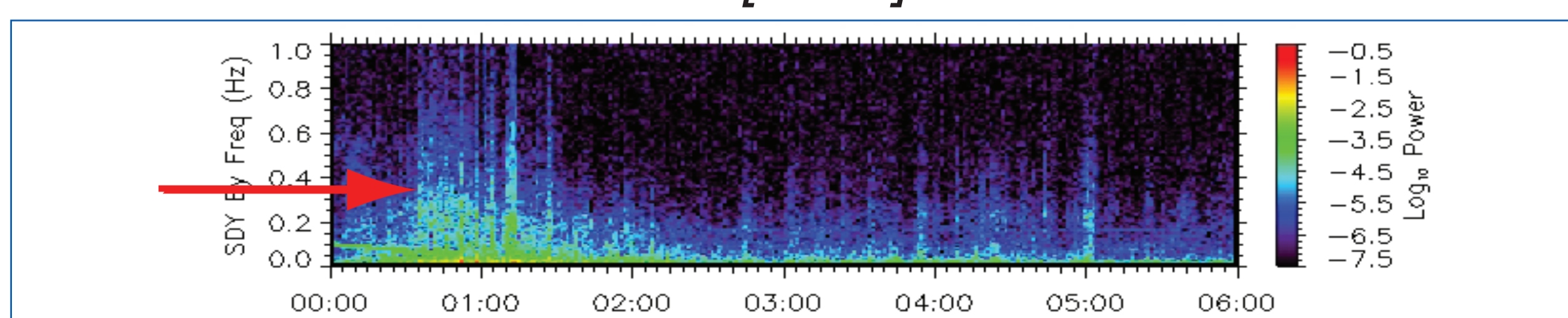


Figure 4. Induction coil data from Søndrestrøm, 00–06 UT.

