Variability of amplitudes, polarization and propagation of whistler-mode chorus emissions measured by the Cluster and Double Star spacecraft.

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Outline

1. Summary of recent Cluster and DSP results
2. Chorus observations on Cluster, relation to fluxes of energetic particles
3. Variability of position and size of the chorus source region and wave polarization from accumulated observations from Cluster 2001-2005
4. Variability of position of the chorus source from accumulated observations from Double Star 2004-2005 related to the geomagnetic activity

Summary of recent Cluster and DSP results 1 →

1. Structure of chorus wave packets

Santolik et al., J. Geophys. Res., 108(A7), 10.1029/2002JA009791, 2003

Santolik et al., Geophys. Res. Lett. 31, 10.1029/2003GL018757, 2004

- Duration: 1 ms (~3 wave periods) to ~40 ms, with decreasing occurrence rate
- Growth rate: 30 – 400 s^{-1}
- Amplitudes: 30 mV/m or 300 nT, maximum amplitudes are inside the chorus wave packets

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→ Summary of recent Cluster and DSP results 2 →

2. Position and size of the chorus source region

Santolik and Gurnett, Geophys. Res Lett 30, 10.1029/2002GL016178, 2003

Parrot et al., Ann. Geophys. 21, 473, 2003

Santolik et al., Geophys. Res. Lett. 31, 10.1029/2003GL018757, 2004

Santolik et al., Ann. Geophys. 22, 2555, 2004

Santolik et al., Planet. Space Sci. 53, 299, 2005

- Central position of the source region from multipoint measurement of the Poynting flux is located close to the geomagnetic equatorial plane, fluctuating with amplitude of ~3,000 km and at speeds of the order of 100 km/s.
- Size of the source region along the field line from multipoint measurement of electromagnetic planarity is 3000–5000 km.
- Size of the source region perpendicular to the field line from multipoint correlation analysis of chorus elements can be as low as a few tens of km.

→ Summary of recent Cluster and DSP results 3

3. Propagation of chorus from its source region

Parrot et al., Ann. Geophys. 21, 1111, 2003

Parrot et al., Ann. Geophys. 22, 2597, 2004

Chum and Santolik, Ann.Geophys. 23, 3727, 2005

Santolik at al., JGR, in press, 2006.

- Chorus can magnetospherically reflect and return back to the equatorial plane at lower L (with a lower frequency than locally generated chorus)
- Chorus can propagate to low altitudes and to the ground in an unducted mode

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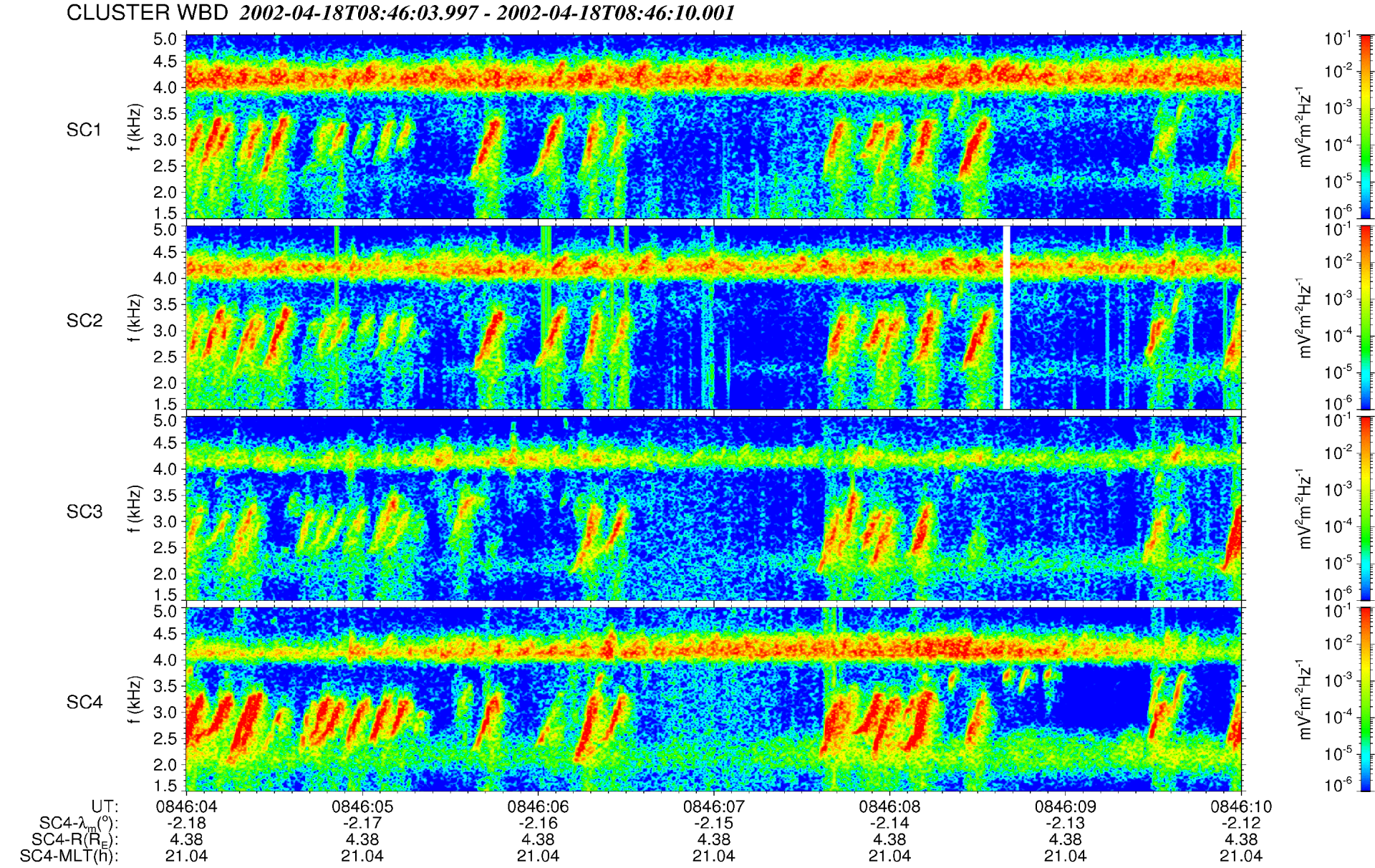


