

Spectral features of lightning-induced ion cyclotron waves at low latitudes: DEMETER observation and simulation

J. Chum¹, F. Jiricek¹, F. Nemec², M. Parrot³,
D. Shklyar⁴, and E. Titova⁵

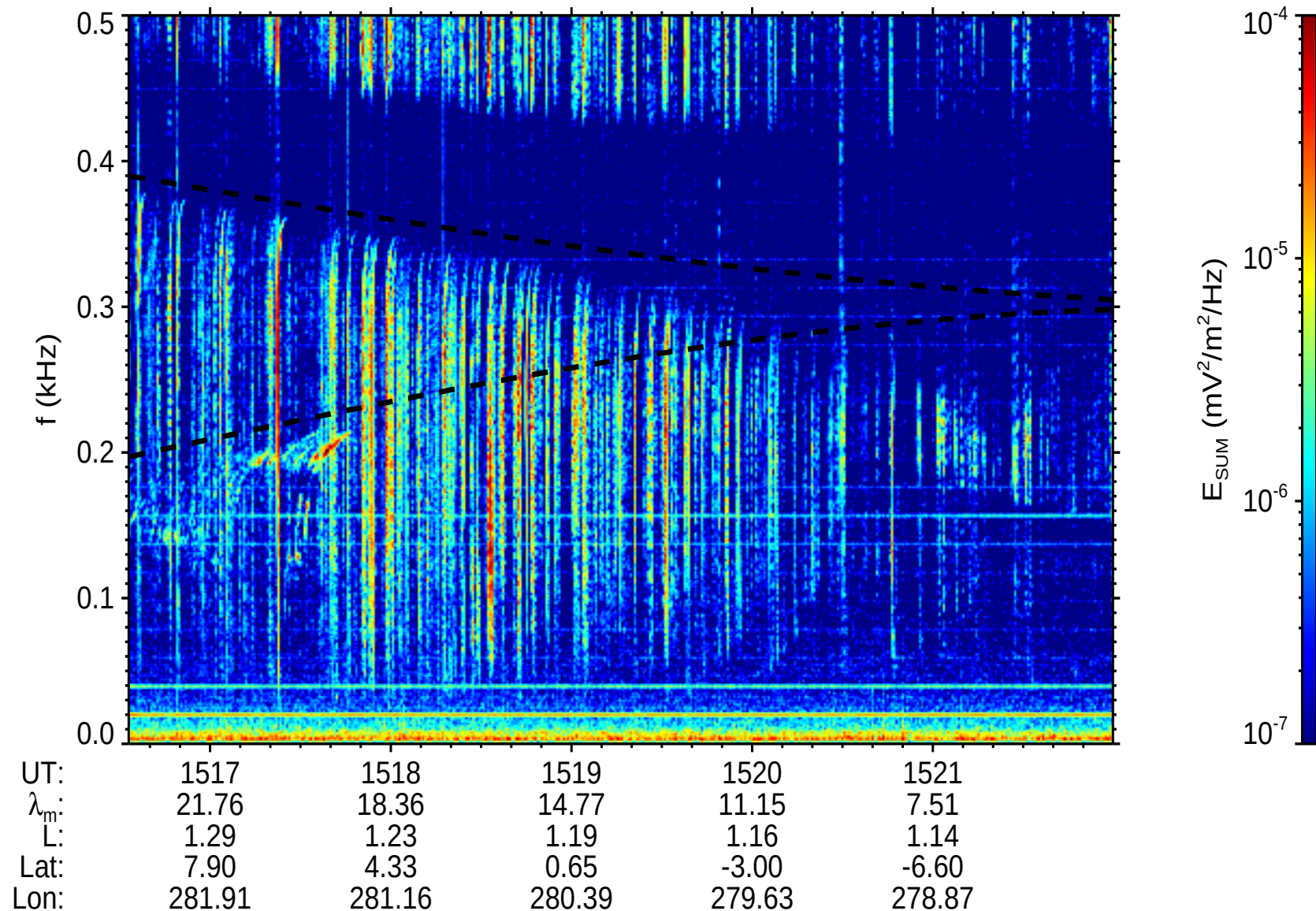
¹*Institute of Atmospheric Physics, AS CR, Prague, Czech Republic.*

²*Faculty of Mathematics and Physics, Charles University in Prague,
Prague, Czech Republic.*

