Large-amplitude Alfven waves observed during Jets dual sounding rocket experiment

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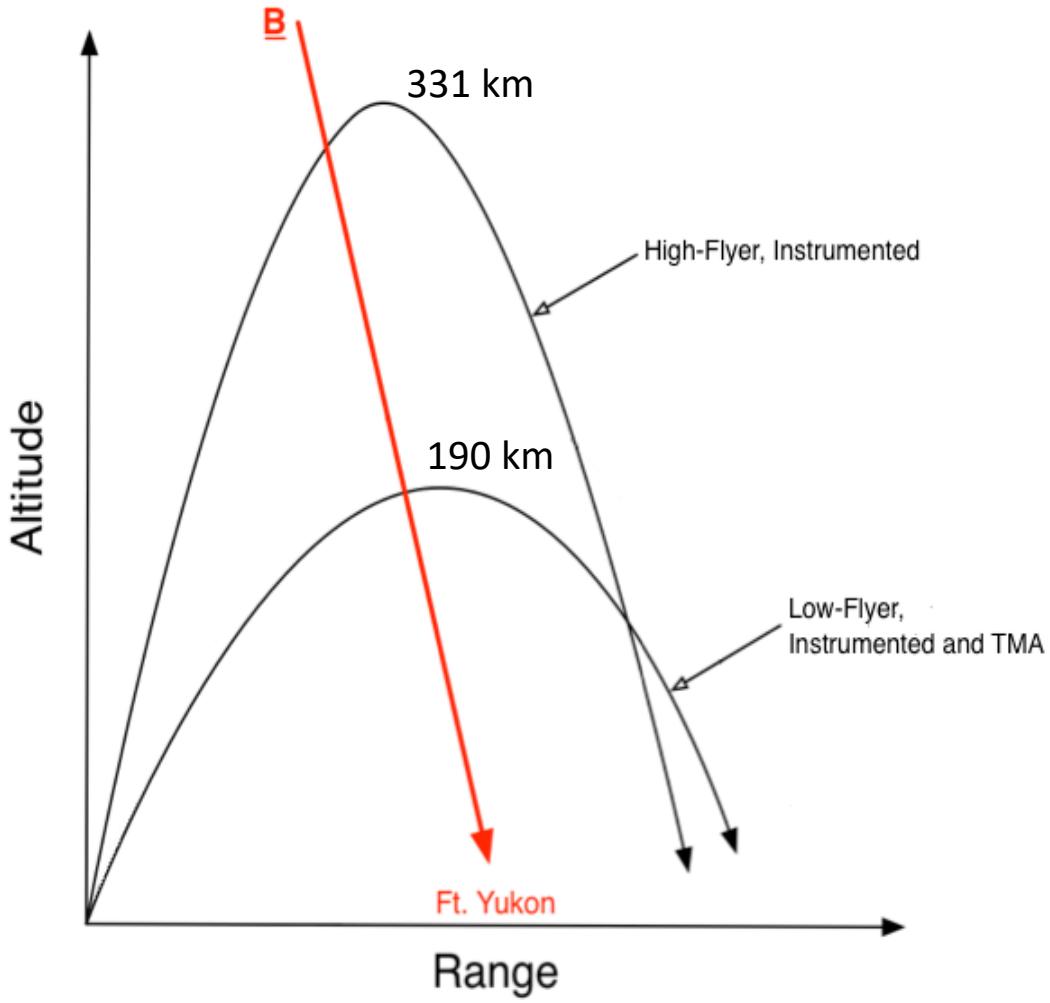
- Auroral Jets experiment consisted of two rockets launched simultaneously into an auroral arc with different apogees of 331 km and 190 km.

- Rockets instrumented to measure plasma and neutral gas parameters, DC electric and magnetic fields, and energetic precipitating electrons.

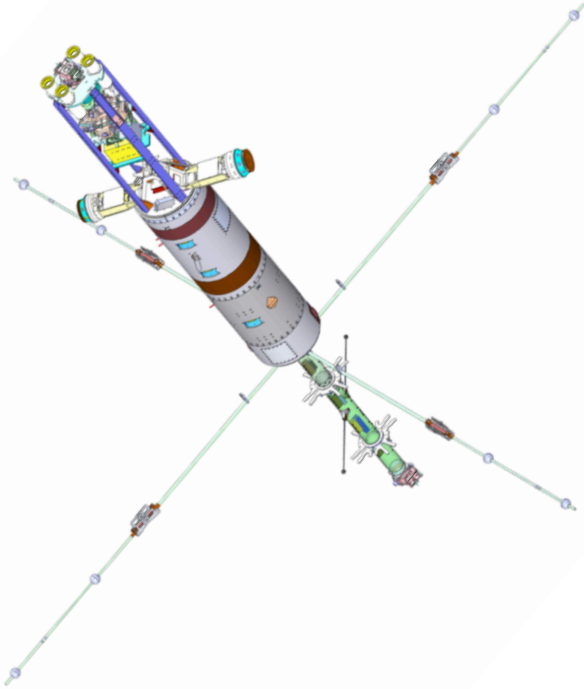
- Launch on March 2, 2017 from Poker Flat, AK.