Power spectrogram of the electric field fluctuations. **(WBD)**

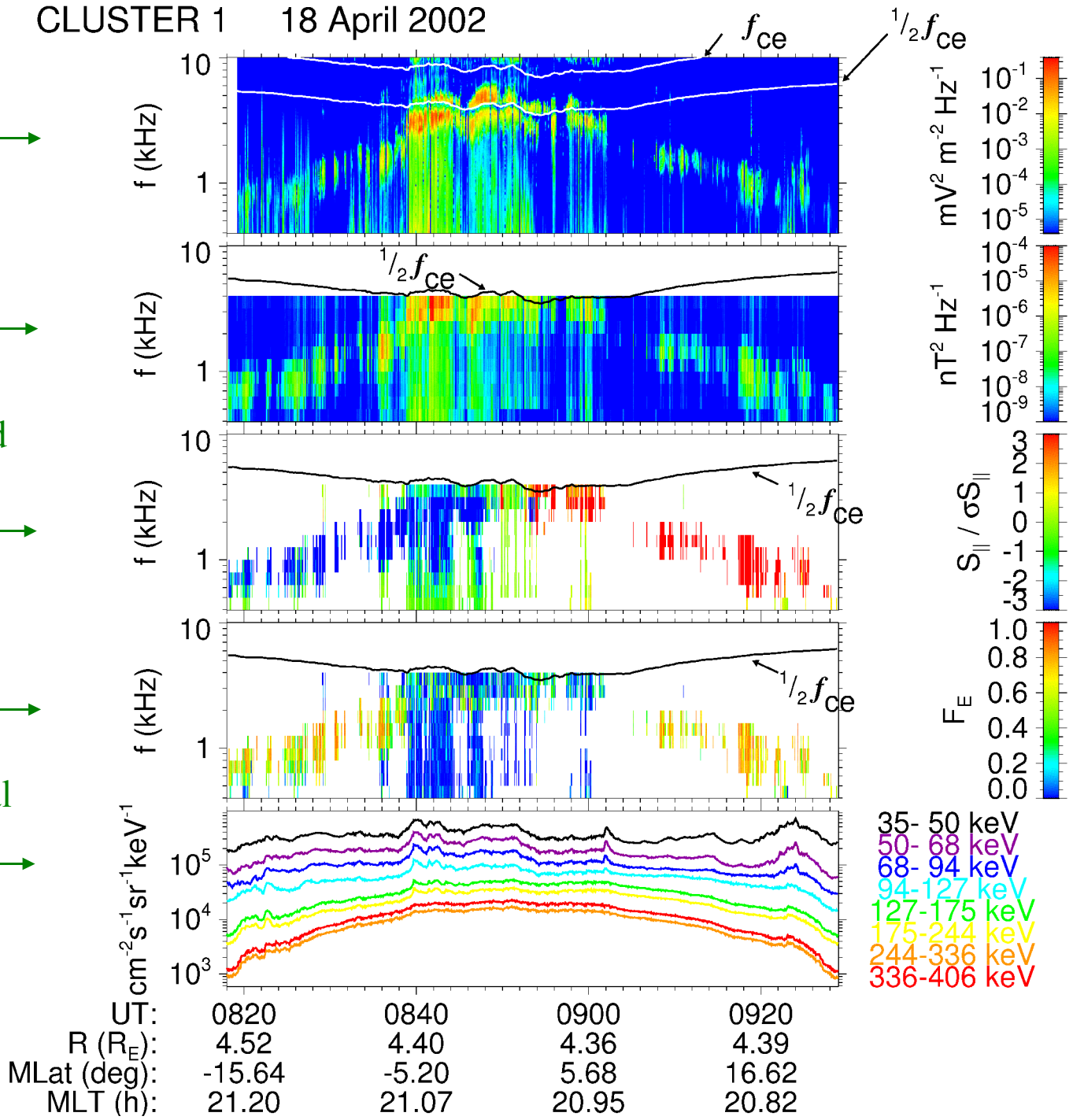
Power spectrogram of the magnetic field fluctuations. **(STAFF-SA)**

Parallel component of the Poynting vector normalized by its standard deviation. **(STAFF-SA)**

Electromagnetic planarity. **(STAFF-SA)**

Omnidirectional differential flux. **(RAPID)**

Kp: 7°, 7-, 6-
Dst: -126, -116 nT
AE: ~500-1100 nT
PLASMA DENSITY~2/cc



Power spectrogram of the electric field fluctuations.

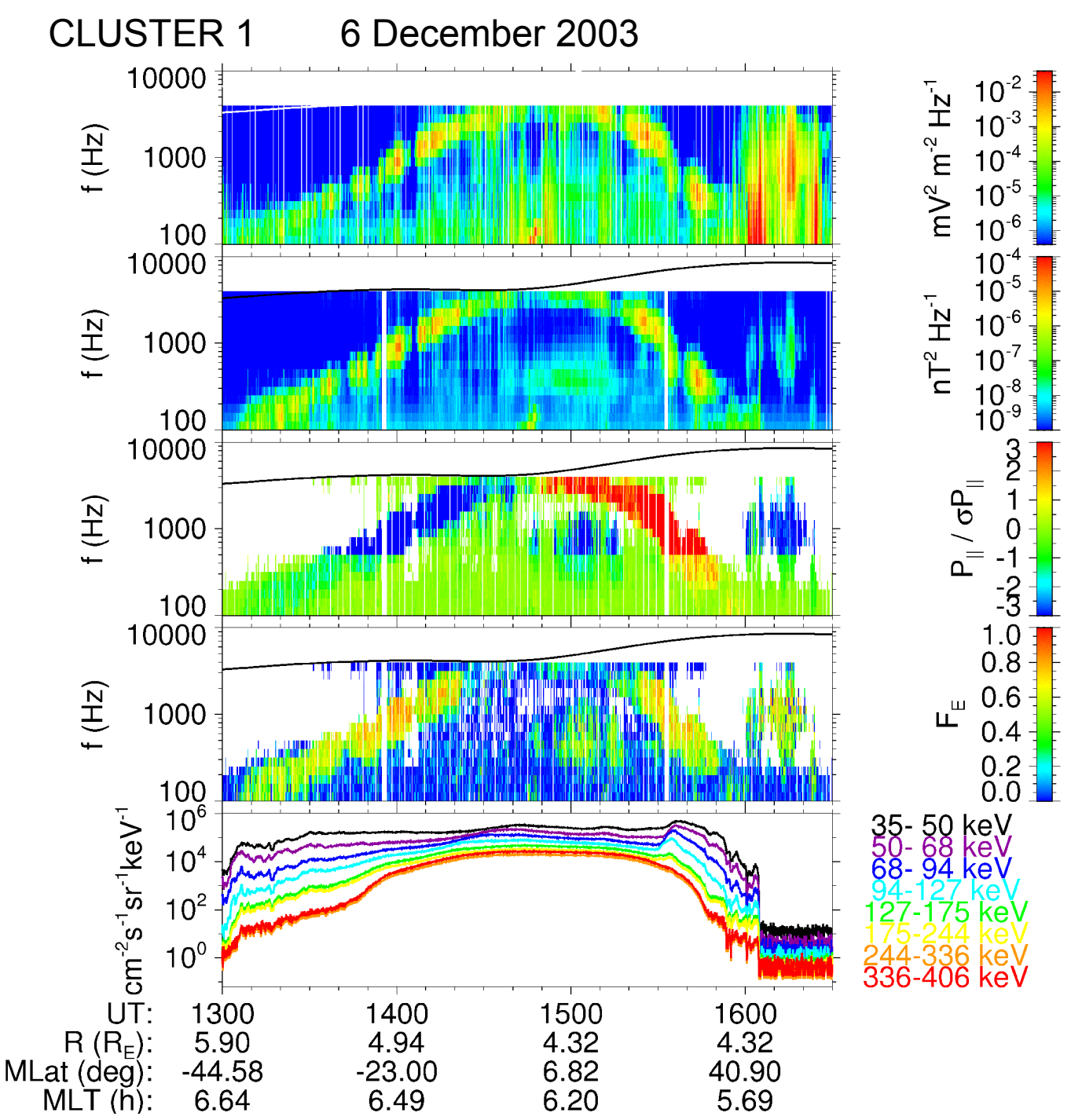
Power spectrogram of the magnetic field fluctuations. **(STAFF-SA)**

Parallel component of the Poynting vector normalized by its standard deviation. **(STAFF-SA)**