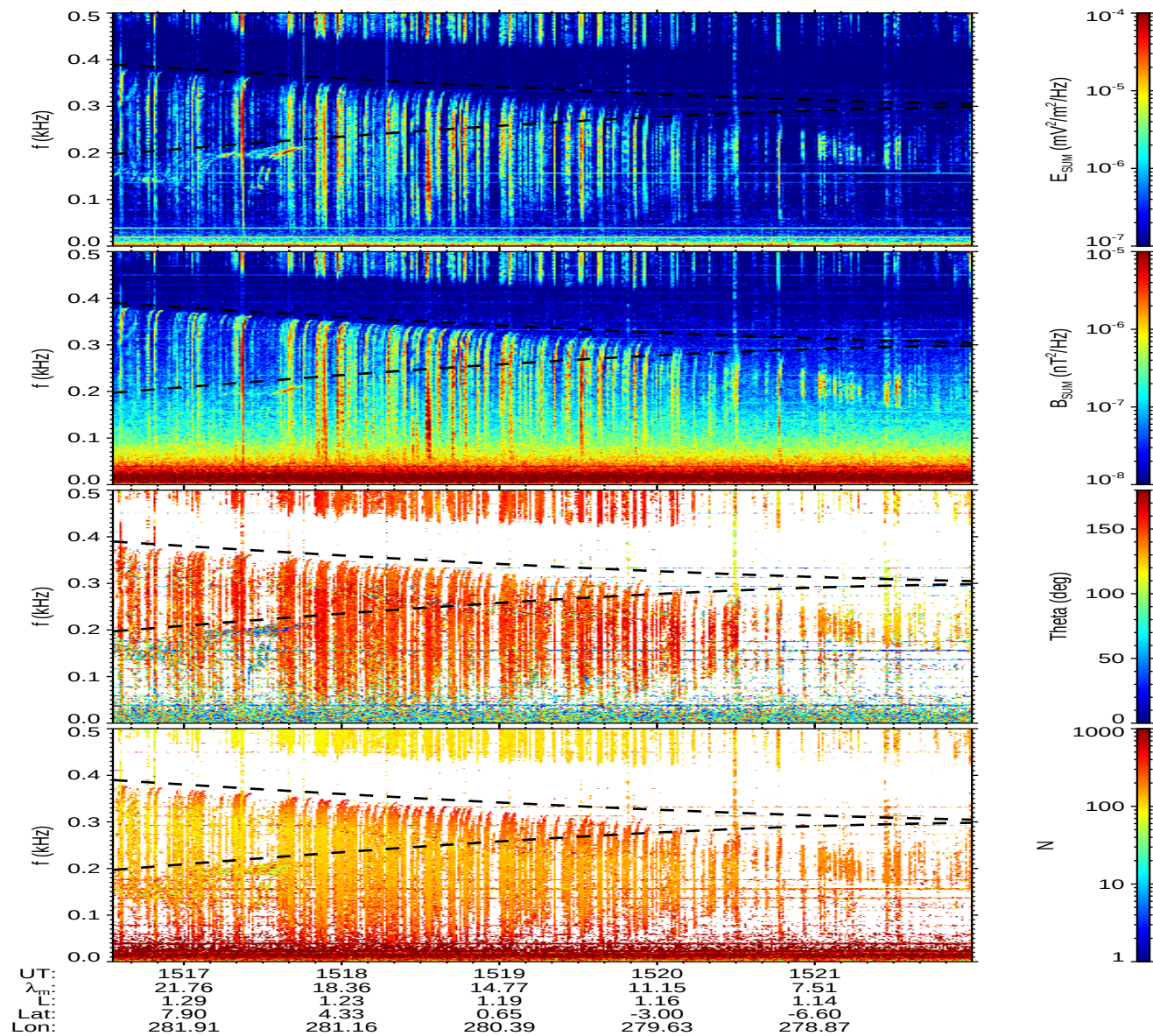
³*LPC2E/CNRS, Orleans cedex 2, France.*

⁴*Space Research Institute of RAS, Moscow, Russia.*

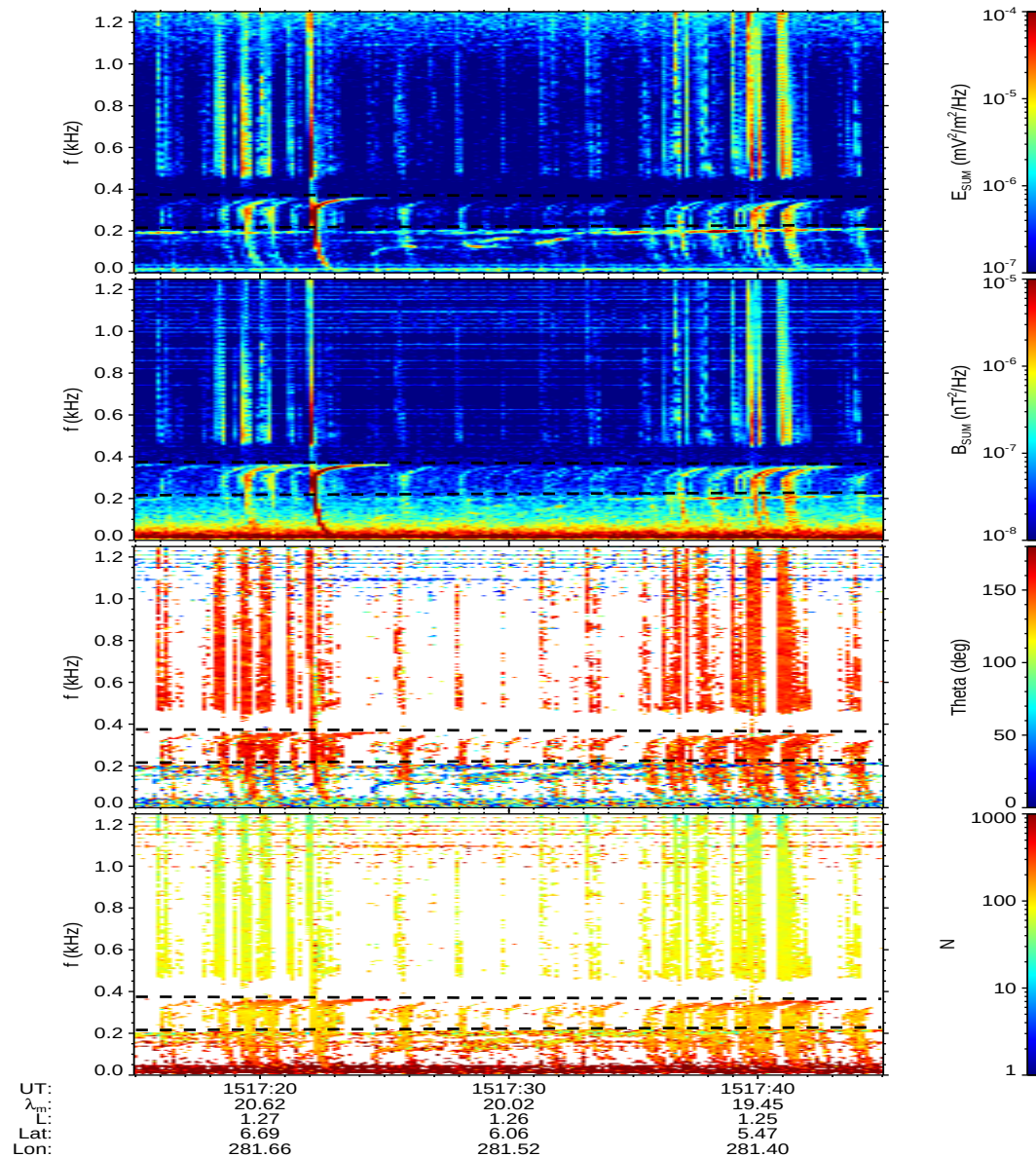
⁵*Polar Geophysical Institute, Apatity, Russia.*



Example of ion cyclotron wave observation on DEMETER.
Waves originate from a thunderstorm in the same hemisphere.



Wave normal angle and refractive index for waves observed in the same hemisphere as the source.