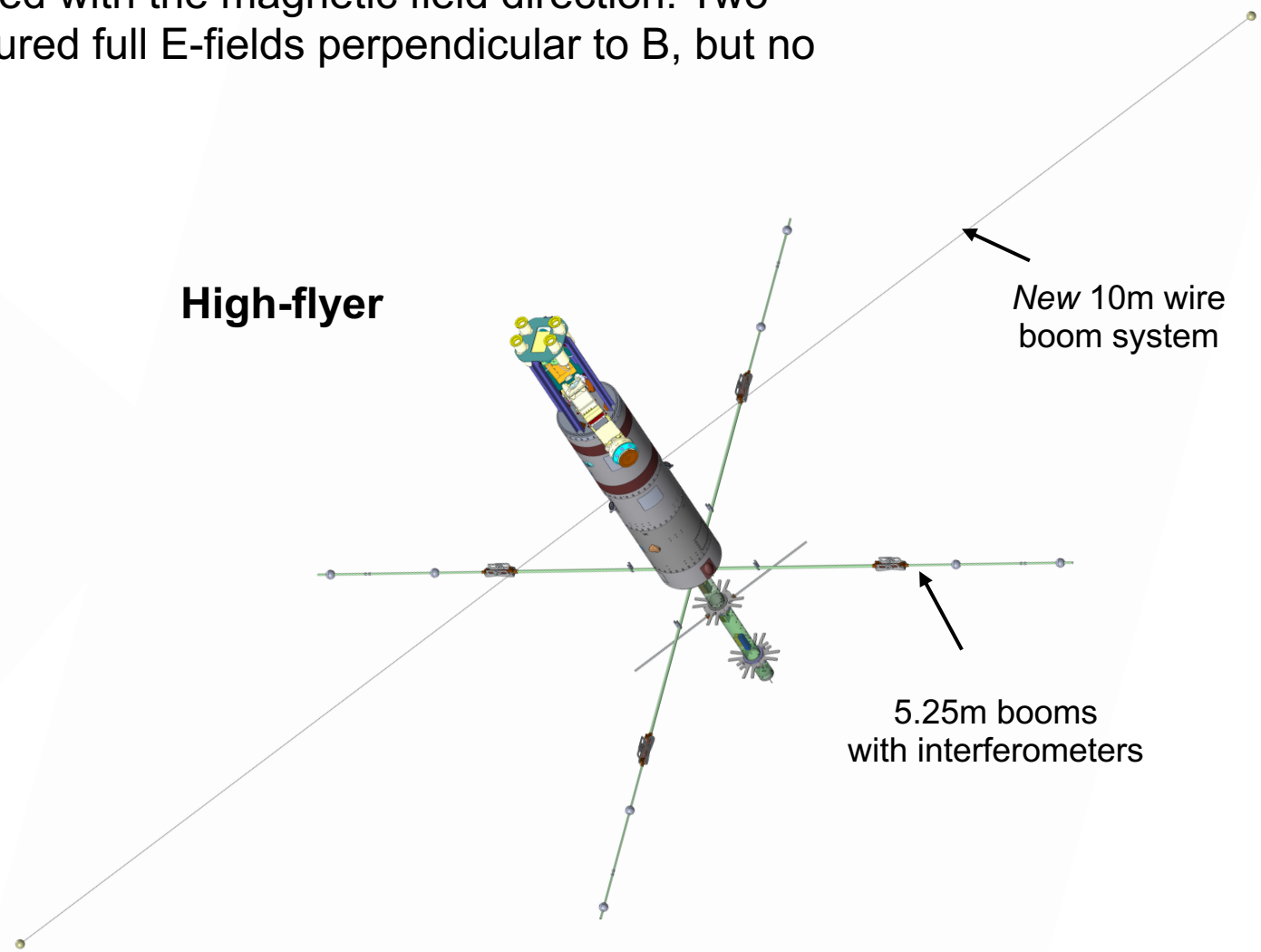
- Both Main Payloads: Electric and Magnetic Fields, Energetic Particle Detectors, Photometers, Langmuir Probes.

- The spin axis of each payload was aligned with the magnetic field direction. Two component electric field experiment measured full E-fields perpendicular to B, but no parallel electric field component available.