Electromagnetic planarity. **(STAFF-SA)**

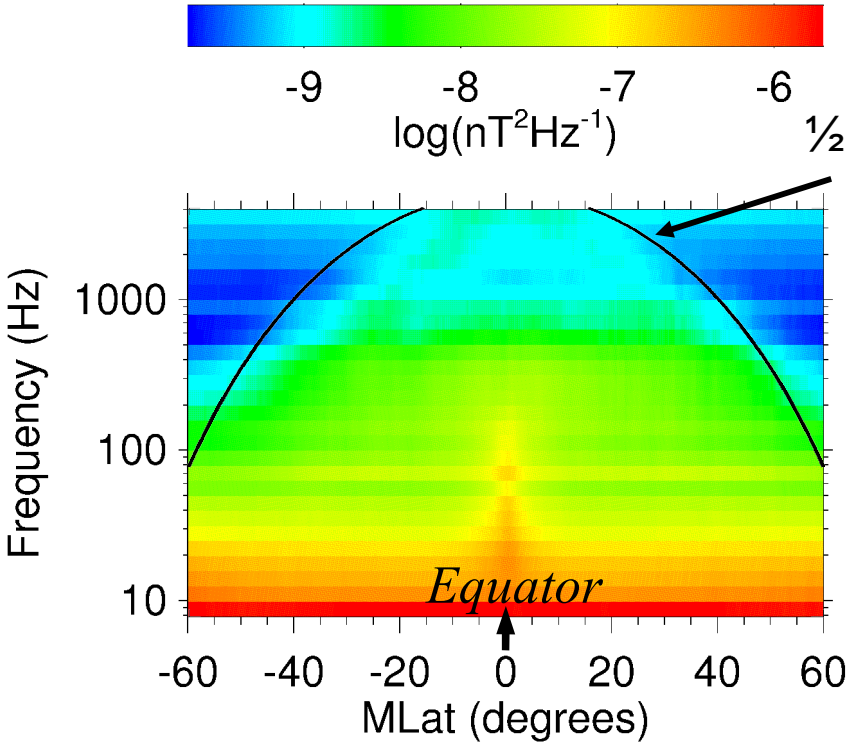
Omnidirectional differentia flux. **(RAPID)**

Kp: 4-, 3°
Dst: -45 nT
AE: ~300 nT
PLASMA DENSITY~10/cc



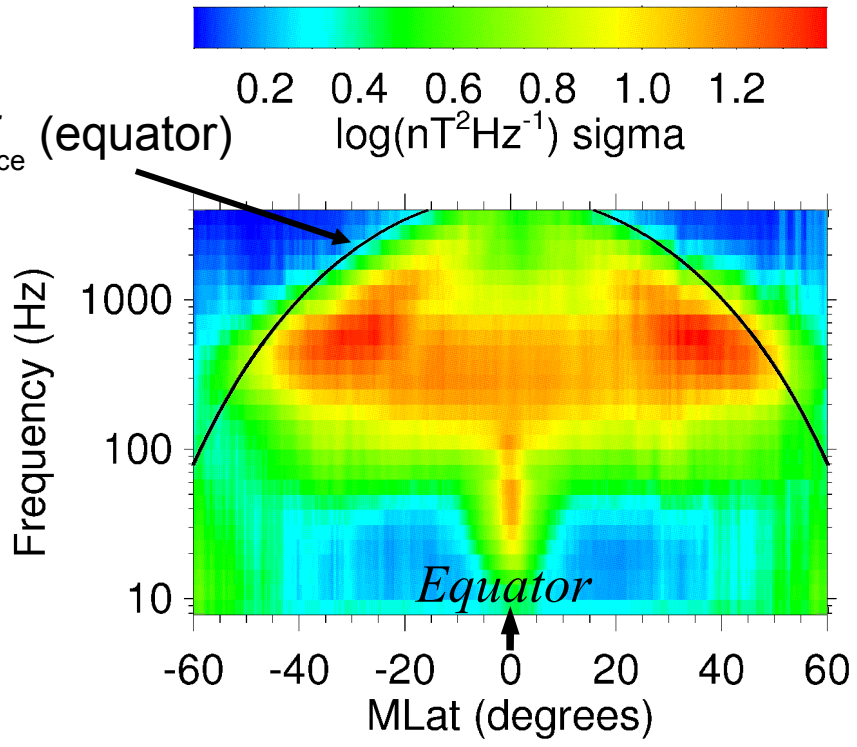
Average latitude-frequency spectrograms

Accumulated STAFF-SA observations 2001-2005



Power-spectral density of **magnetic** field fluctuations

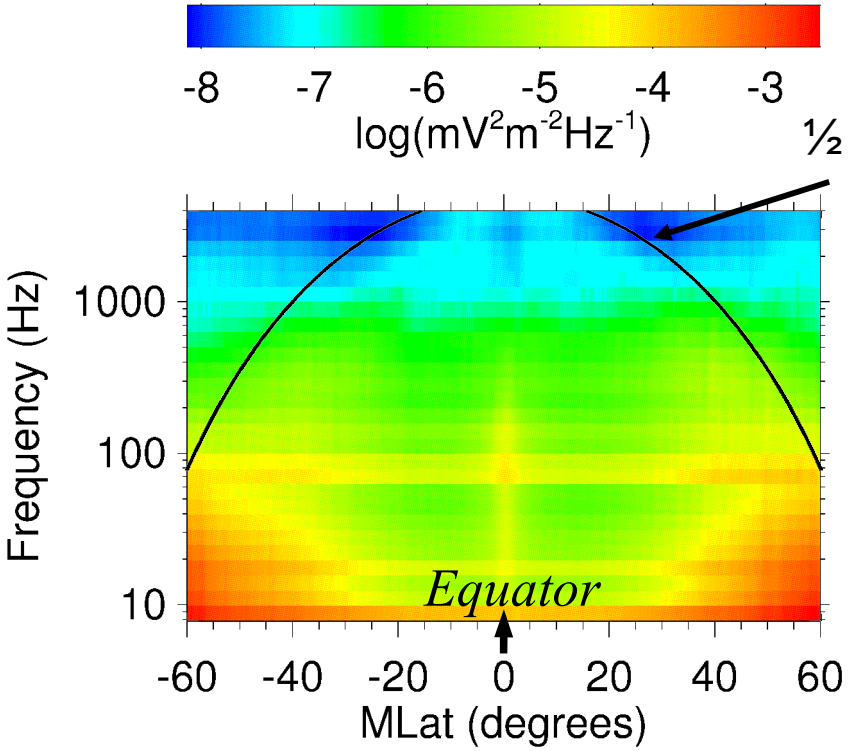
Average of data recorded along the 2001-2005 Cluster orbits close to the perigee



Standard deviation of data recorded along the Cluster orbits close to the perigee