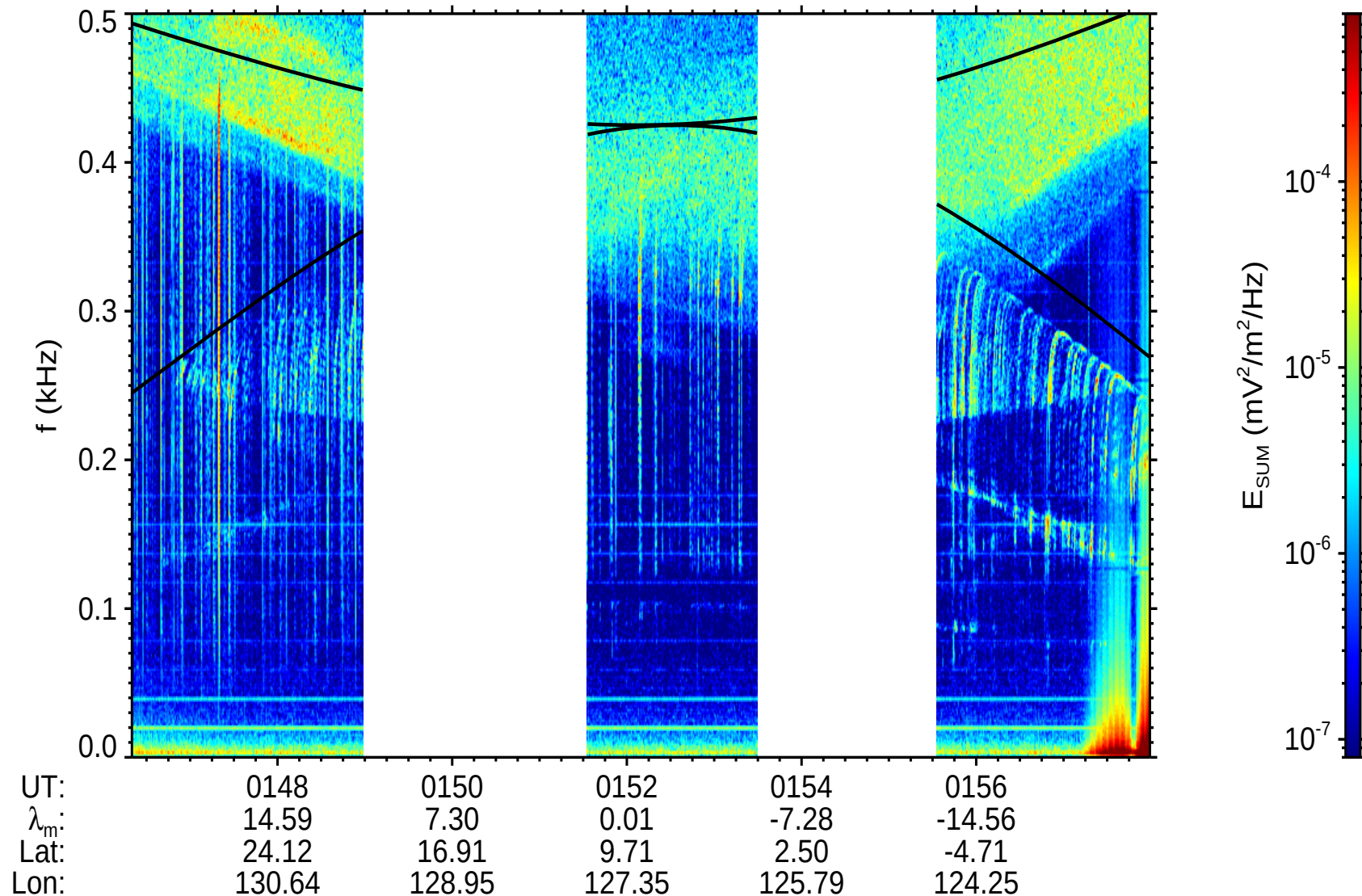


Proton whistlers

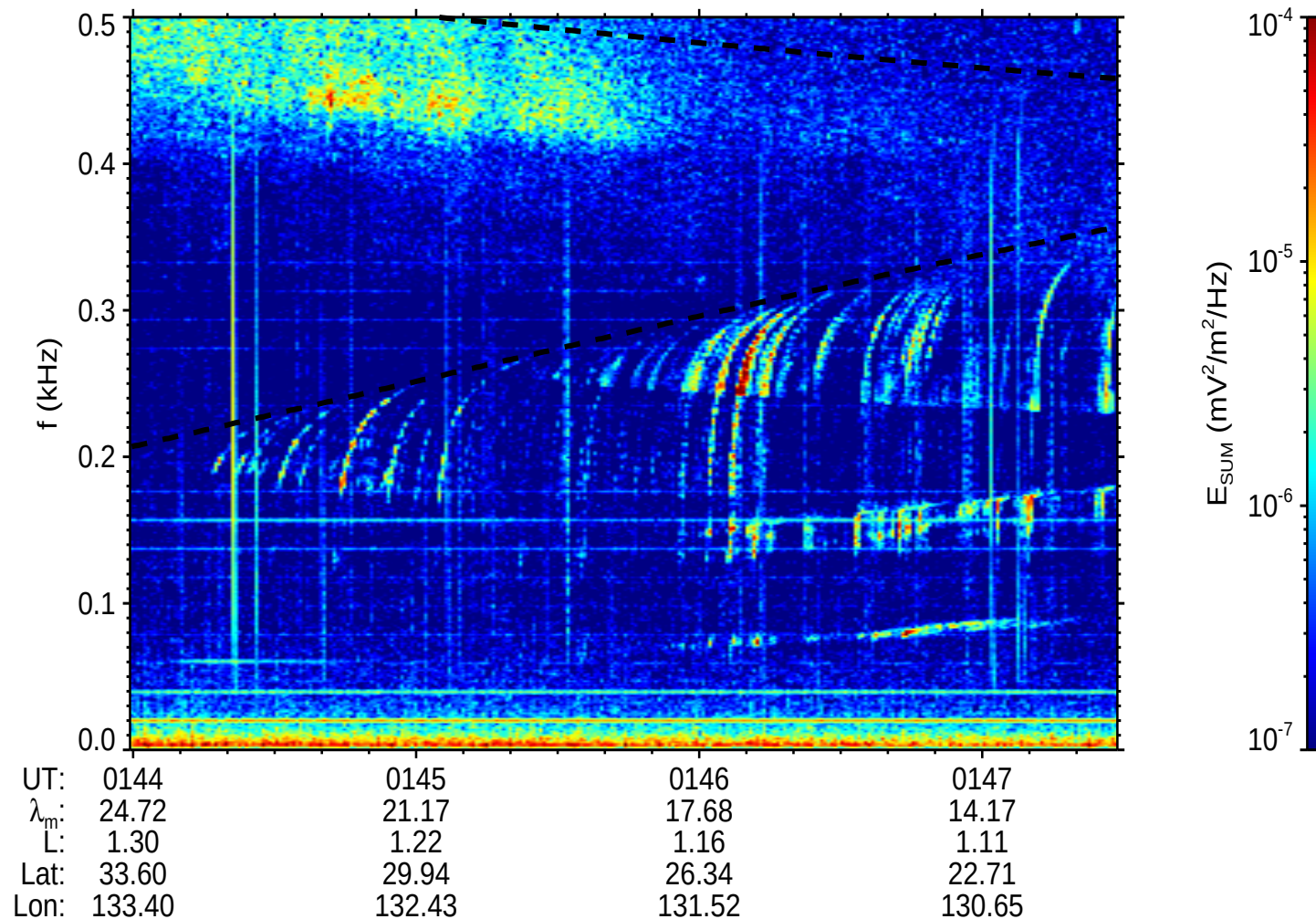
observed in the same hemisphere as the lightning stroke.

First found in the VLF recordings from the Injun 3 and Alouette satellites (Smith et al., 1964; Brice, 1964) and explained by Gurnett et al. (1965).