Low-flyer

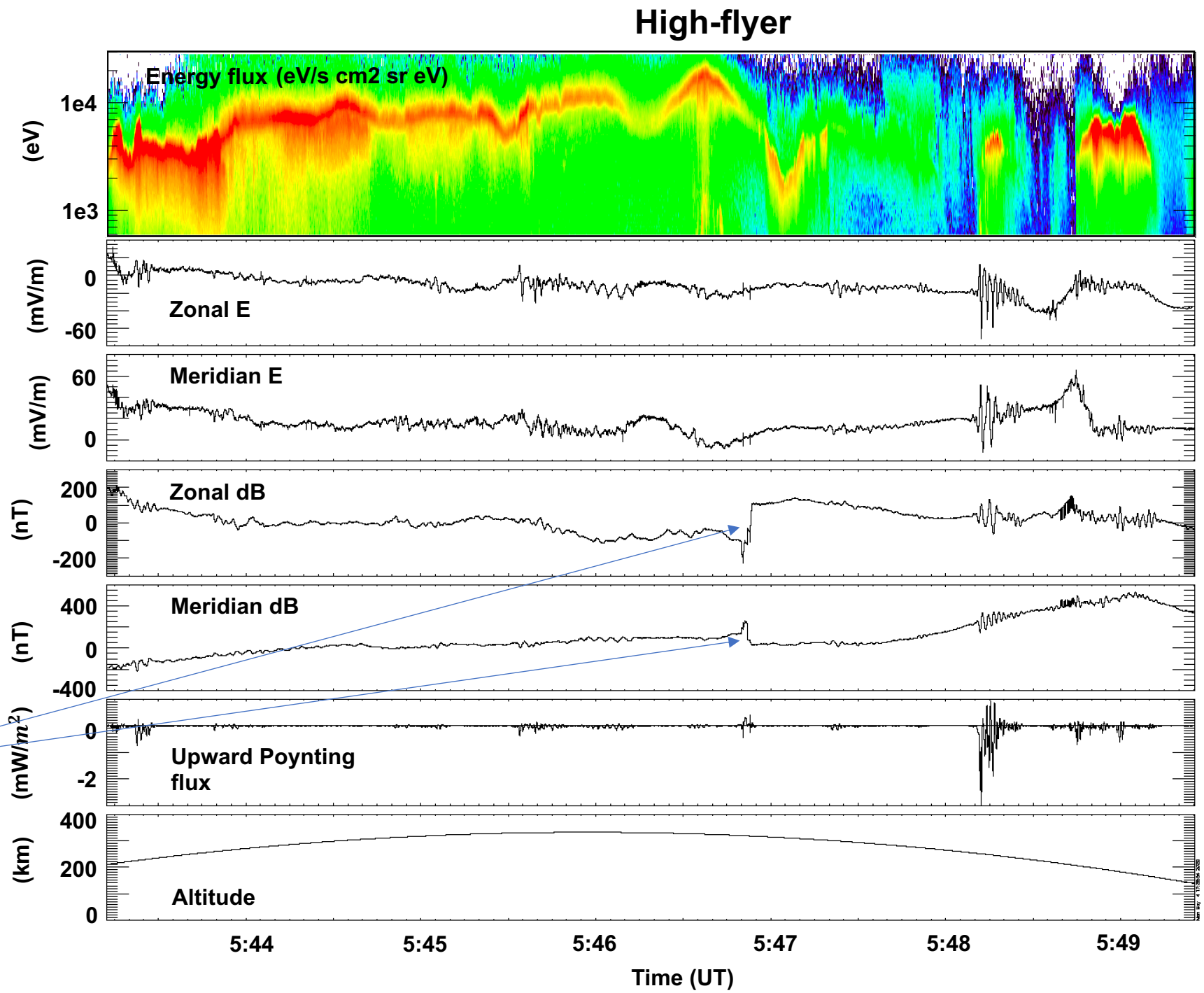


High-flyer



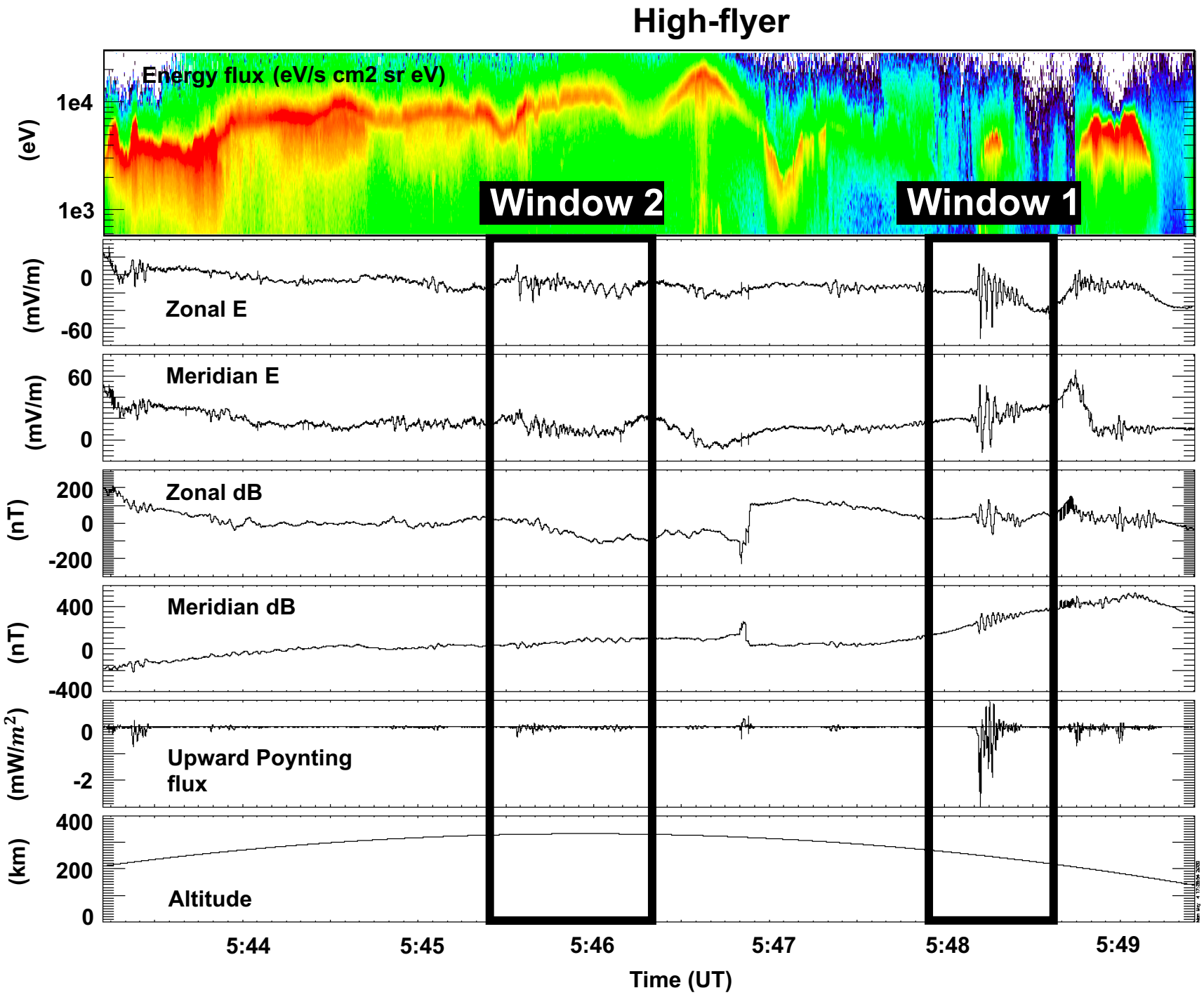
- Large amplitude Alfven waves were observed in electric and magnetic field measurements.

Instrumental:
ACS adjustment



- Large amplitude Alfven waves were observed in electric and magnetic field measurements.

- We focus on two regions of intense Alfven waves, but the data show evidence of Alfven waves throughout the flight.

