

Multipoint Observations of Compressional Pc5 Pulsations in the Dayside Magnetosphere and Corresponding Particle Signatures

G. I. Korotova (IZMIRAN and UMD)

D. G. Sibeck (NASA/GSFC)

Van Allen Probes team

Outline

- We study the spatial, temporal, and spectral characteristics of compressional Pc5 pulsations observed deep within the magnetosphere during the recovery phase of the strong magnetic storm which began on December 31, 2015.
- We investigate the mode of the waves and their nodal structure.
- We focus on the properties of double frequency pulsations that occurred in the vicinity of the geomagnetic equator.
- We study the particle response to the compressional Pc5 pulsations
- We search for possible solar wind triggers and test two possible generation mechanisms: drift-bounce resonance, and mirror instability..

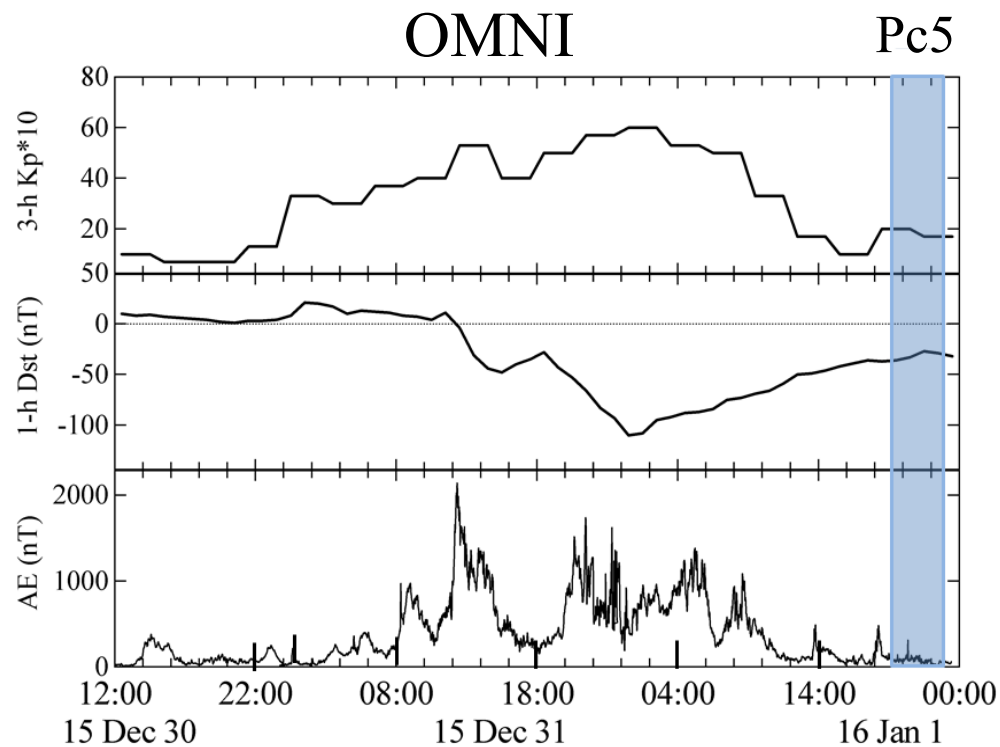
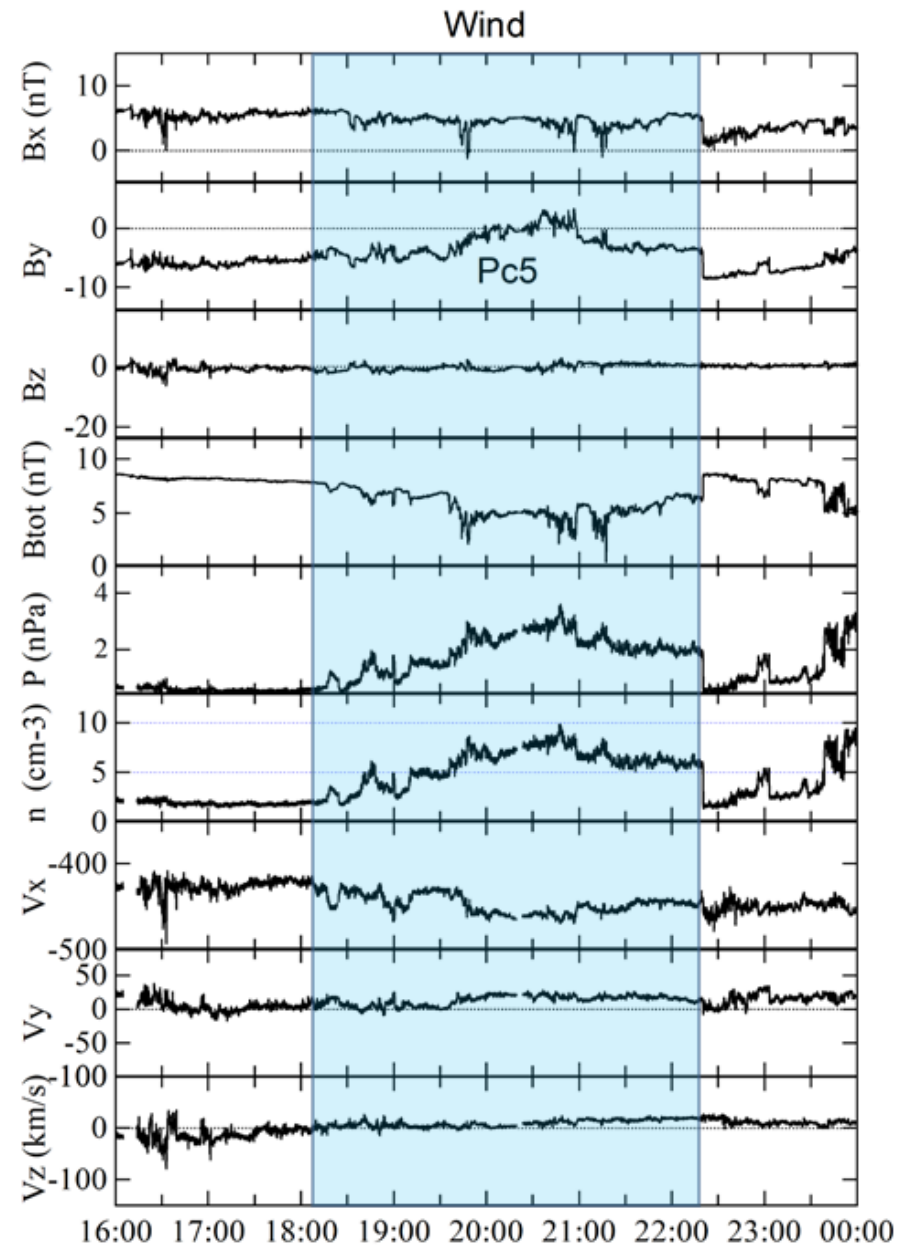


Figure 1. Geomagnetic activity indices Dst, Kp and AE indices from 12:00 UT on December 30 to 24:00 UT January 1, 2016.