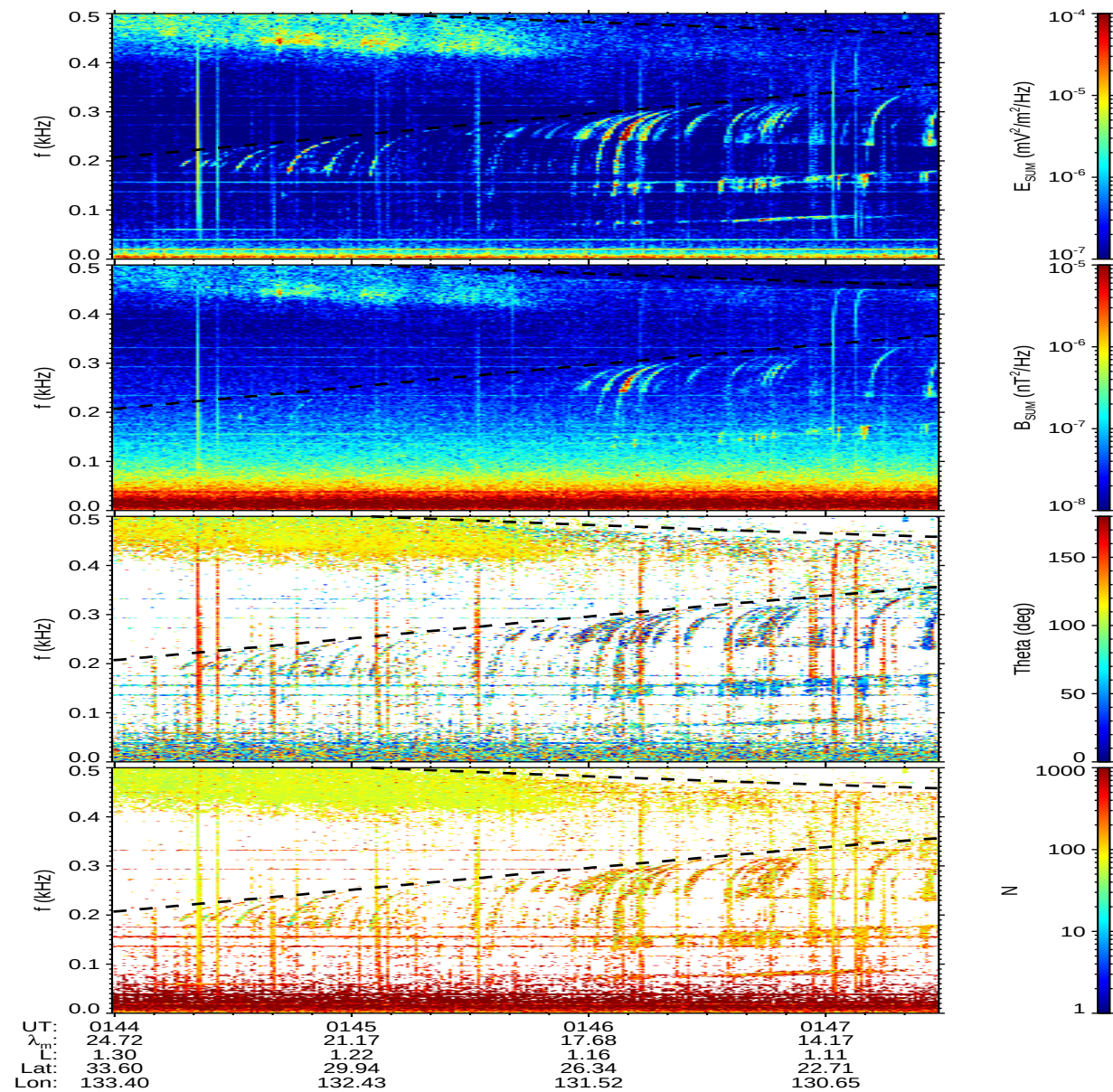
Wave normal angle and refractive index for waves observed in the same hemisphere as the source. Better time resolution.