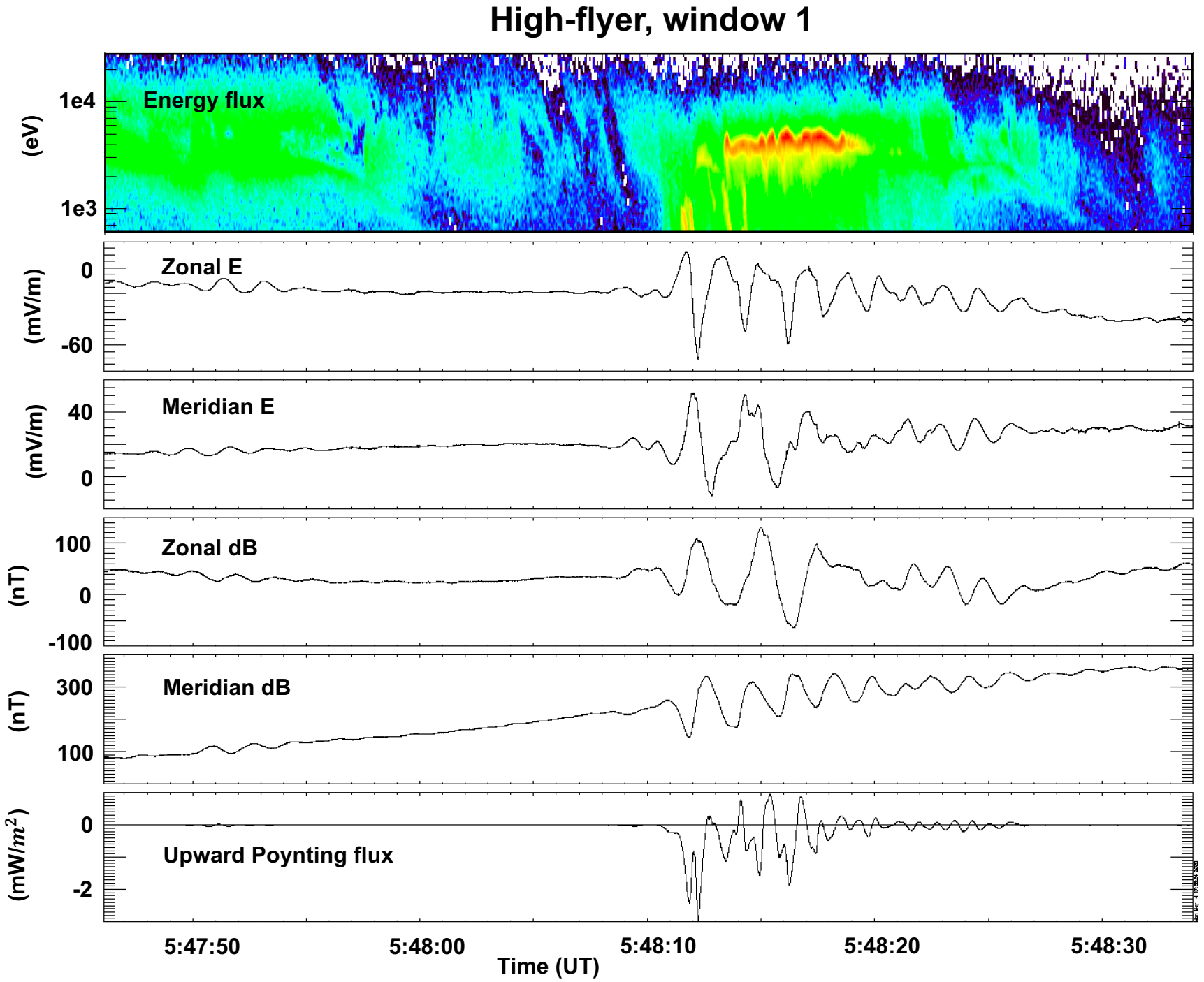


Observation:

- Poynting flux, indicative of downward propagating wave as well as a standing wave pattern.

- Peak-to-peak zonal electric field of >80 mV/m.

- Peak downward Poynting flux of $> 3mW/m^2$.



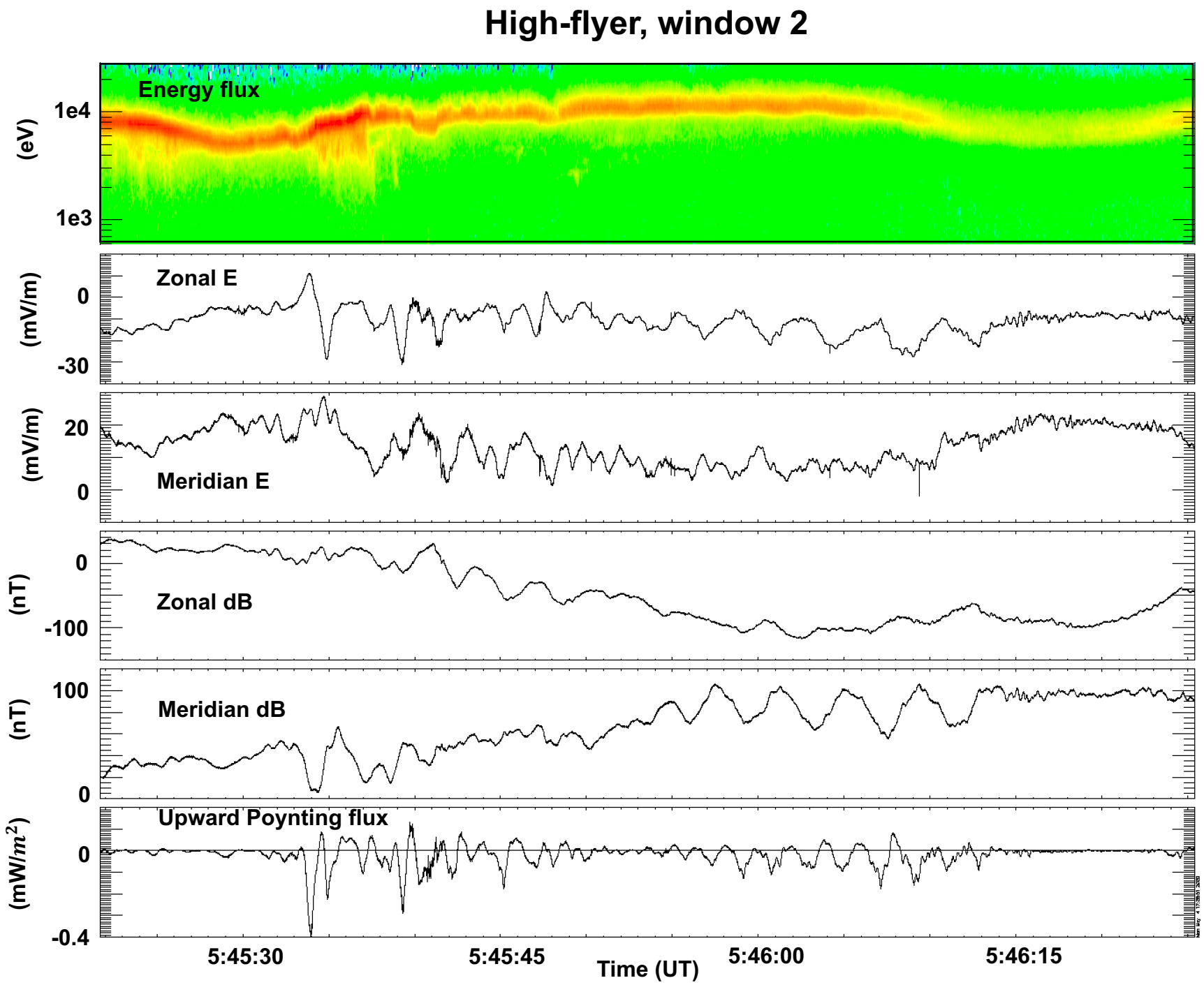
Observation:

- Poynting flux, indicative of downward propagating waves.