Figure 2. Wind observations of the magnetic field and plasma from 16:00 UT to 24:00 UT on January 1, 2016. Shading highlights the interval of interest.



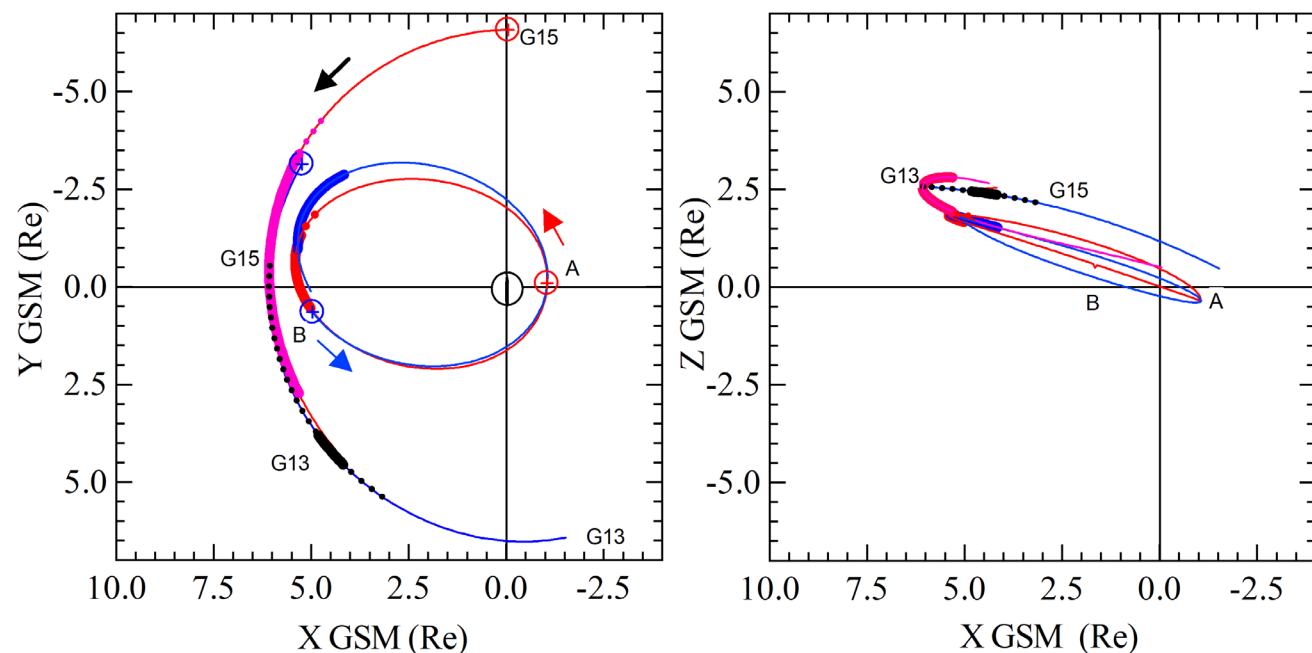


Figure 3. Trajectories of Van Allen Probes A (red) and B (blue) and GOES-13 (blue) and 15 (red) from 15:00 UT to 24:00 UT in the X-Y and X-Z GSM planes. The thick line segments (dots) indicate the locations of the spacecraft at the times when compressional (weak) Pc5 magnetic field pulsations occurred.

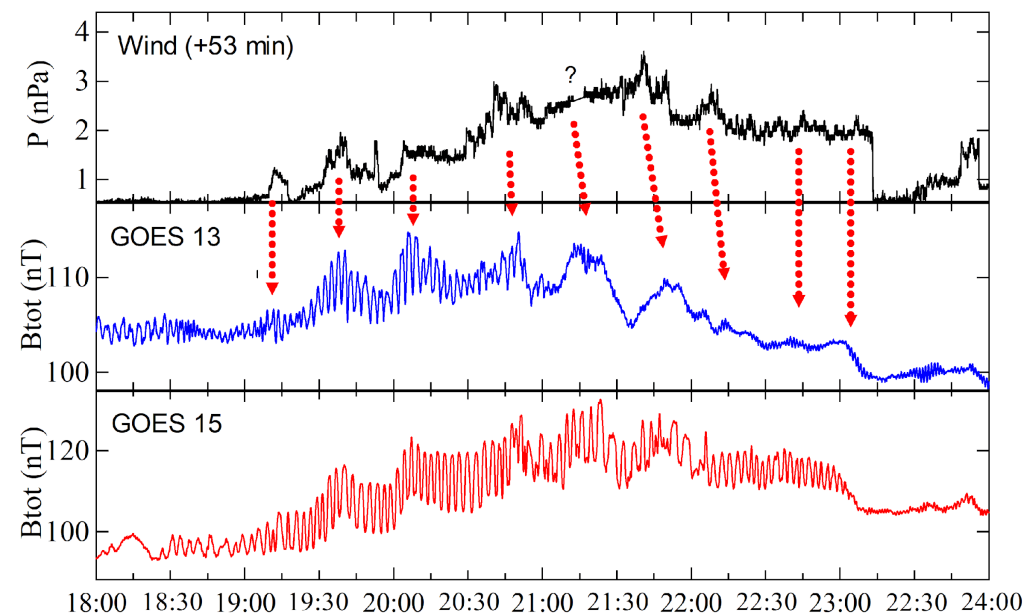


Figure 4. Observations of the solar wind dynamic pressure at Wind (time shifted) and B_{tot} at GOES-13 and -15. The arrows connect enhancements of the dynamic pressure to corresponding compressions of the magnetosphere.