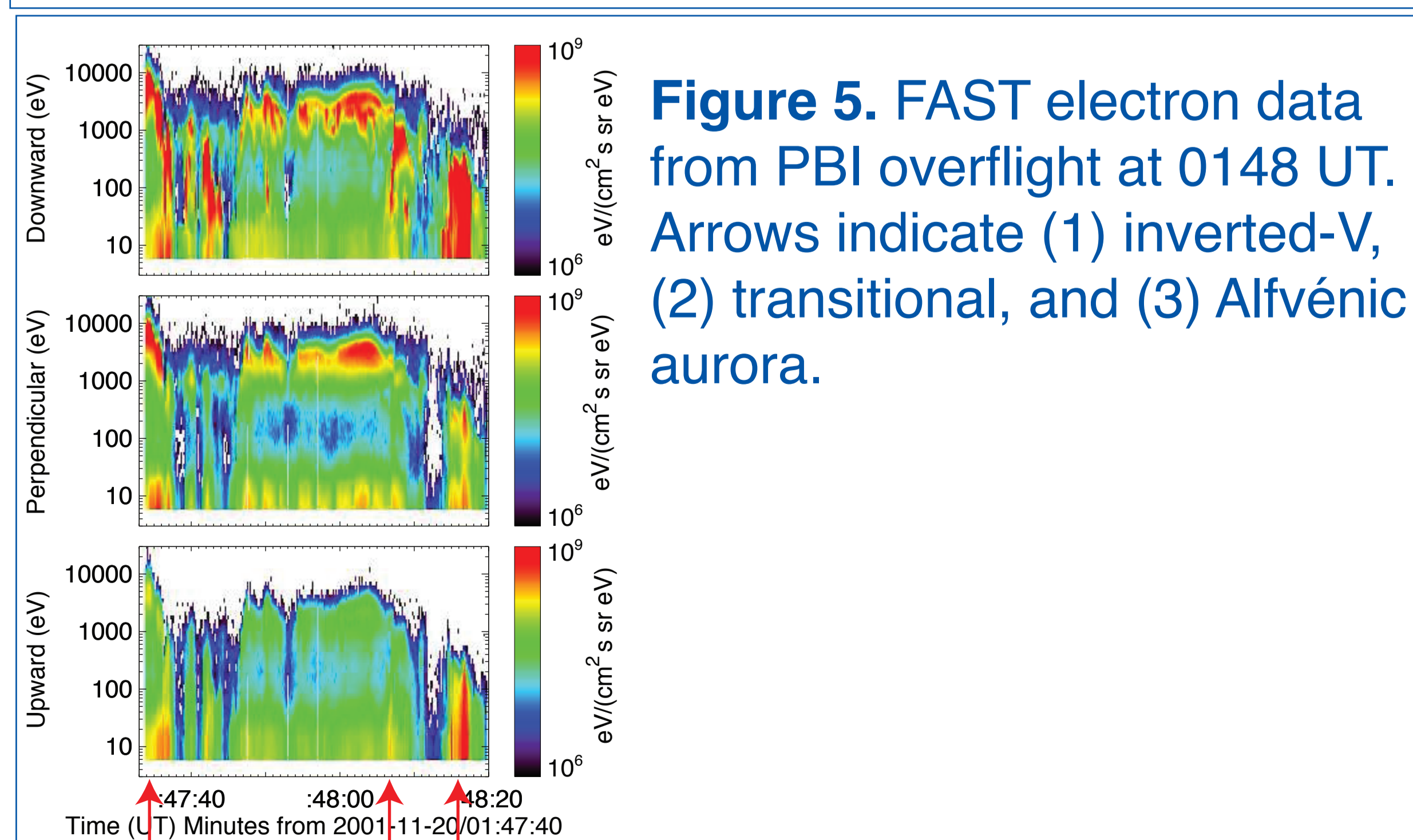


Figure 5. FAST electron data from PBI overflight at 0148 UT. Arrows indicate (1) inverted-V, (2) transitional, and (3) Alfvénic aurora.