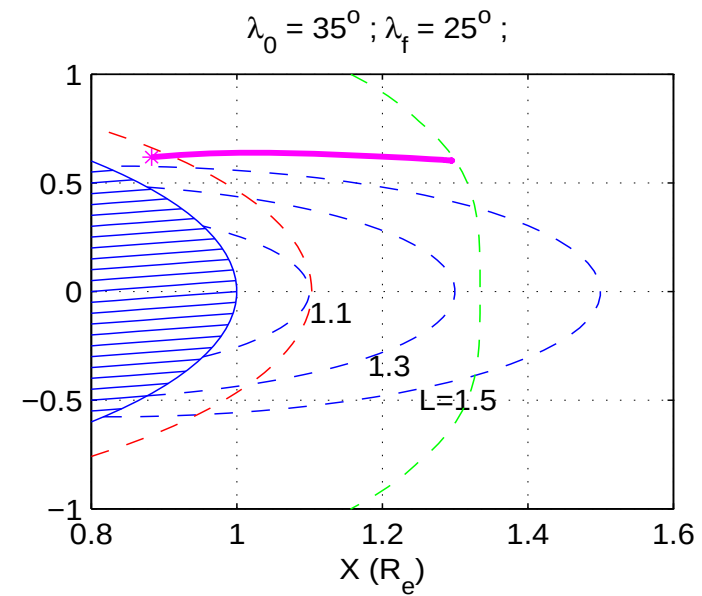
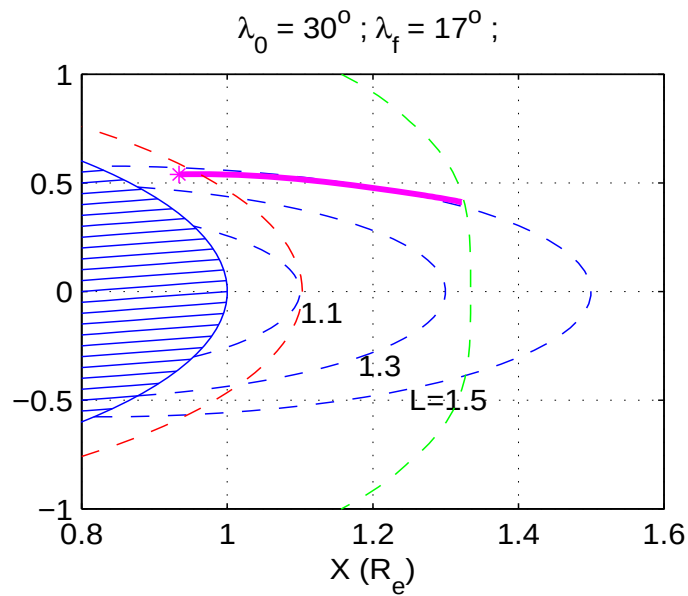
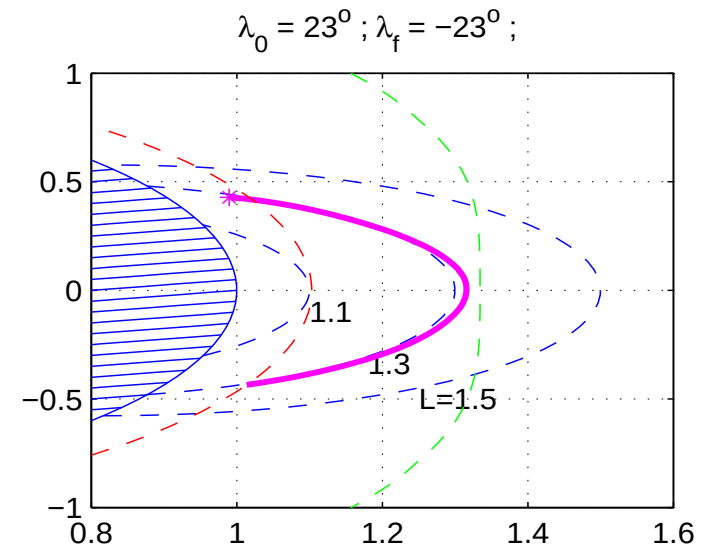
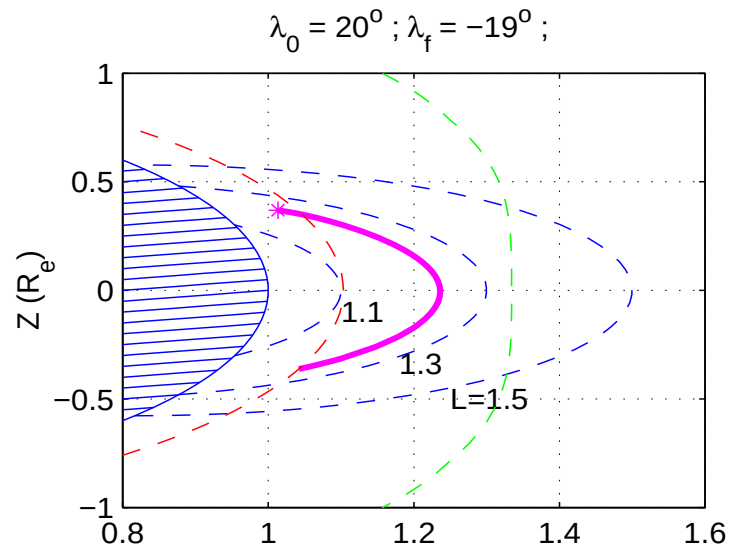
Example of ion cyclotron wave observation on DEMETER.
Waves originate from a thunderstorm in the opposite hemisphere