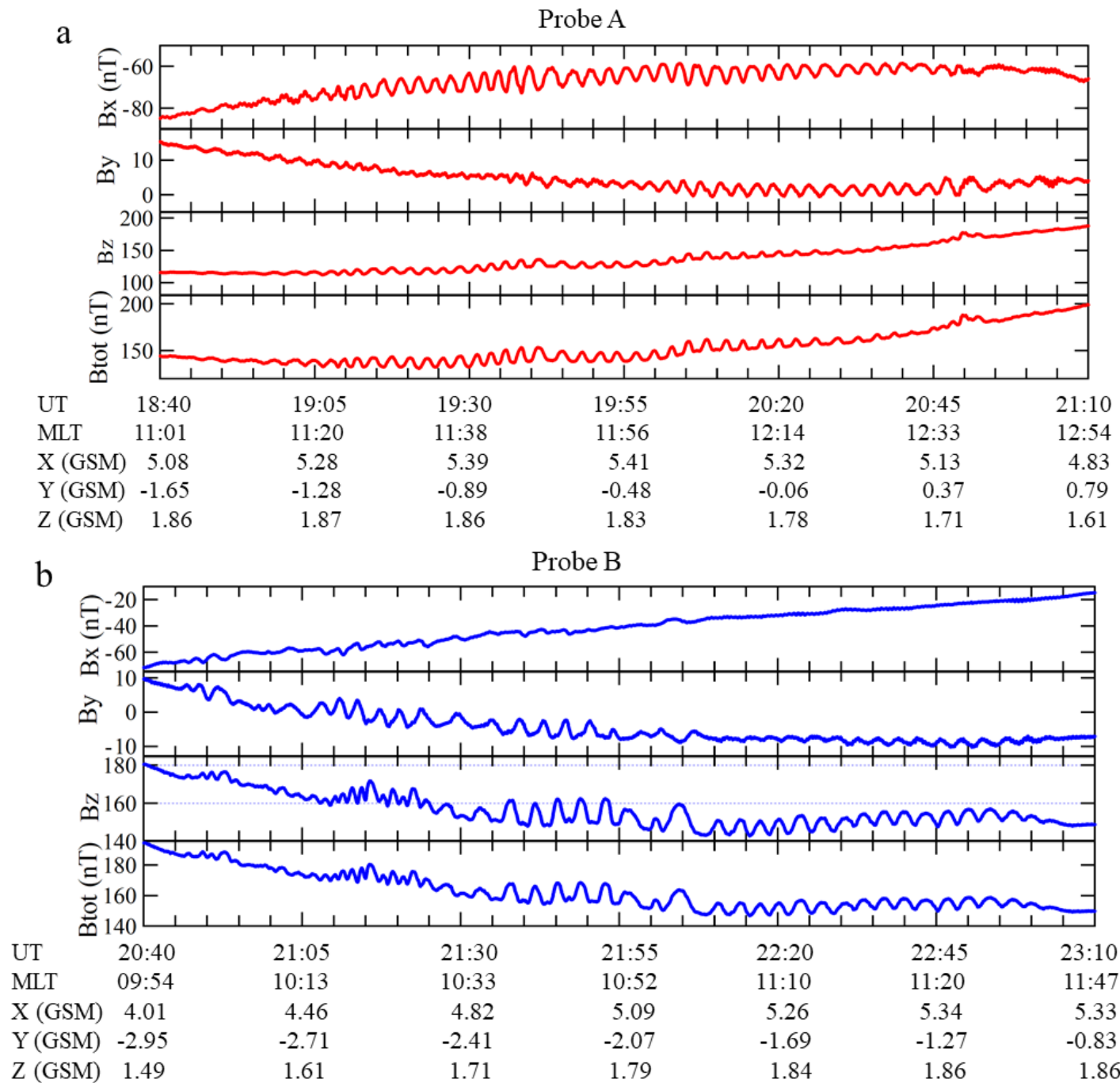
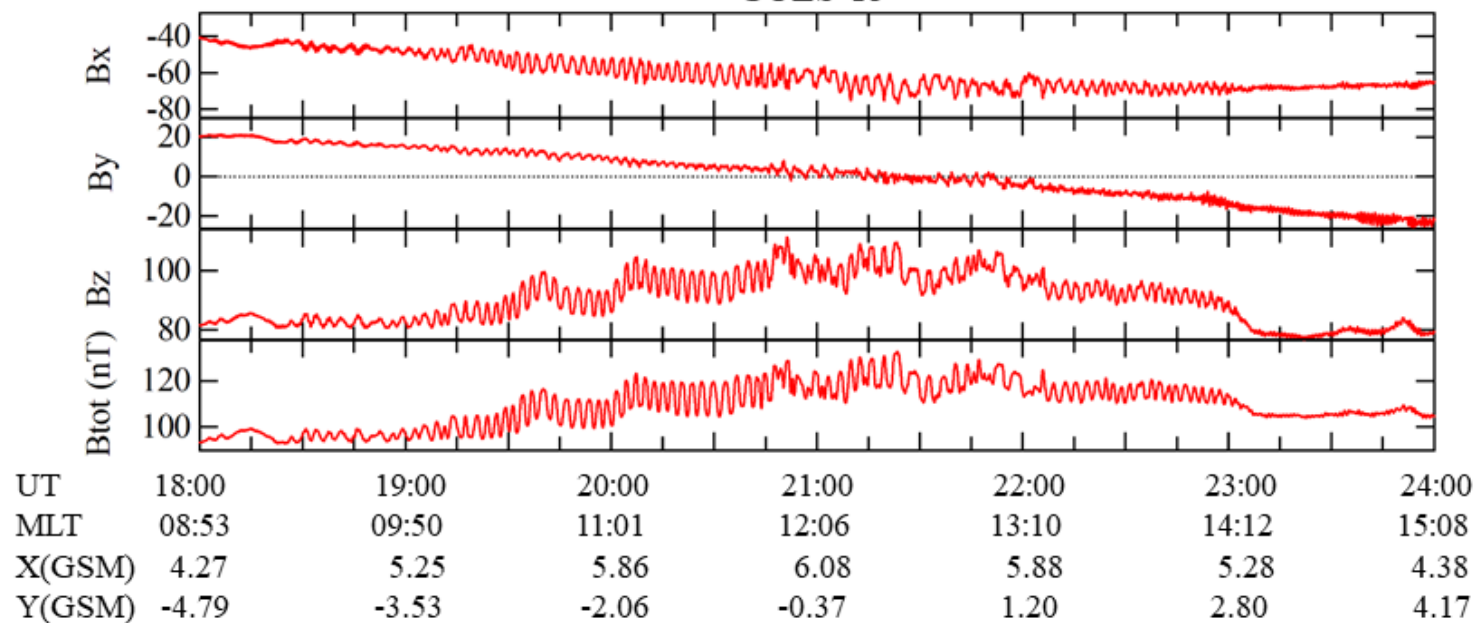


Figure 5. Van Allen Probes A (a) and B (b) magnetic field observations in GSM coordinates from 18:40 UT to 21:10 UT and from 20:40 UT to 23:10 UT on January 1, 2016, respectively.