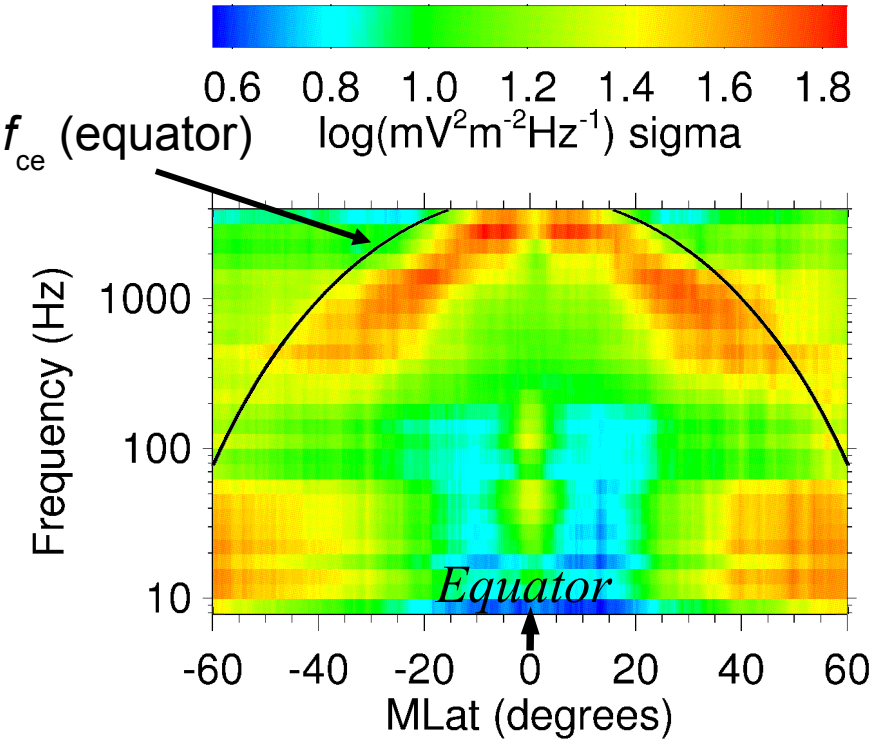
Average latitude-frequency spectrograms

Accumulated STAFF-SA observations 2001-2005



Power-spectral density of **electric** field fluctuations

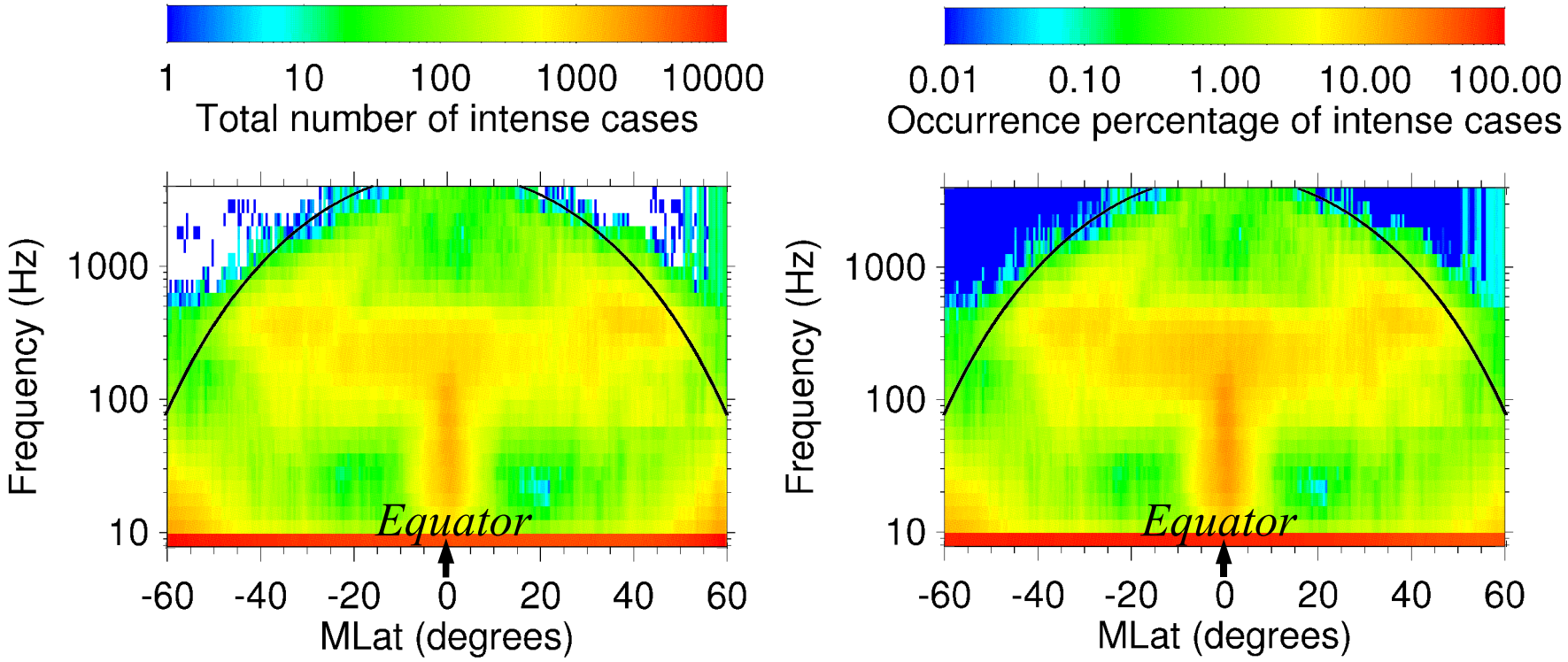
Average of data recorded along the 2001-2005 Cluster orbits close to the perigee



Standard deviation of data recorded along the Cluster orbits close to the perigee

Average latitude-frequency spectrograms

Accumulated STAFF-SA observations 2001-2005

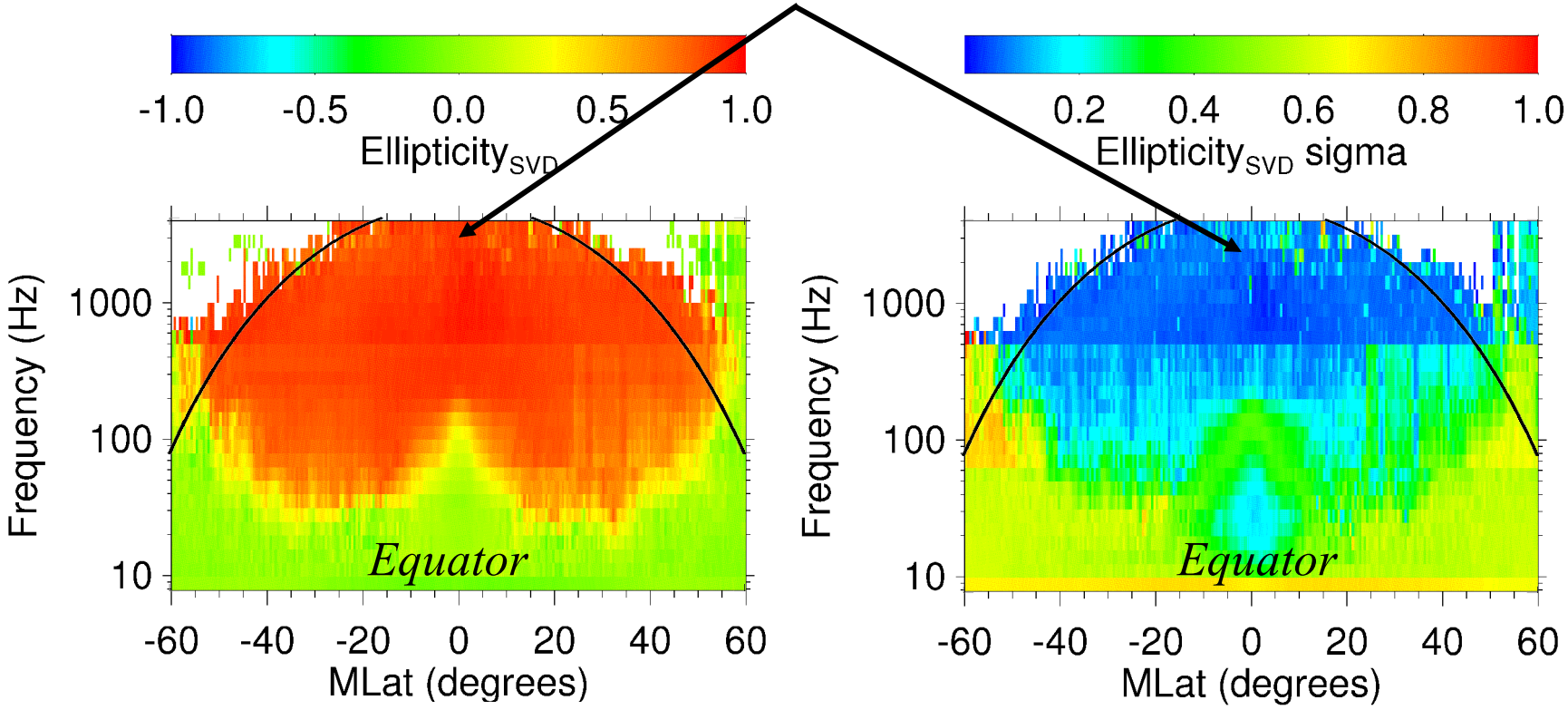


Total number and occurrence rate of intense cases when the power spectral density of magnetic field fluctuations exceeds 10^{-6} nT^2 Hz^{-1}

Average latitude-frequency spectrograms

Accumulated STAFF-SA observations 2001-2005

Highly elliptical or circular (right-hand) polarization



Ellipticity of polarization from the singular value decomposition of the magnetic spectral matrix.

