Photo by Mike Nicolls

Initial Results of the CASCADES-II Sounding Rocket:
A Series of Poleward Boundary Intensifications

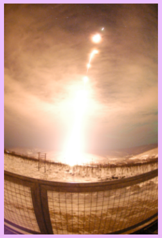


Photo by Robert Michell

Meghan Mella, Kristina Lynch
Dartmouth College
Contact: Meghan.Mella@Dartmouth.edu

Paul Kintner, Erik Lundberg
Cornell University

Marc Lessard
University of New Hampshire

Hans Stenbaek-Nielsen
University of Alaska Fairbanks

Nickolay Ivchenko, Hanna Dahlgren
KTH

Robert Michell
SWRI

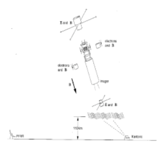
Abstract

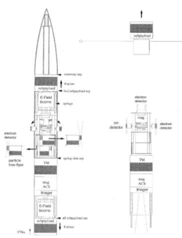
CASCADES-II was launched on 20 March 2009 at 11:04:00UT from the Poker Flat Research Range. The payload had five sub-payloads for multipoint measurements of auroral dynamics and structure. The signatures in the keograms at the time of flight can be described as a series of Poleward Boundary Intensifications, which are repeated brightenings along the poleward edge of the auroral oval that may move equatorward. There have been theories suggesting that these repeated poleward brightenings are related to Alfvénic activity at the Plasma Sheet Boundary Layer (PSBL)[Liu, et al. 1995]. The launch of CASCADES-II into this dynamic Alfvénic structure will provide a rich case study of this less-studied type of event.

Initial analysis of the optical data indicates the payloads cross through the equatorward edge of a PBI at the beginning of flight, followed by a period of unstructured aurora, until reaching the onset of the next PBI at a higher latitude. During these two PBIs we observe increased activity in all particle detectors. The field aligned electrons on multiple payloads show impressive dispersion signatures. Also we see Alfvén waves with amplitudes of over 200mV/m in both electric field instruments at the end of the flight, together with strong perturbations of the magnetic field. In this Alfvénic region we observe very structured ion precipitation. The in situ data for this event will be a good case study for various theories and models of Alfvénic aurora. In this poster I will present a brief overview of the rocket design and launch, along with initial in situ data as well as PFISR and THEMIS data during the time of flight, focusing in particular on what this case study can tell us about PBIs.

Payload Concept

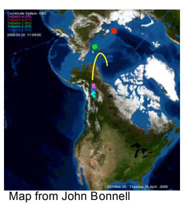
- 5 subpayloads for multipoint measurements, all with GPS and magnetometers





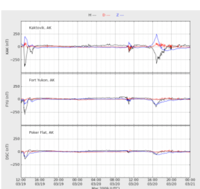
- Two payloads (with electron detectors) ejected across field lines separated from main payload (with two electron detectors, an ion detector, and an imager) by 500m at apogee
- Subpayloads (with electric field booms and thermal electron detectors) ejected along magnetic field lines separated by 4km at apogee

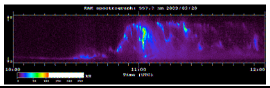
Launch Conditions

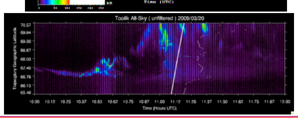


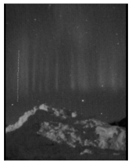
Map from John Bonnell

- Launched 20 March 2009 at 1104:00 UT
- Apogee of 564km
- Negative bay in H seen by ground based magnetometers
- PBI signatures seen in keograms
- Tall rays imaged during rocket flight



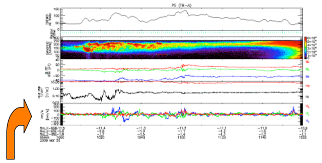




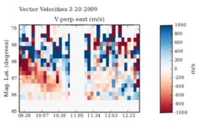


Satellite and Radar Data

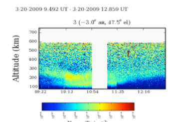
Bursty Bulk Flows (BBFs) are often seen in the tail and are connected to flows observed in the ionosphere. Many studies have been done connecting BBFs to PBIs using satellite and radar data from events similar to our event.