GOES 15



GOES 13

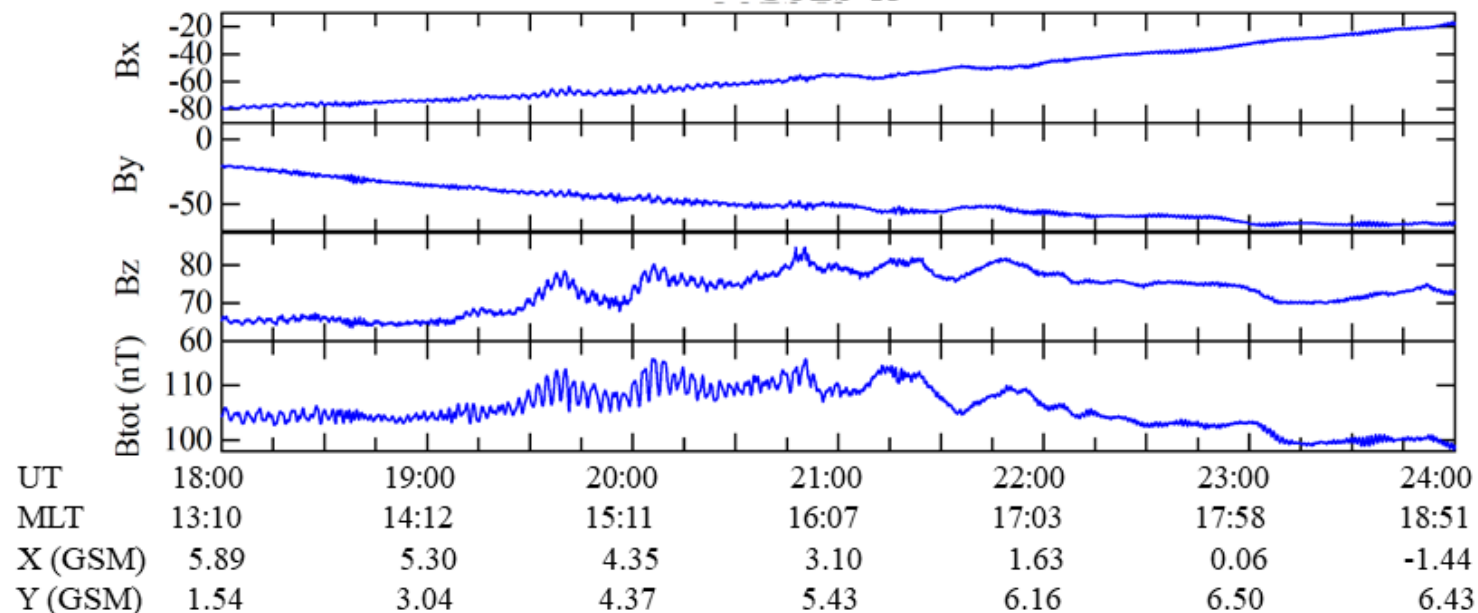


Figure 6. GOES-13 and -15 observations of the magnetic field in GSM coordinates from 18:00 UT to 24:00 UT on January 1, 2016.

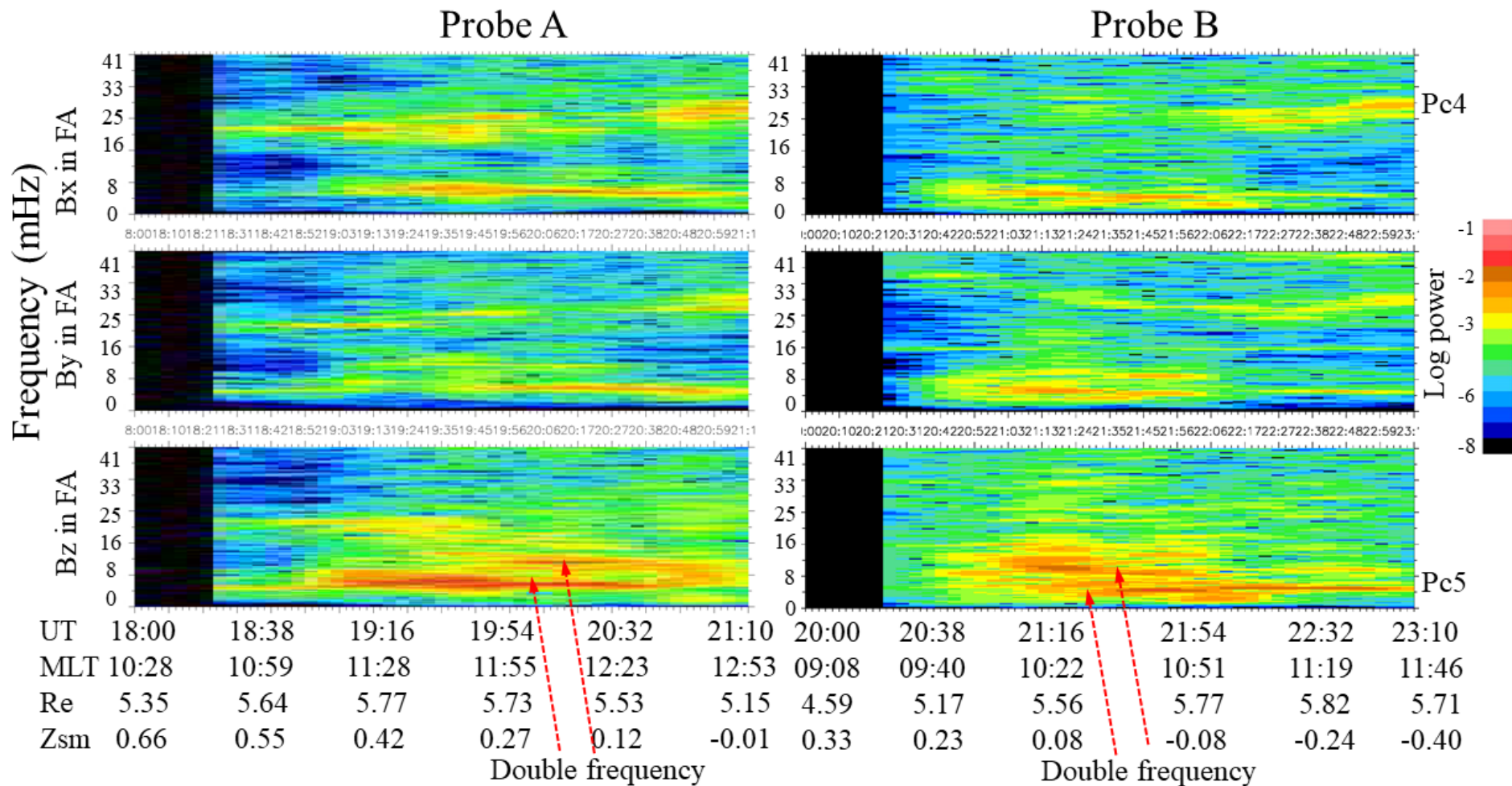


Figure 7. Three component dynamic spectra of magnetic field data at Van Allen Probes A and B from 18:00 UT to 20:45 UT and from 21:10 UT to 23:10 UT on January 1, 2016, respectively. The strongest spectral density occurs in the compressional component (Bz) expected for the compressional Pc5.