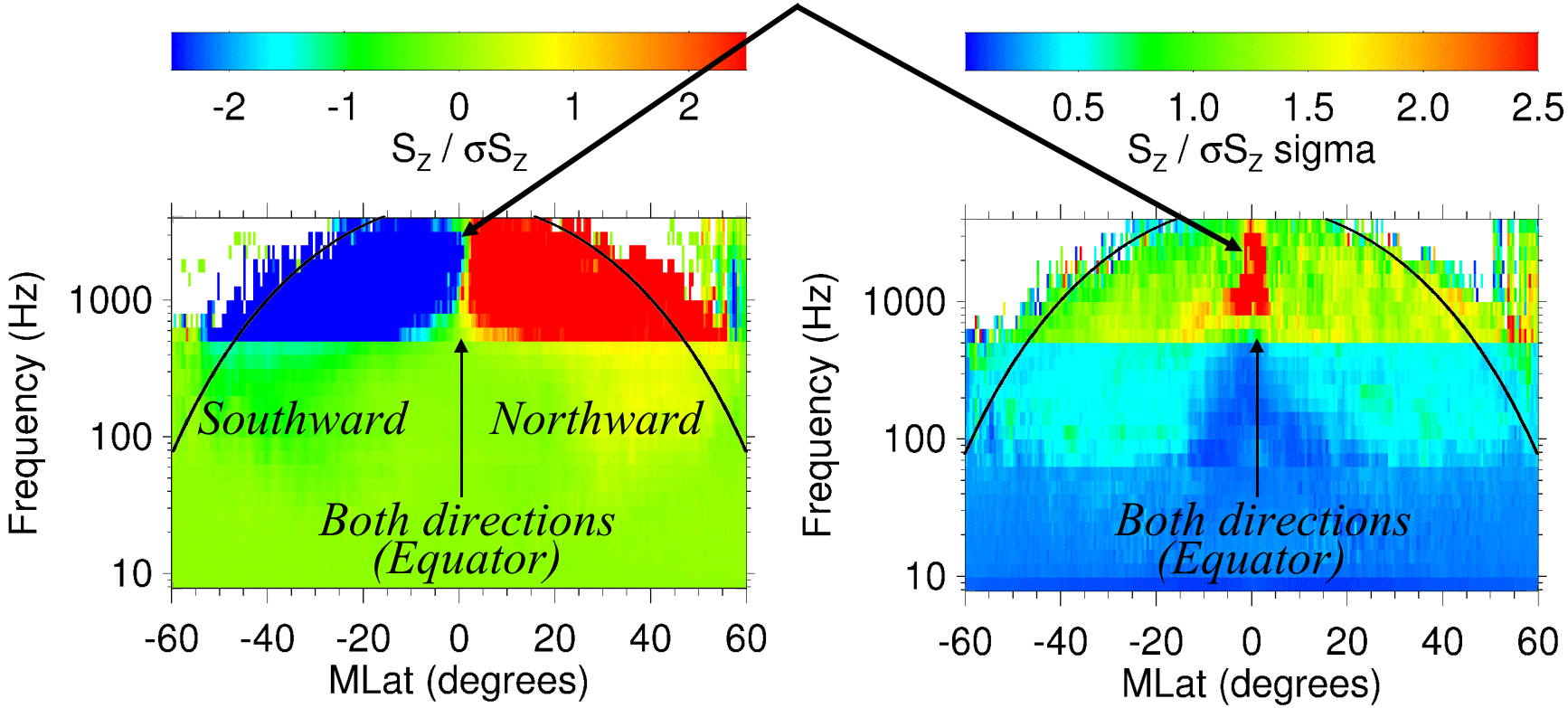
Average of data recorded along the 2001-2005 Cluster orbits close to the perigee

Standard deviation of data recorded along the Cluster orbits close to the perigee

Average latitude-frequency spectrograms

Accumulated STAFF-SA observations 2001-2005

Source of chorus is located within a few degrees of the magnetic equator



Parallel component of the Poynting vector normalized by its standard deviation.

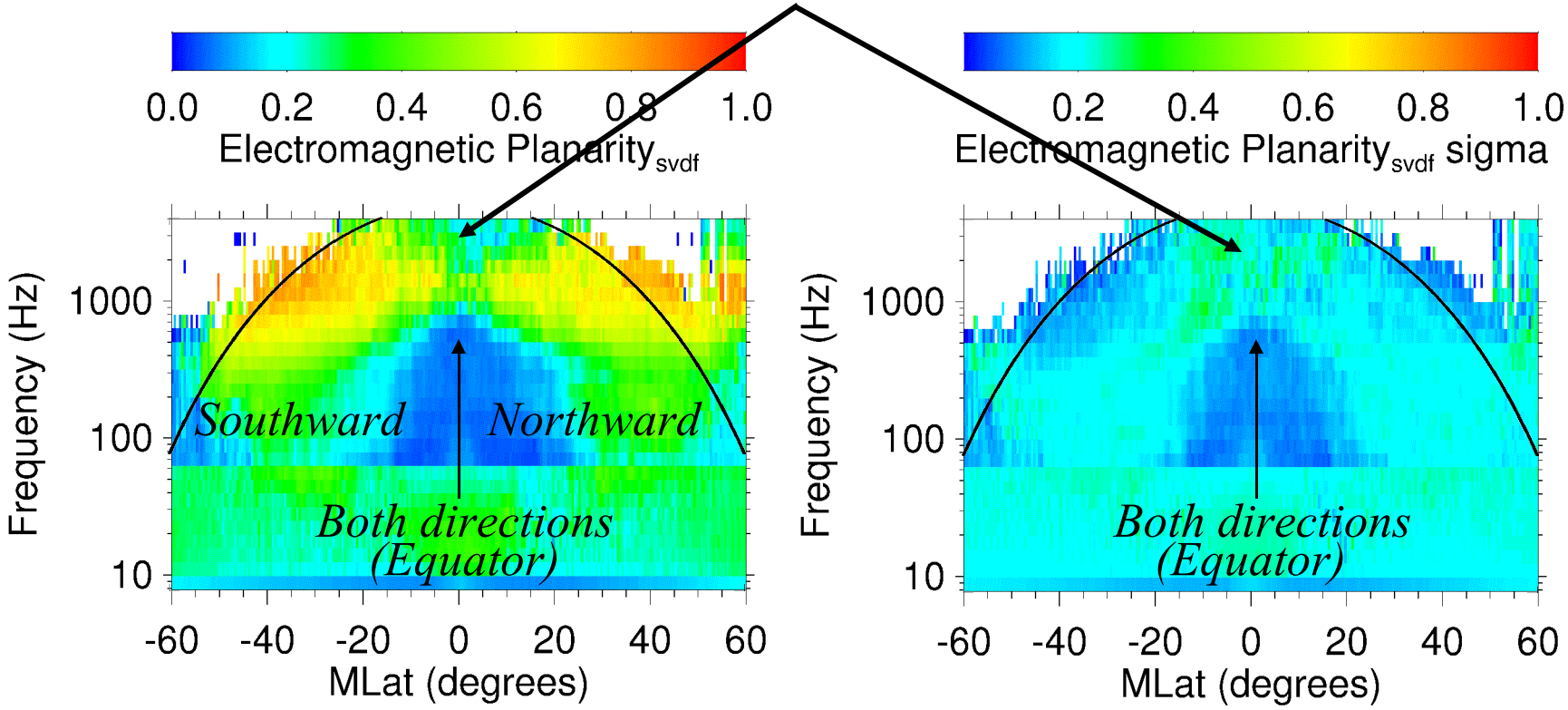
Average of data recorded along the 2001-2005 Cluster orbits close to the perigee