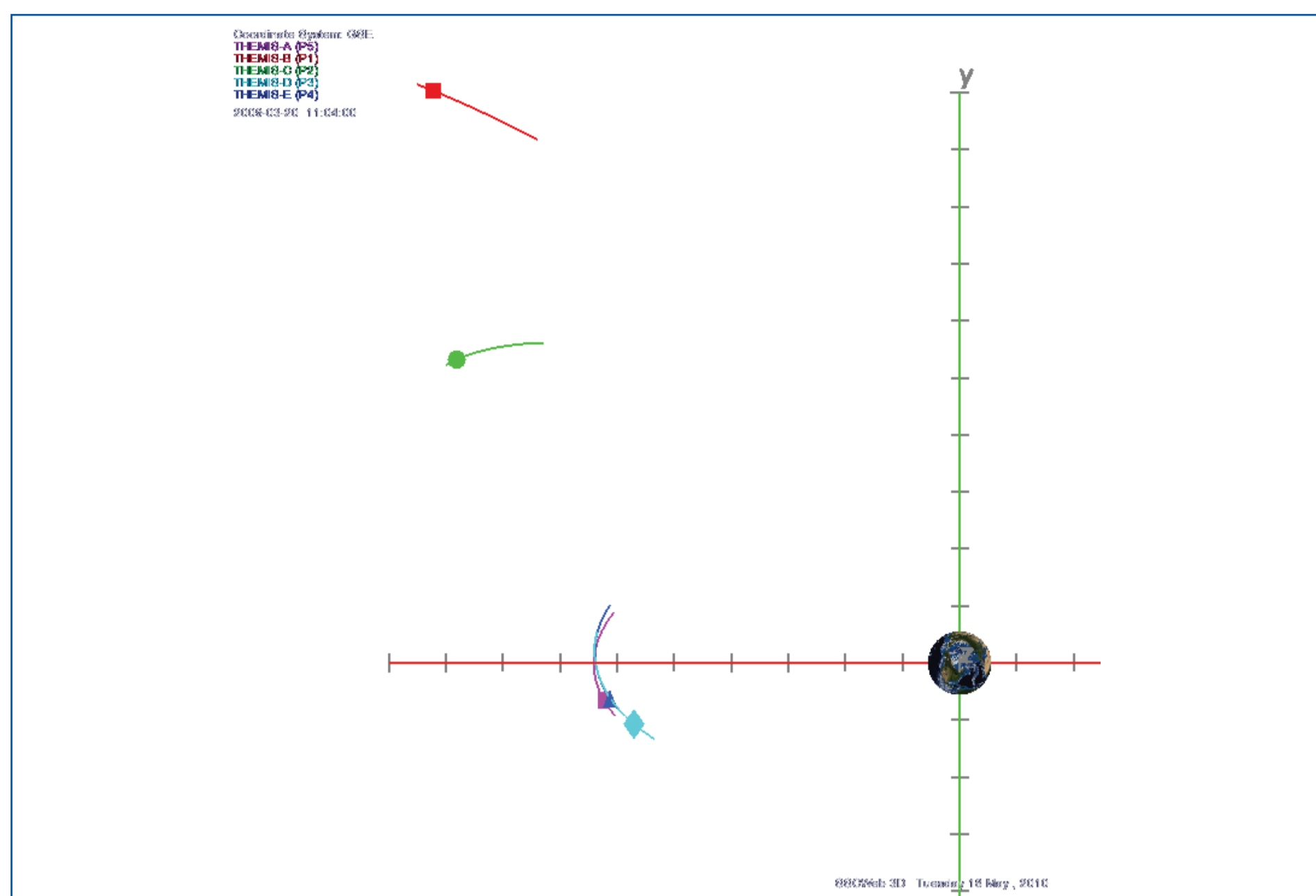


Figure 6. Positions of THEMIS spacecraft at 1104 UT, when CASCADES-2 was launched

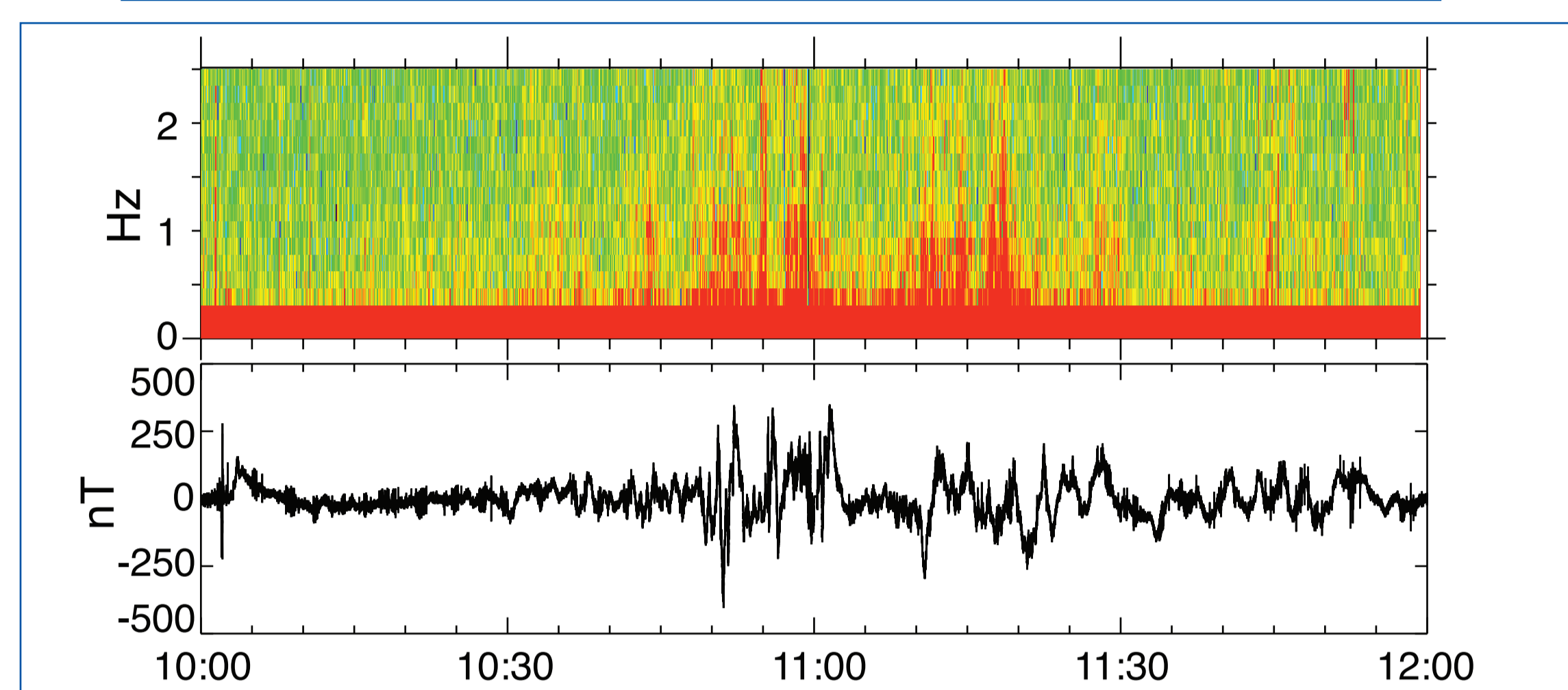


Figure 7. Induction coil data from Kaktovik, 10–12 UT.