- Peak-to-peak meridian magnetic field perturbation of magnitude ~40 nT.

- Peak downward Poynting flux of $< 0.4\ mW/m^2$.

- Some E fluctuations without dB components are observed.

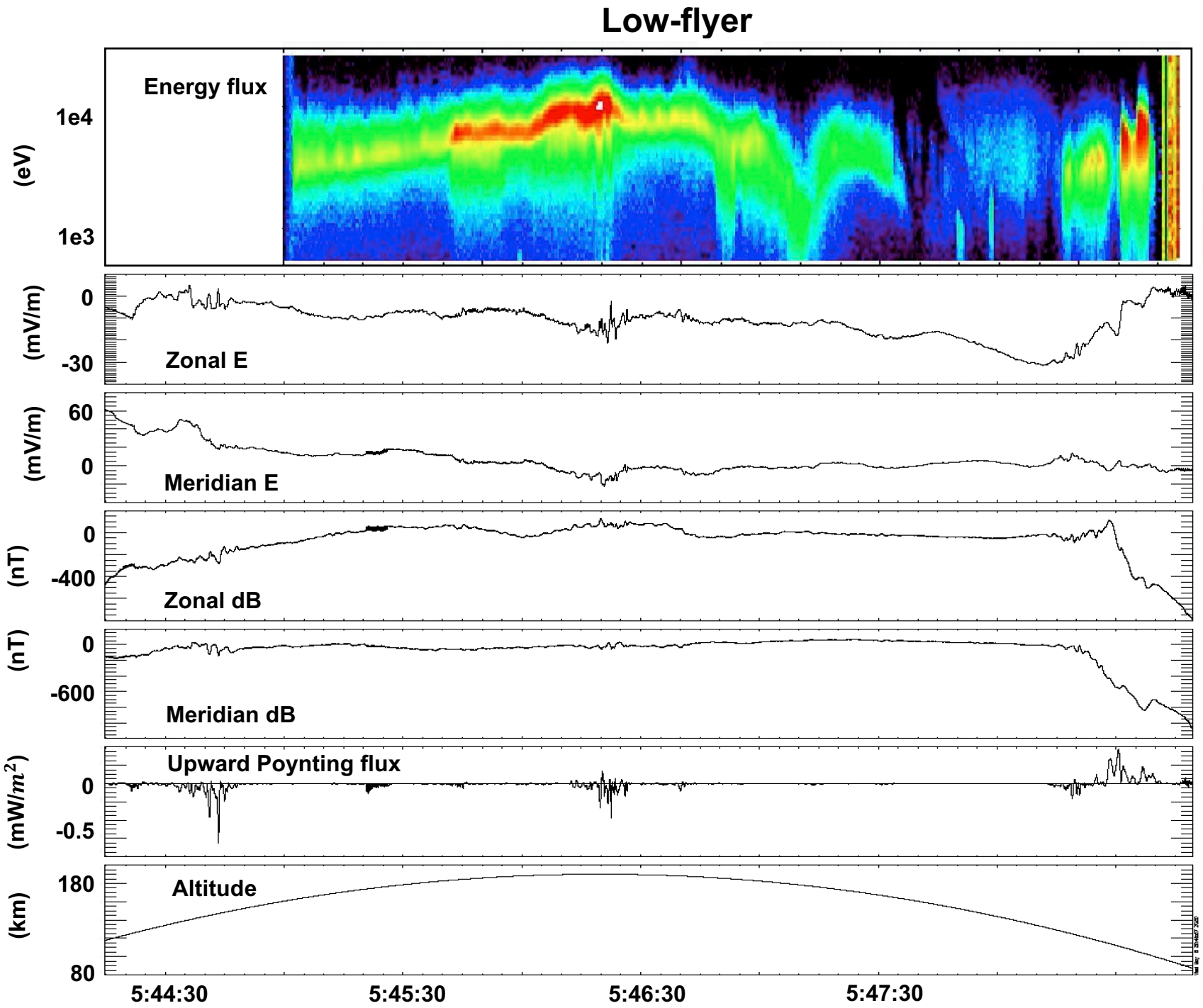


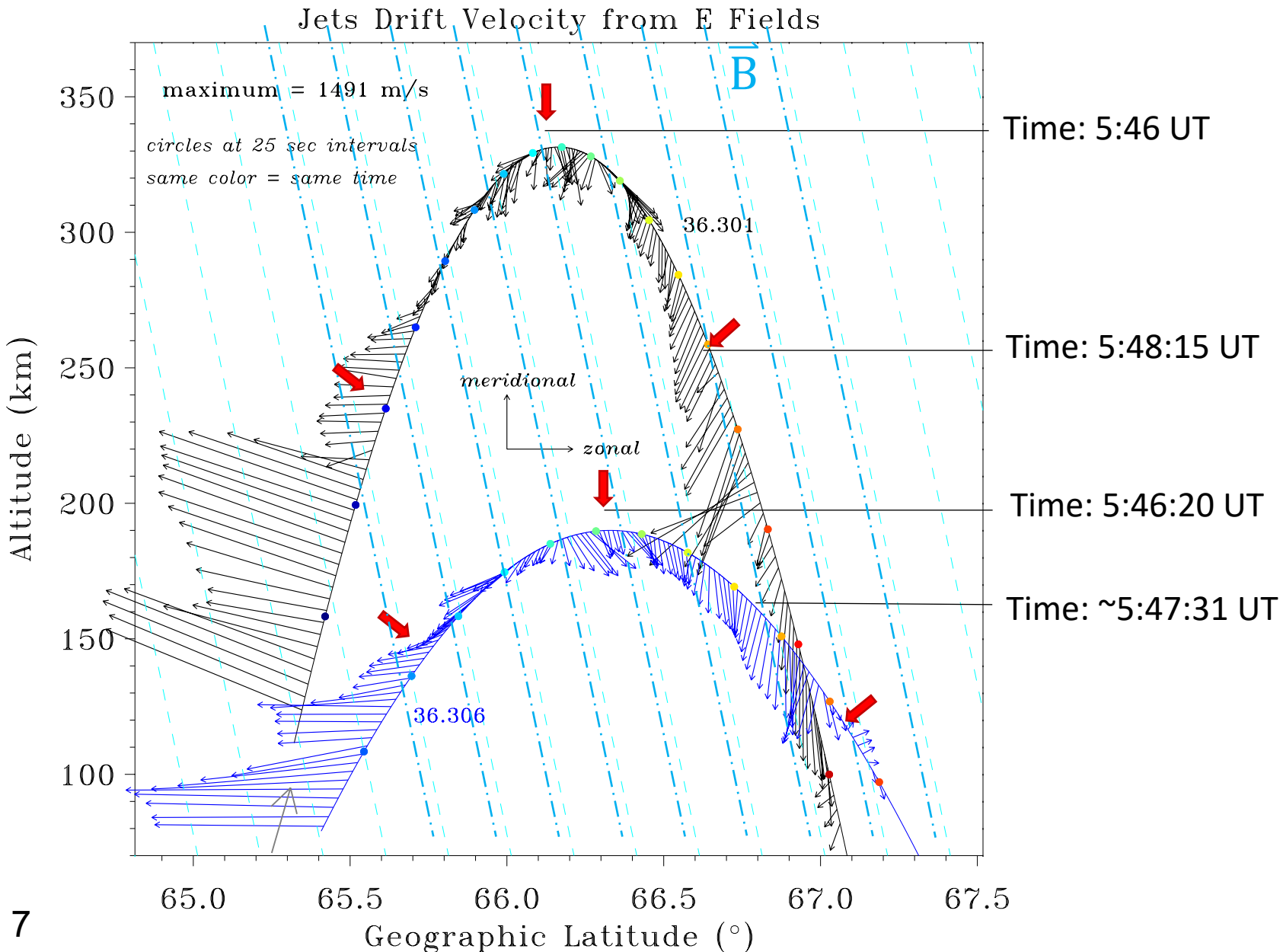
Observation:

- Poynting flux, indicative of downward and upward propagating waves.

- Alfven wave activity at altitudes as low as 150 km.

- Peak downward Poynting flux of $< 0.6\, mW/m^2$.





Time: 5:46 UT

Time: 5:48:15 UT

Time: 5:46:20 UT

Time: ~5:47:31 UT

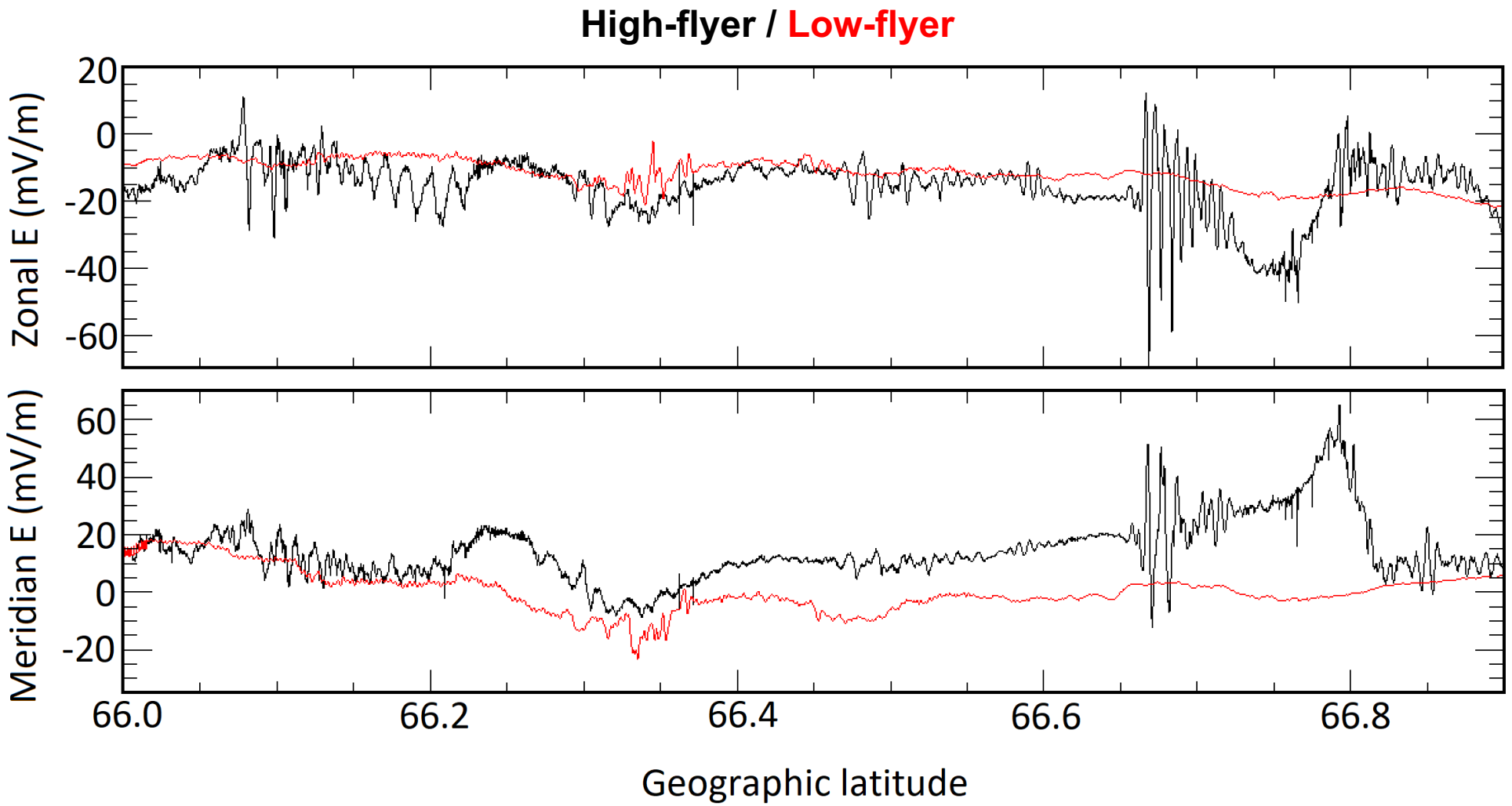
When/where the strongest Alfven waves were observed on the two payloads---indicated by red arrows.

The blue dashed lines represent magnetic field lines.

Note: payloads reach the same latitudes at different times.