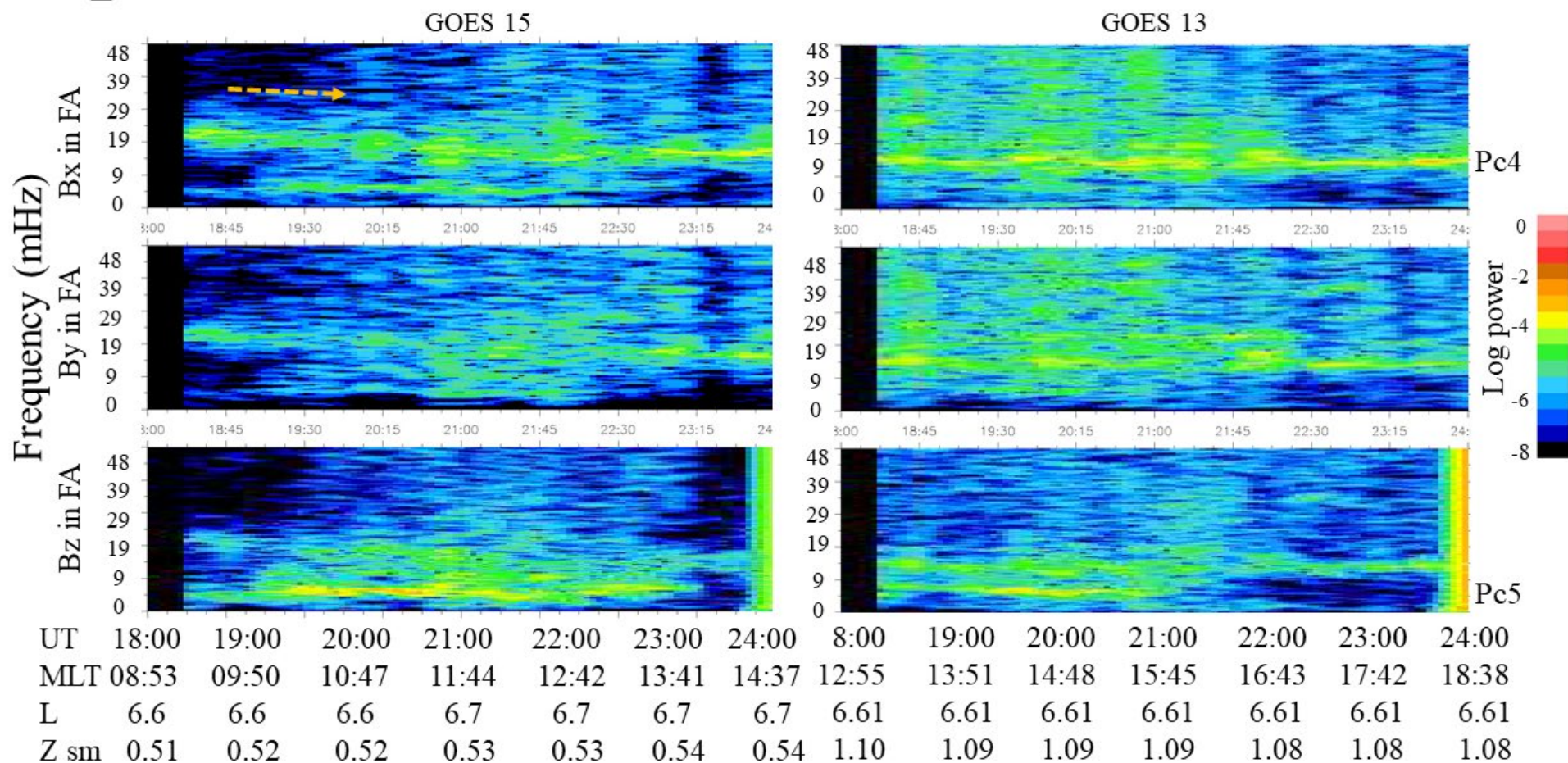


Figure 8. Three components of dynamic spectra of the magnetic field data at GOES-15 and GOES-13 from 18:00 UT to 24:00 UT on January 1, 2016.

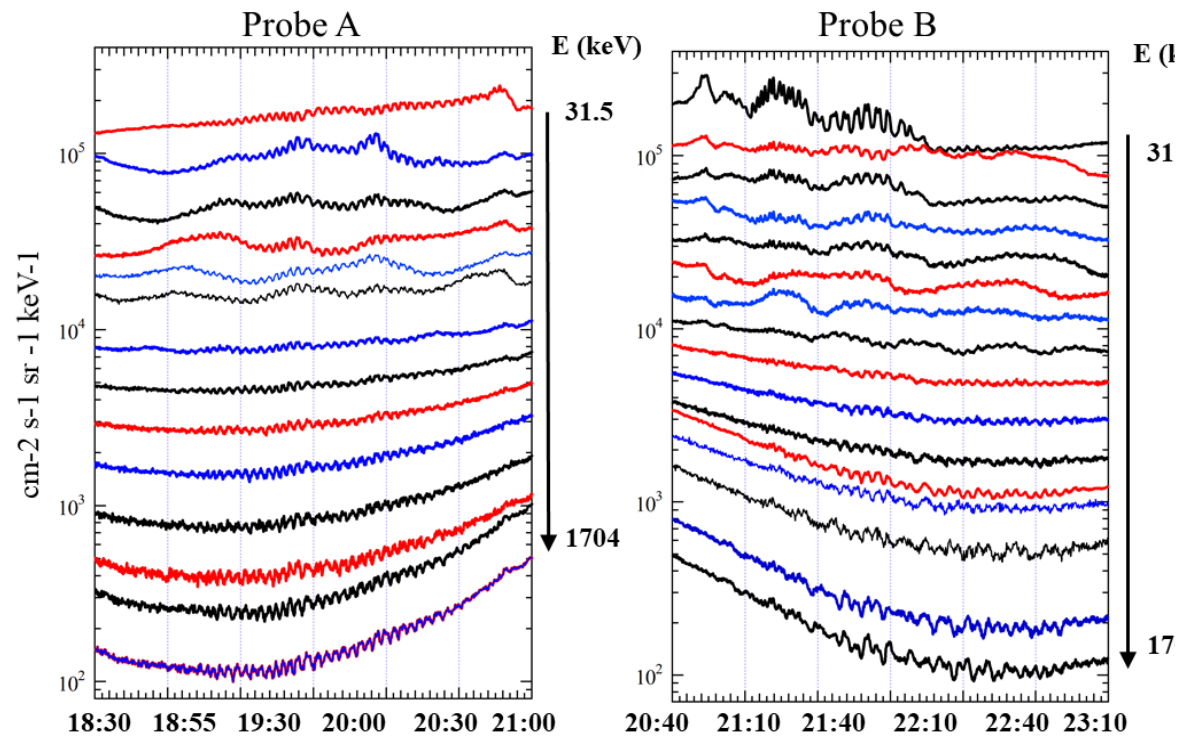


Figure 9. Van Allen Probes A and B observations of e fluxes in the range of energies from 31.5 keV to 1704 keV from 18:30 UT to 21:00 UT and from 20:40 UT to 23:10 UT, respectively.