Non-Substorm PBI: 20 March 2009

- CASCADES-2 rocket launched into PBI at 1104 UT
- Conjunction with 3 THEMIS probes (Figure 6)
- Pi1B observed downrange (Figure 7)
- Fast flows and Pi1B-like waves observed on all 3 THEMIS probes in conjunction (Figure 8)

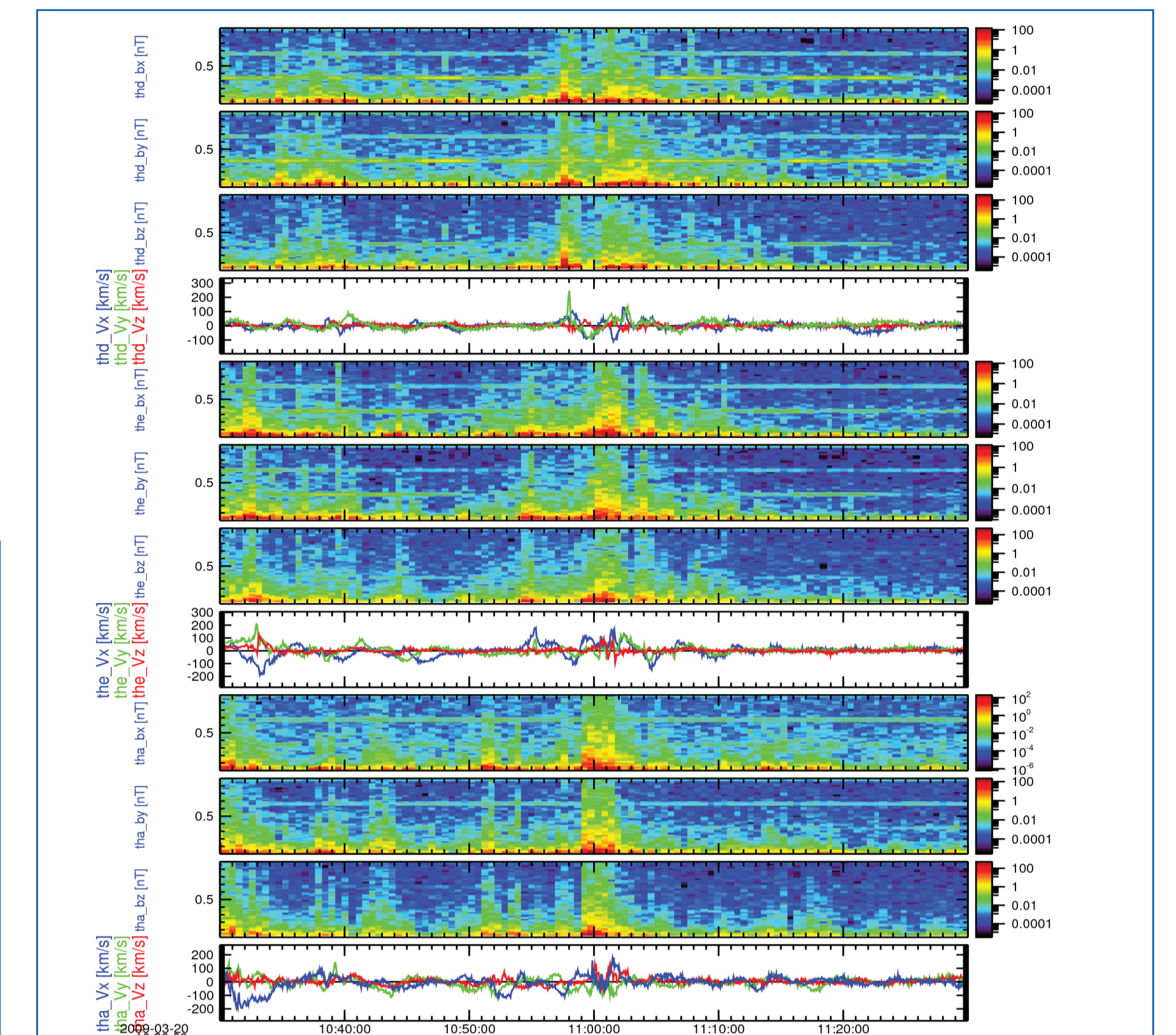


Figure 8. Magnetic field spectrograms and flow velocities for THEMIS D, E, and A, 1030–1130 UT.