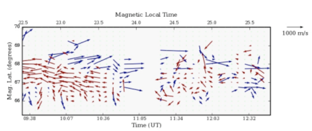


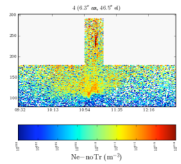
At the time of launch, earthward flows are seen in the tail by THEMIS.



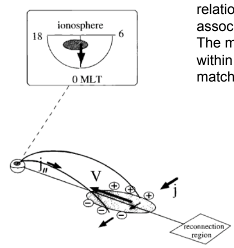
Before launch, PFISR observes westward flows pulling equatorward. The electron density is enhanced both before and during launch.



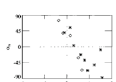




Connection of BBF to PBI



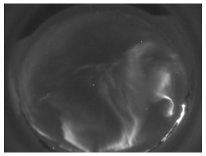
These figures from Nakamura et al. show the spatial relationship between the BBF footprint and the associated ionospheric auroral signature.
The map to the left shows the THEMIS footprint to be within one hour east of the rocket trajectory, which matches this picture.



Since the event during the time of launch can be classified as a PBI, what can this case study say about the correlation among flows in the magnetotail, auroral intensifications detected on ground-based instruments, and Alfvén waves on the rocket?

CASCADES-II Location

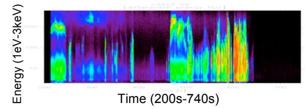
	L-Shell	MLT
Launch	5.7RE	23:34
Apogee	8.7RE	23:41
Onset of Alfvénic Aurora	9.7RE	23:44
LOS	14.6RE	23:46



North-South aligned auroral arcs seen just prior to launch, a common signature of PBIs.

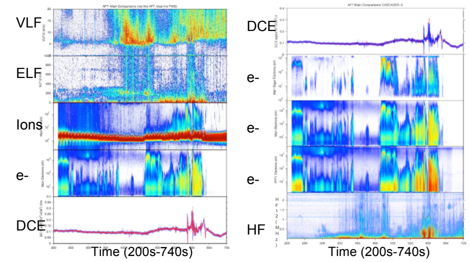
In Situ Data

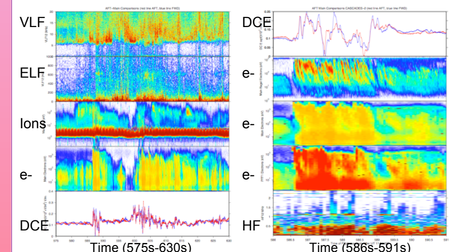
The in situ data gives us a detailed look at the ionospheric signatures seen in conjunction with the BBFs and PBIs.



The electron spectrogram for the full flight shows inverted-V type aurora at the equatorward edge of a PBI, and Alfvénic aurora near the end of flight, at the onset of the next PBI.

Full flight summary plots showing particle data and electric field data.

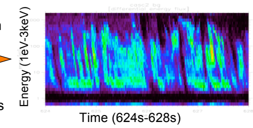




Zoomed data showing detailed data toward the end of flight during Alfvénic aurora.

In situ electron dispersion signatures during Alfvénic aurora give a source region of 429 km above payload with a frequency of 10 Hz.

Electron structure width can be approximated from in situ data as well as camera data to be 2-5 km at 600s time of flight, when the tall rays are seen.



- We observe a dispersive Alfvén wave at 1000km with a frequency of 10Hz
- From the camera we get a perpendicular phase velocity which gives a $k_\perp$ of $2*\pi/2$km
- From the e^- or the camera data we get $k_\perp$ which gives a $v_\perp$, which is consistent with above
- From the delay between in situ particle and electric field measurements we get a $v_\parallel$ which is consistent with Chris Chaston's model and also gives a $k_\parallel$
- The 2 payload DCE should give a direct observation of the parallel phase velocity
- A five point magnetic field measurement will allow us to calculate $\nabla \times B$ to get the current.

References and Acknowledgements

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