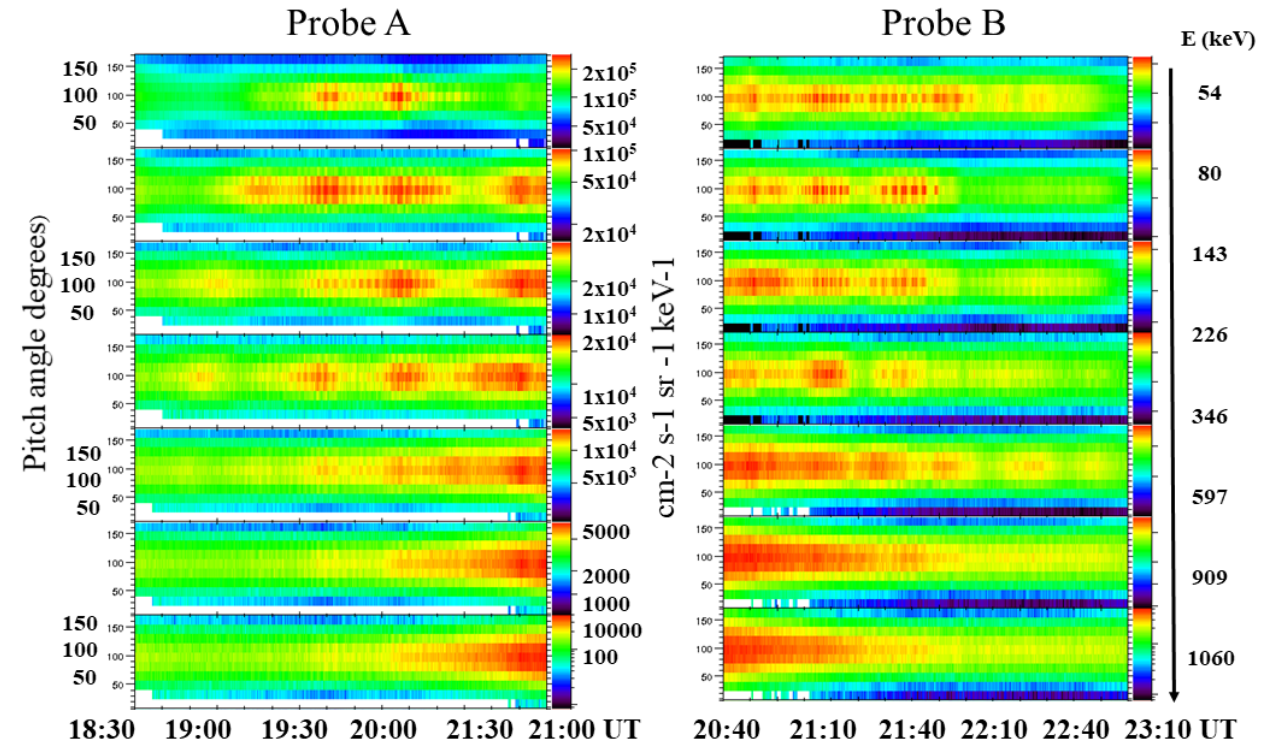


Figure 10 (right panel). Van Allen Probes A and B observations of pitch angle distributions for electrons in the range of energies from 54 keV to and 1060 keV.