Standard deviation of data recorded along the Cluster orbits close to the perigee

Average latitude-frequency spectrograms

Accumulated STAFF-SA observations 2001-2005

Source of chorus is located within a few degrees of the magnetic equator



Electromagnetic planarity obtained from the singular value decomposition of the spectral matrix of magnetic and electric components.
Average of data recorded along the 2001-2005 Cluster orbits close to the perigee

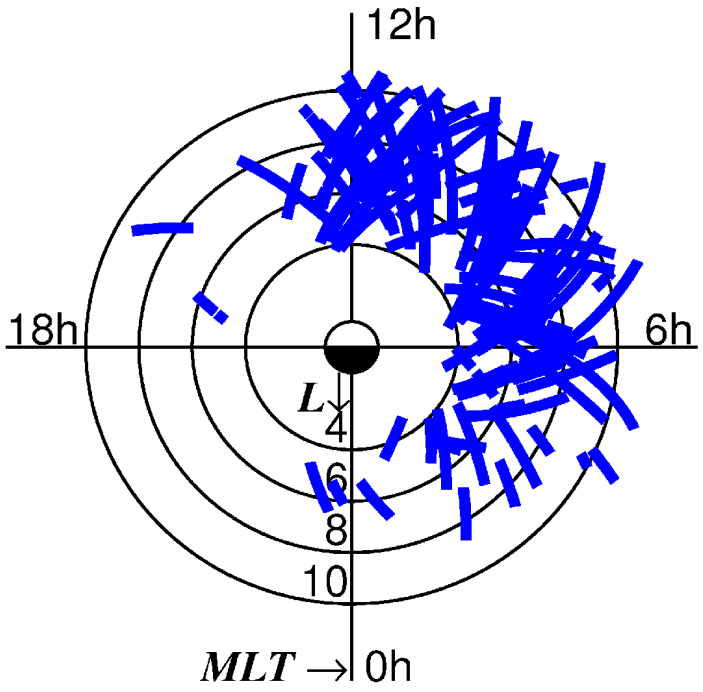
Standard deviation of data recorded along the Cluster orbits close to the perigee

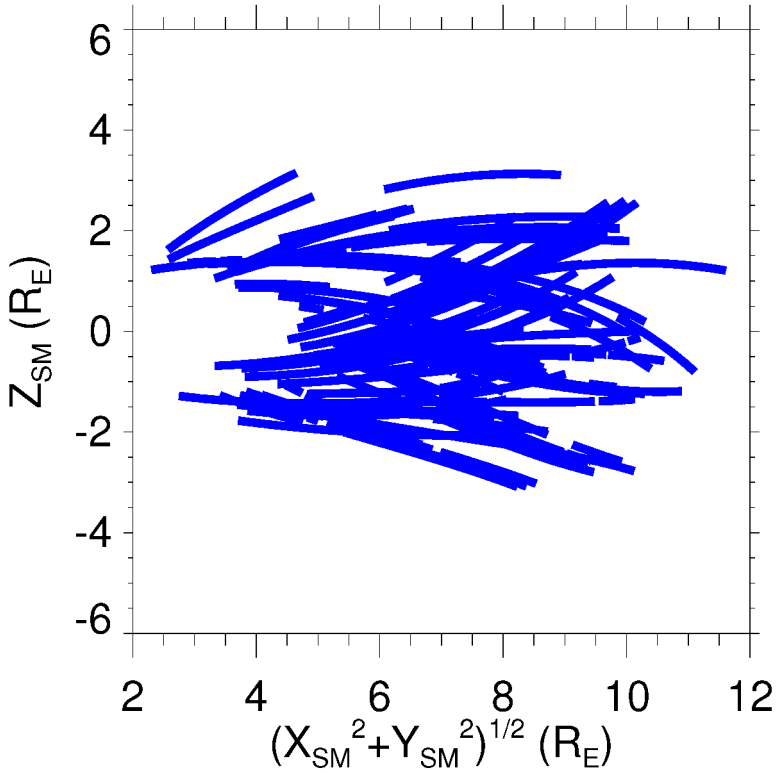
探测

Double Star TC-1

STAFF-DWP observations 2004-2005

Chorus cases (150 orbits, 170,000 spectra)