Electric fields from the two rockets overplotted on each other.

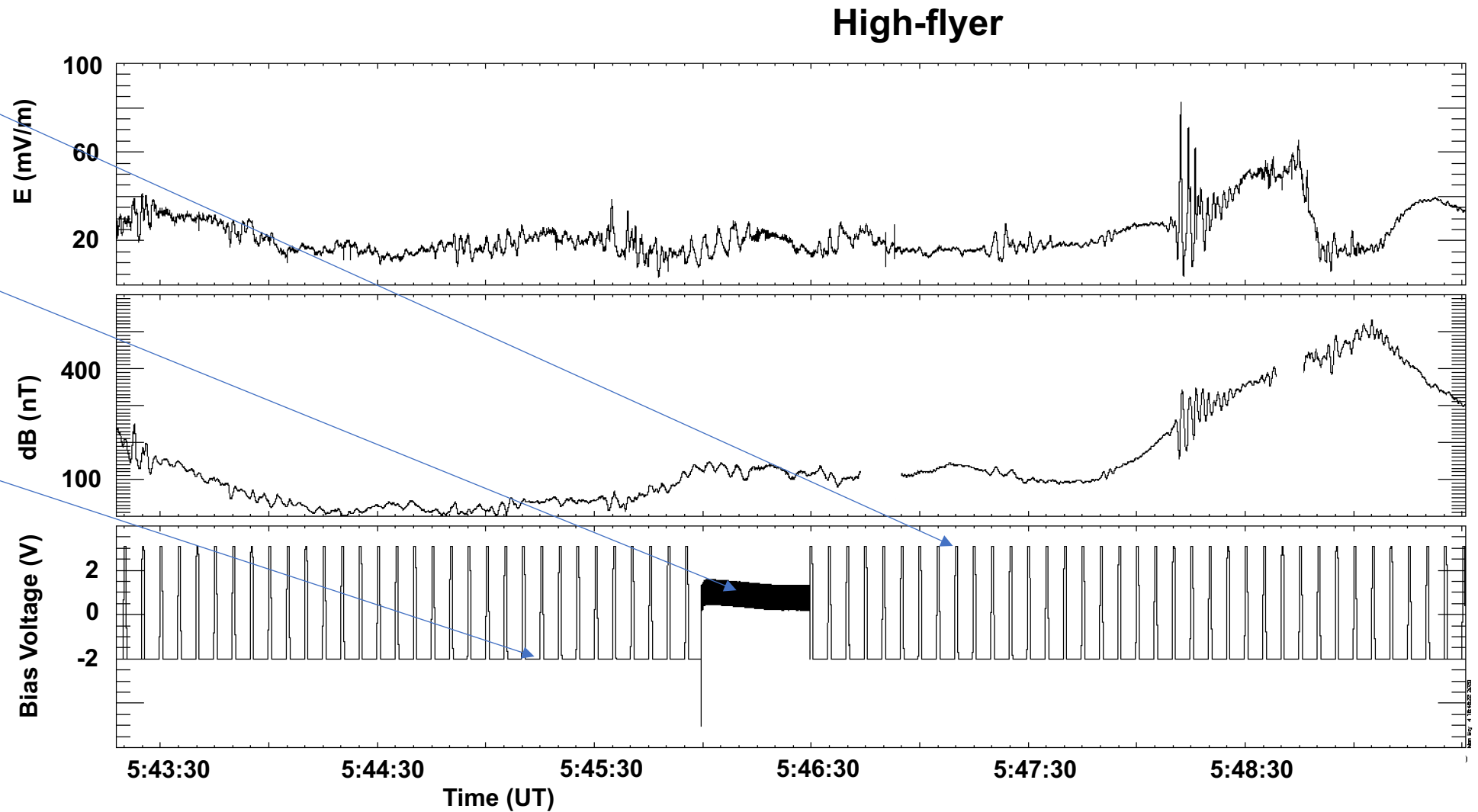
• The absence of waves on low flyer associated with intense high-flyer Alfven waves.



Plasma density from Langmuir probe

Langmuir probe measurements at the time of Alfven waves:

1. Regular voltage sweeps every 5 seconds.
2. Fast sweeps for high resolution T_e measurements.
3. Fixed-bias ion current measurement between sweeps.