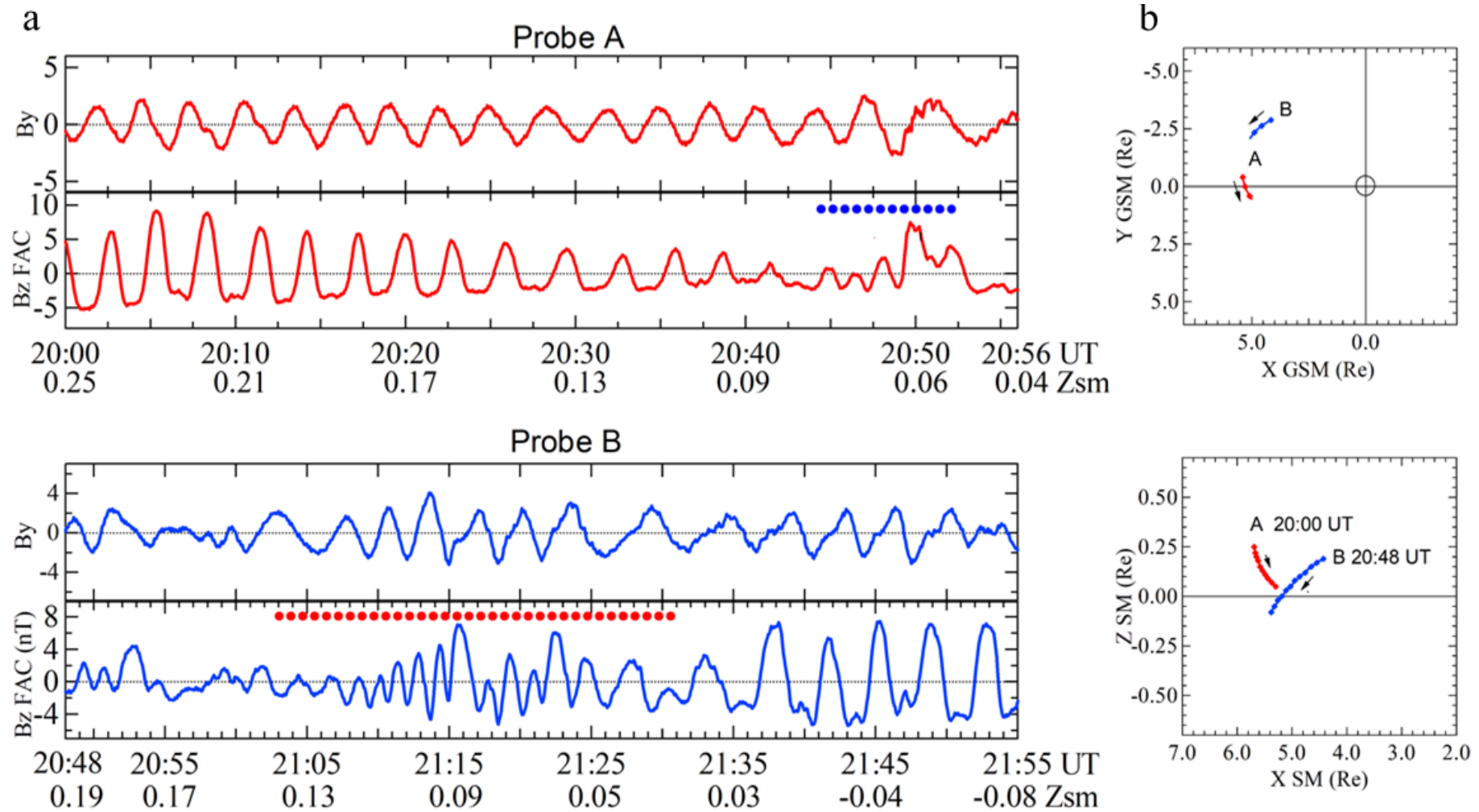


Figure 11. Van Allen Probes A and B observations of double frequency pulsations (a) from 20:00 UT to 20:56 UT and from 20:48 UT to 21:55 UT, respectively, and (b) their locations in the X - Y GSM and X - Z SM planes.

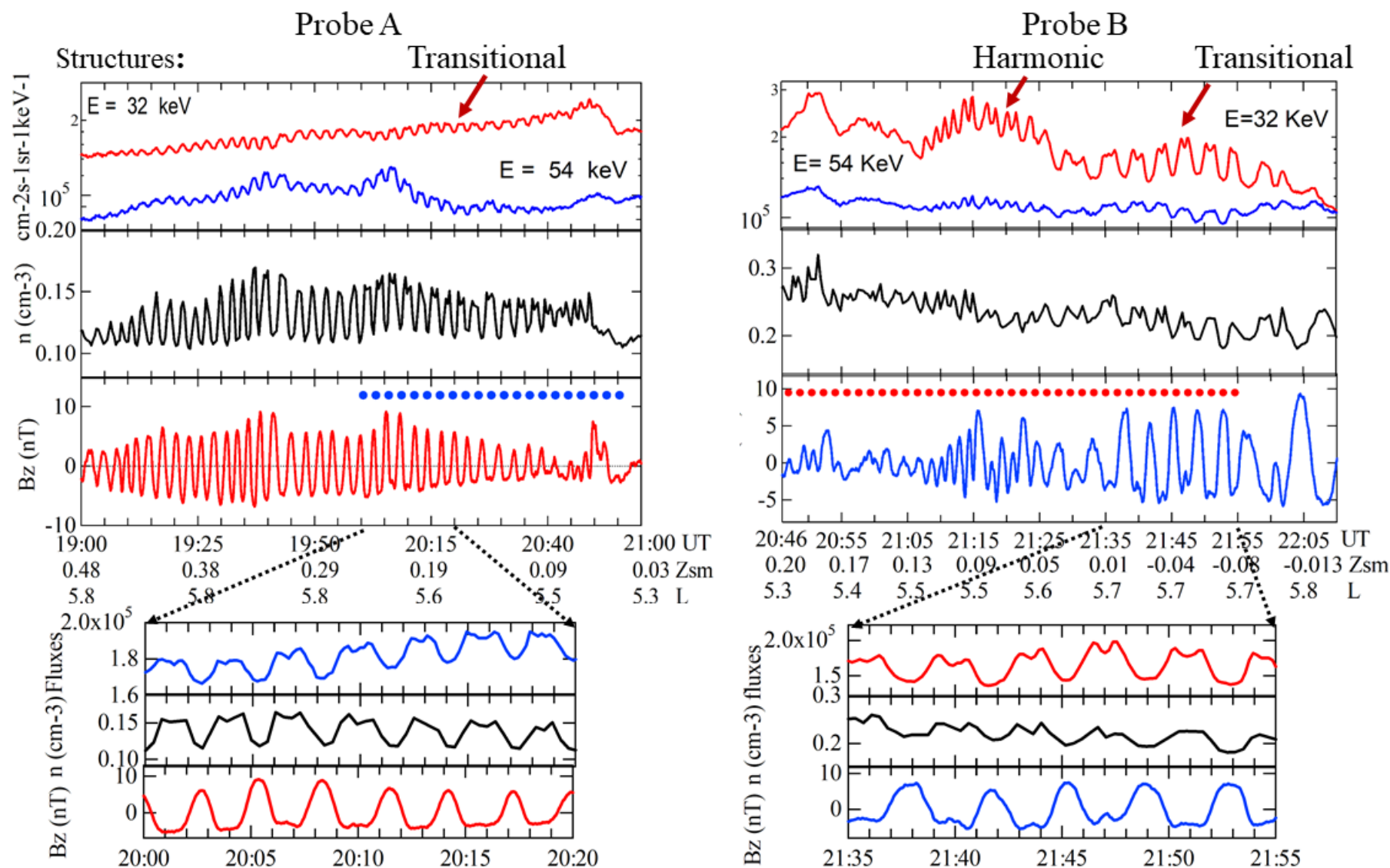
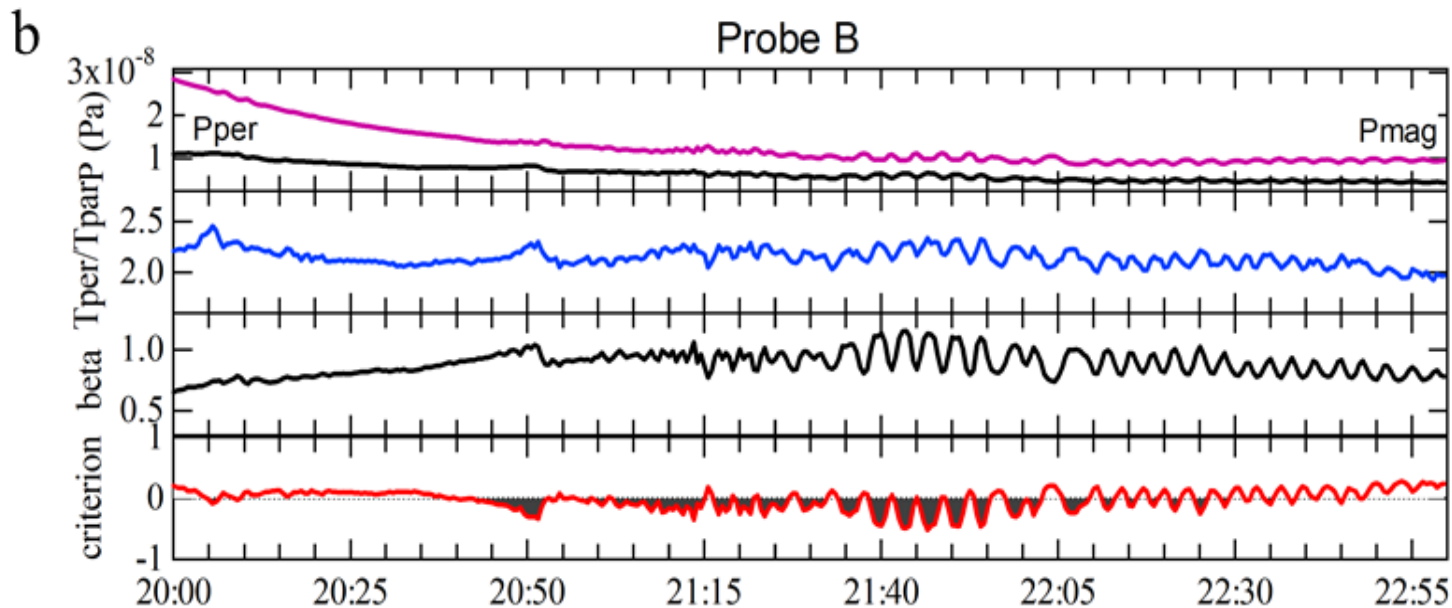
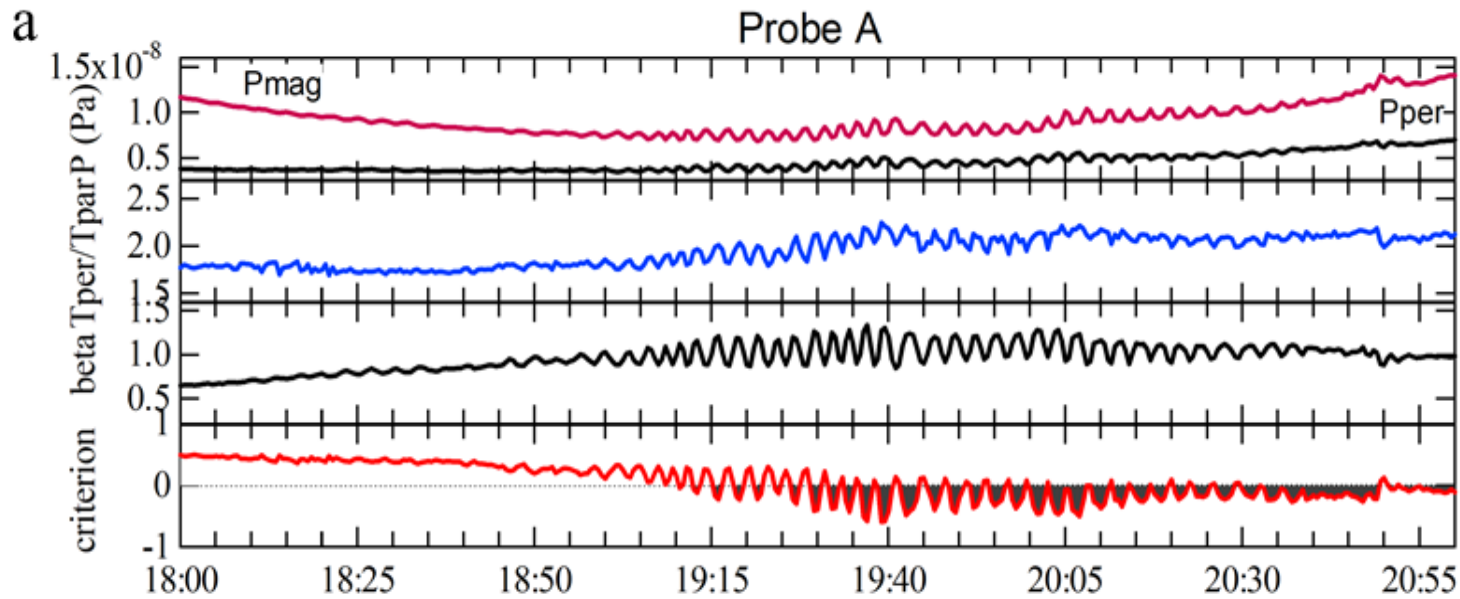