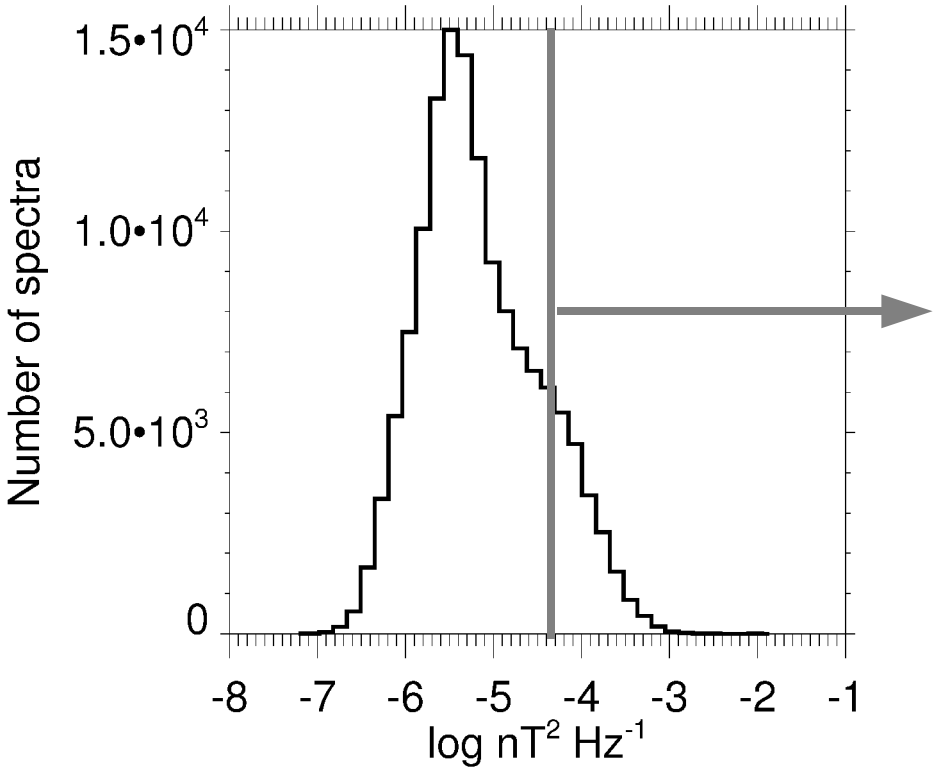
探测

Double Star TC-1

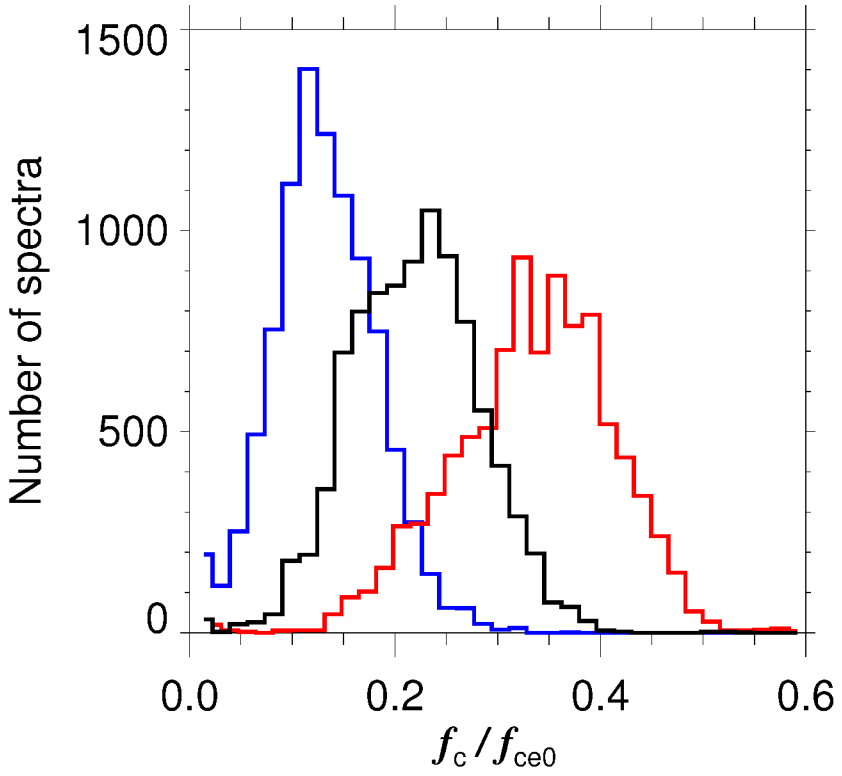
STAFF-DWP observations 2004-2005

Chorus cases

intensity



characteristic frequencies



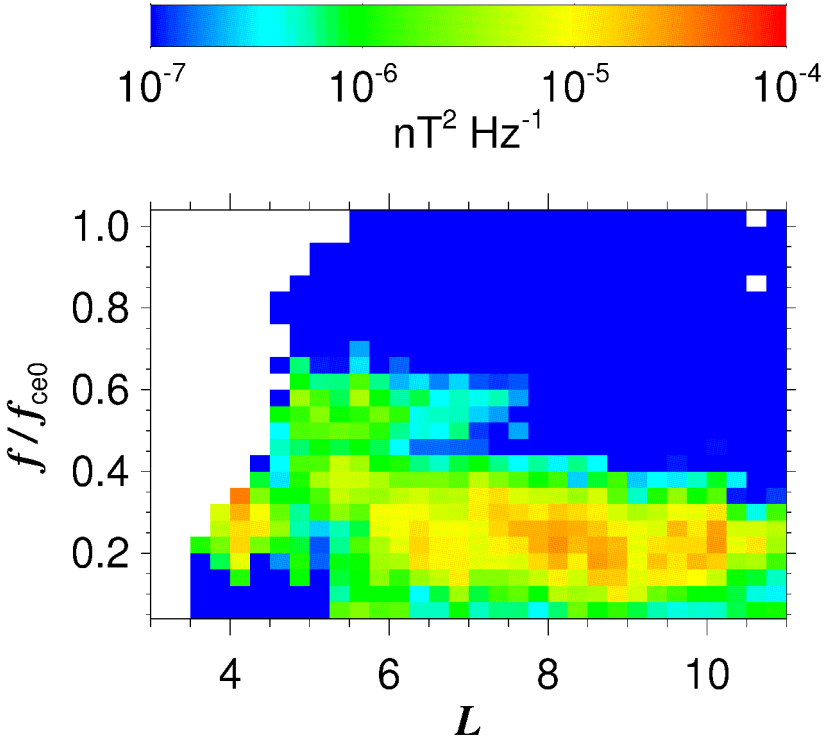
探测

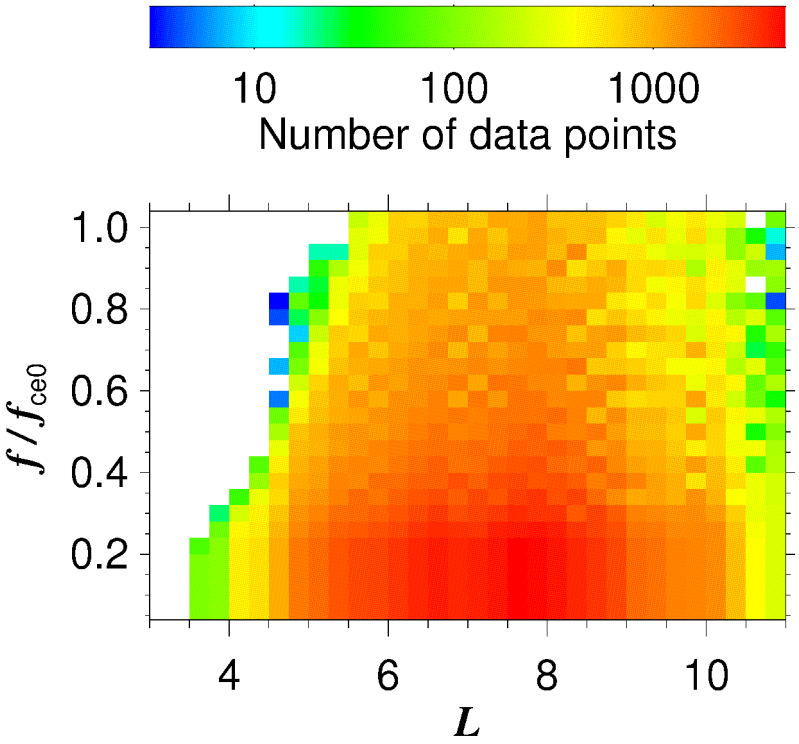
Double Star TC-1

STAFF-DWP observations 2004-2005

Chorus cases

average power spectral density





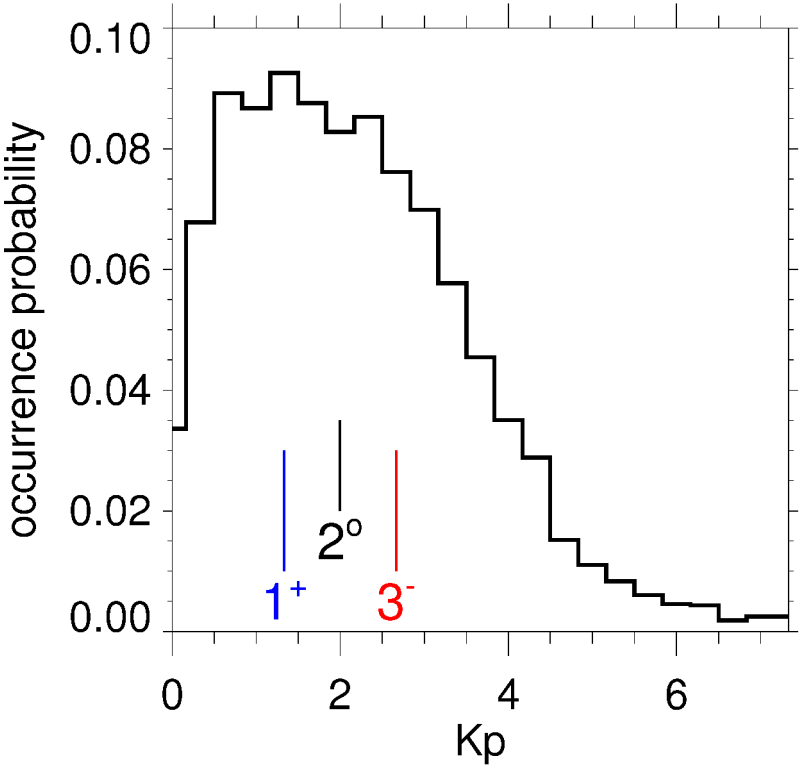
探测

Double Star TC-1

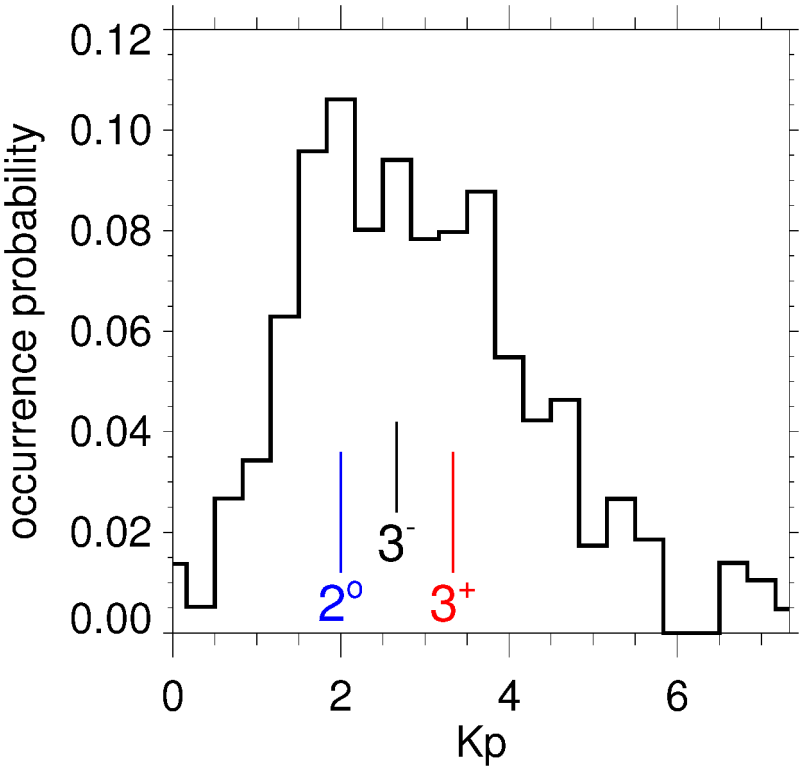
STAFF-DWP observations 2004-2005

Kp distribution

Entire time interval



Chorus cases



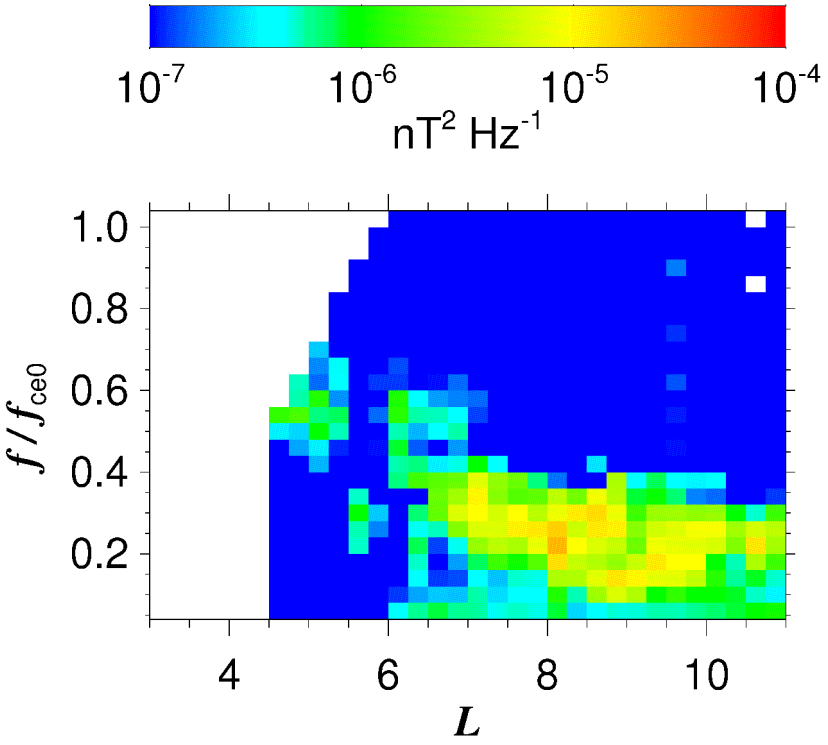
探测

Double Star TC-1

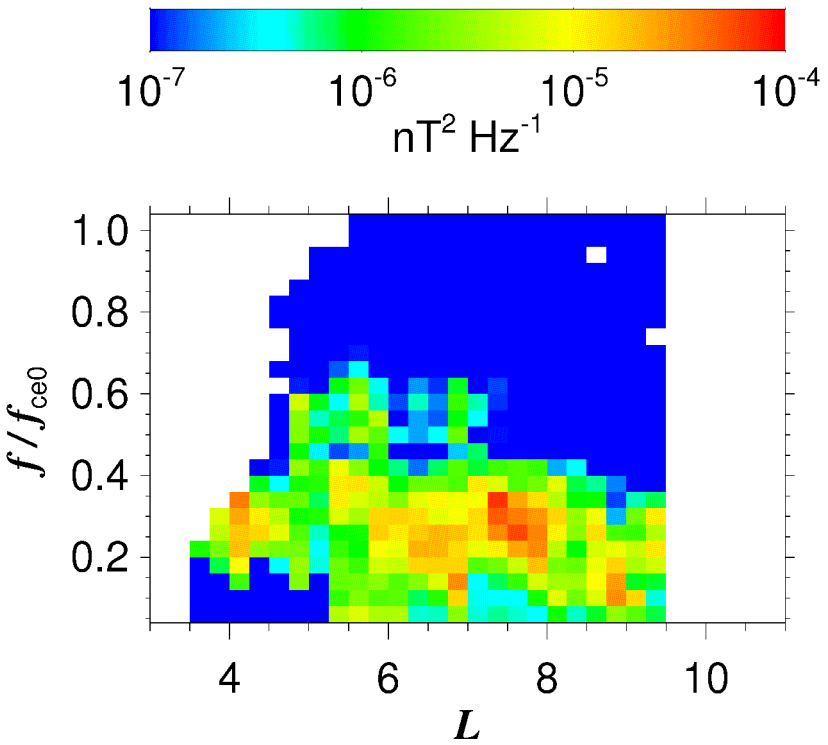
STAFF-DWP observations 2004-2005

Kp distribution

low Kp < 2o



high Kp > 3+



Summary

- Many new experimental and theoretical results on chorus source region have been recently obtained using Cluster and Double star data. Chorus appears as highly variable emission in the entire data set.
- Analysis of large volumes of data from the Cluster and Double Star spacecraft clearly shows that source region of chorus is located within a few thousands of km from the geomagnetic equatorial plane.
- The region of observed maximum intensity seems to be shifted towards L~8 for low and moderate geomagnetic activity.
- Intense chorus cases have been found when the geomagnetic activity was higher, with Kp>2