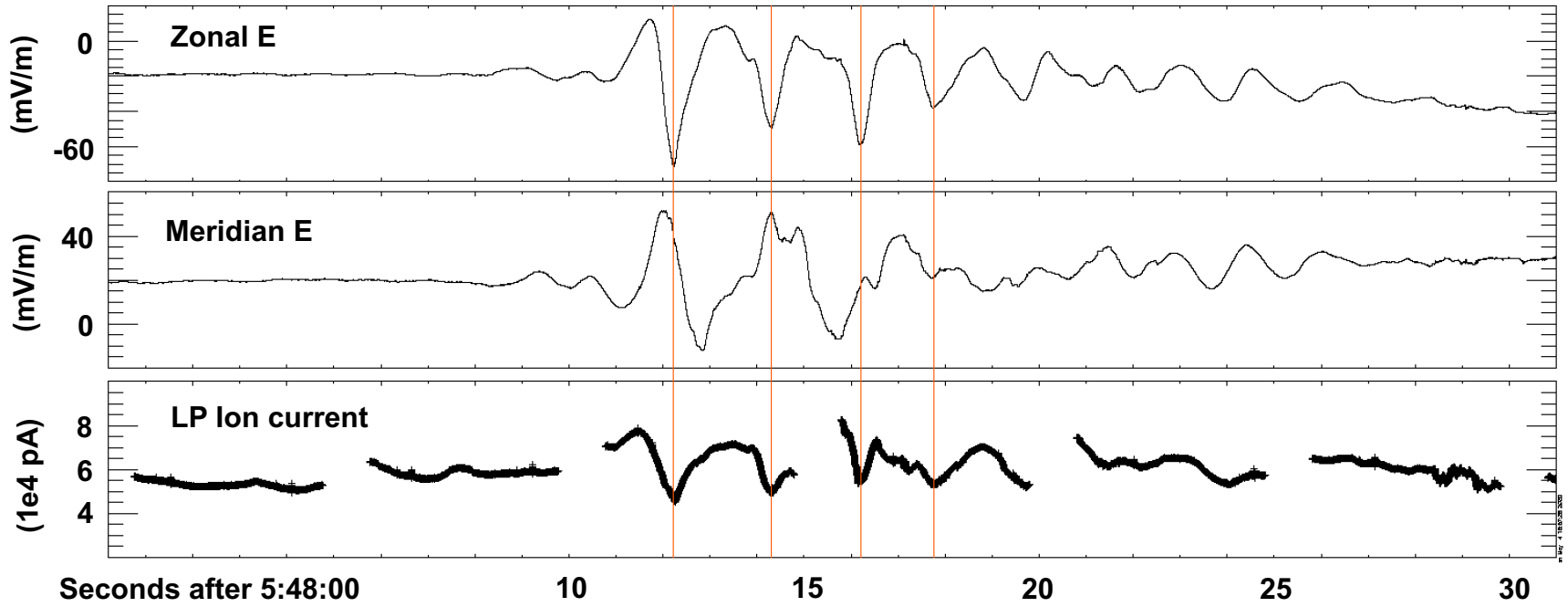


Plasma density from Langmuir probe

• Fixed bias (at -2V) ion current in-between Voltage sweeps closely follow the zonal component of the electric field---suggesting existence of **large-amplitude plasma density variations** associated with Alfven waves at the altitude of 250 km.

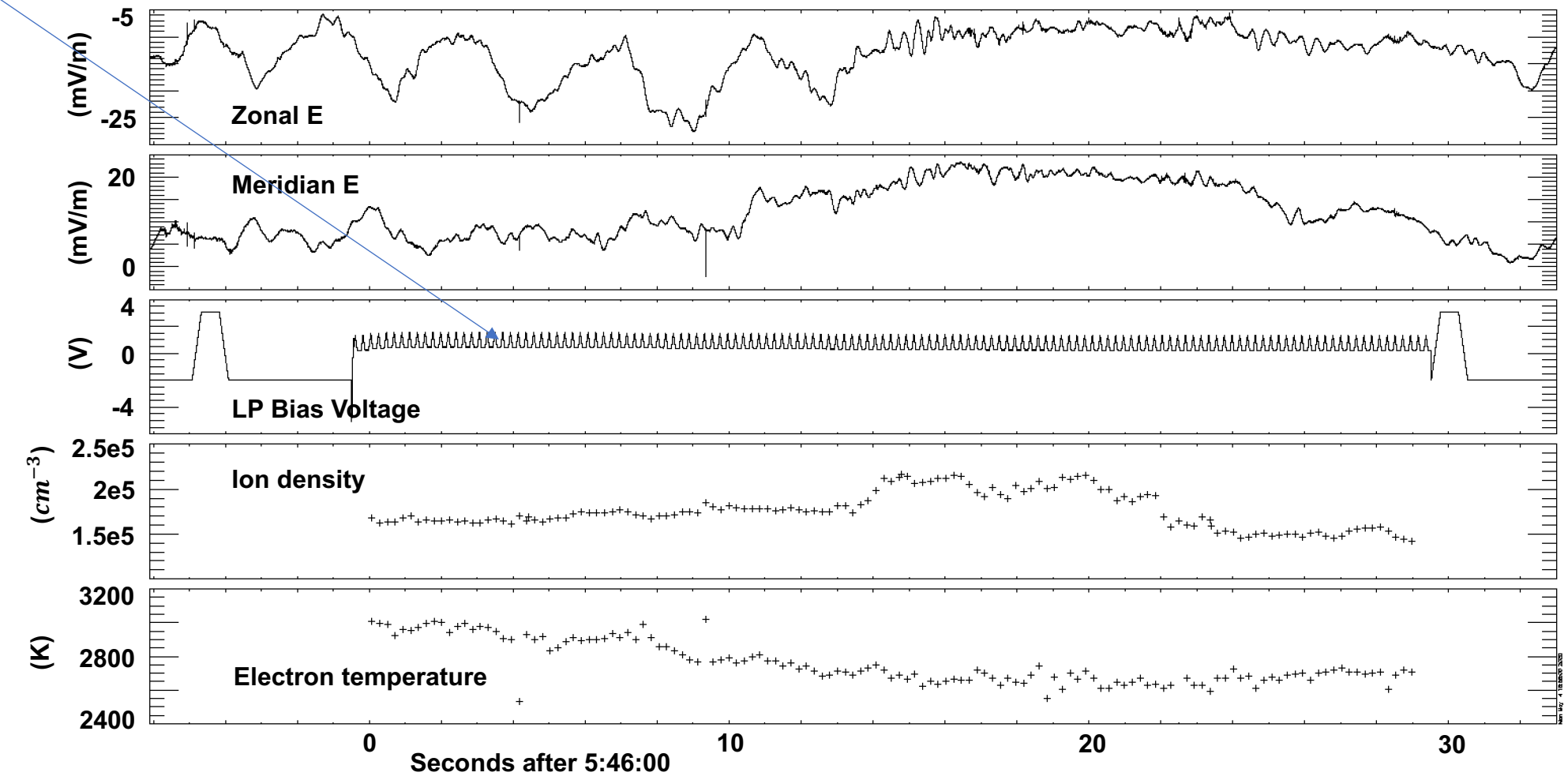
• The density variation may be associated with electron precipitation.

• Variations of ionospheric conductivity is a major component of ionospheric feedback instability that leads to generation of large-amplitude Alfven wave trapped between the ionosphere and the auroral acceleration region.



Plasma density from Langmuir probe

• High resolution ion density and electron temperature measurements from LP's fast sweeps do not show density/temperature fluctuations associated with the downward propagating Alfven waves.



Summary

• Large-amplitude (80 mV/m and 100 nT, peak-to-peak) Alfven waves were observed with two sounding rockets launched into an auroral arc. The wave activities were observed at altitudes as low as 150 km.

• Alfven waves were observed simultaneously on the same magnetic field lines at 330 and 190 km.

• The observed waves show signatures of downward propagation as well as a standing wave pattern.

• Large amplitude (factor of 2) modulation of LP's fixed bias ion current was detected associated with Alfven waves---suggesting a connection to ionospheric feedback instability.

• Whereas most auroral Alfven wave studies have focused on higher latitudes including the auroral acceleration region, the rocket data presented here demonstrates that Alfven wave energy within the low altitude auroral region (< 300 km) during the break-up of an auroral arc is both significant and complex.