Figure 12. Van Allen Probes A (left panel) and B (right panel) presents electron fluxes for energies at 31.9 keV and 54.8 keV from EMFISIS, electron densities from HOPE and the B_z component of the magnetic field.



Figures 13a and b Van Allen Probes A and B plasma and magnetic field parameters. characterizing the pulsations. The figure shows the Pmag, Pplasma_per, Tper/Tpar, beta, and the results for the mirror instability criterion on January 1, 2016. Shaded grey areas indicate the times when the drift mirror instability is satisfied (< 1).

Conclusions

- During the recovery phase of a strong magnetic storm Van Allen Probes and Goes -13 and -15 observed compressional Pc 5 pulsations over a large longitudinal extent.
- From 19:00 UT to 23:02 UT, successive magnetospheric compressions enhanced the peak-to-peak amplitudes of Pc5 waves with 4.5-6.0 mHz frequencies from 0-2 to 10-15 nT at both Van Allen Probes A and B, particularly in the prenoon magnetosphere.
- Poloidal Pc4 pulsations with frequencies of ~22-29 mHz were present in the radial Bx component. The frequencies of these Pc4 pulsations diminished with increasing radial distance, as expected for resonant Alfvén waves standing along field lines.
- The GOES spacecraft observed Pc5 pulsations with similar frequencies to those seen by the Van Allen Probes, but Pc4 pulsations with lower frequencies.

Conclusions

- Since the frequencies of the Pc4 pulsations depended on local time and radial distance from Earth, their sources must be more localized than those for the Pc5 pulsations.
- We report the first evidence for meridional sloshing of the equatorial node in the double-frequency variations of electrons fluxes and electron density observed by MagEIS and HOPE, respectively. We found that the amplitude of this meridional oscillation was ~ 0.16 Re about an equatorial node whose mean position was near $Z_{SM} = \sim 0.08$ Re.
- The energetic electrons oscillated out of phase with the magnetic field and did not display any phase shift across all energies.
- We interpret the compressional Pc5 waves in terms of drift-mirror instability.