Discussion

- Two propagation paths from near-Earth neutral line to ionosphere (Figure 9):
 - Direct propagation along field line to probable PBI initiation point [Keiling et al., 2000]
 - Tamao path [Chi et al., 2006] to substorm onset location
- PBIs in equatorial plane are fast mode [Arnoldy et al., 1998]
- Waves propagating along field lines are shear mode [Lessard et al., 2006]
- Tamao path requires mode conversion

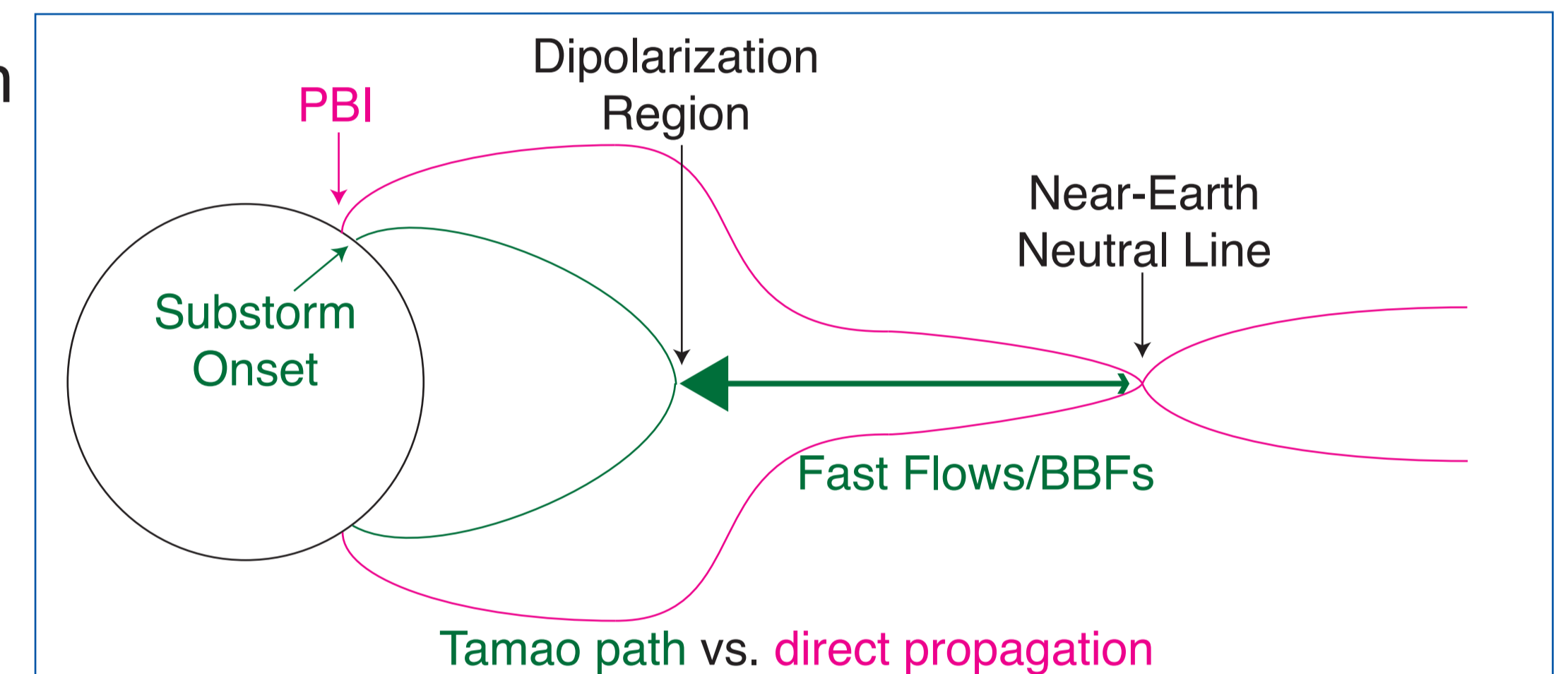


Figure 9. Cartoon showing two propagation paths from near-Earth neutral line to ionosphere: Tamao path (green) and direct path (magenta).

Hypothesis: Near-Earth neutral line reconnection not sufficient for substorm onset—must have near-tail process as well, or non-substorm PBI results

Summary

- Pi1B observed in association with PBIs as well as substorms
- Also linked to Alfvénic aurora and fast flows
- Places constraints on substorm initiation models

Acknowledgements

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