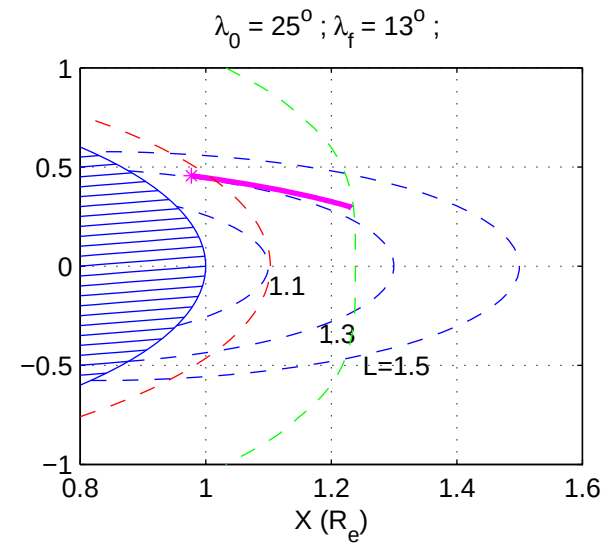
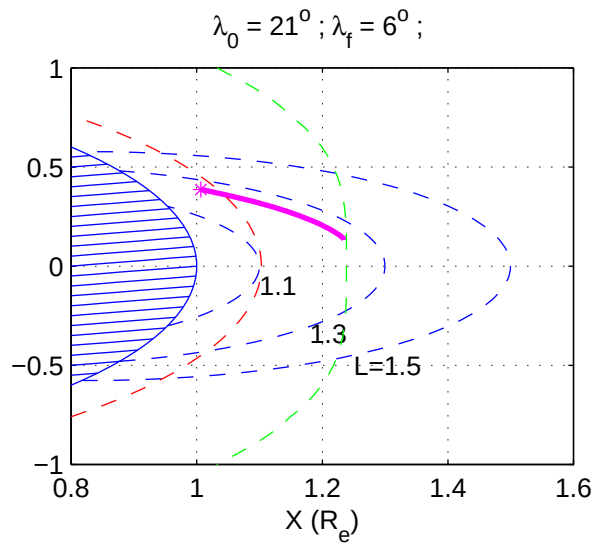
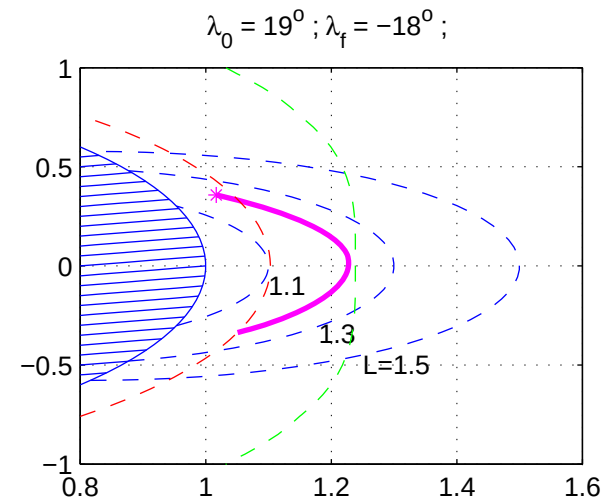
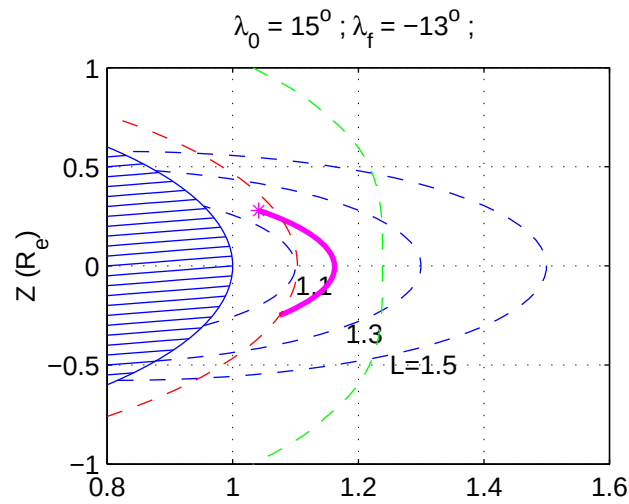
Example of ion cyclotron wave observation on DEMETER.
Waves originate from a thunderstorm in the opposite hemisphere.
Better time resolution.



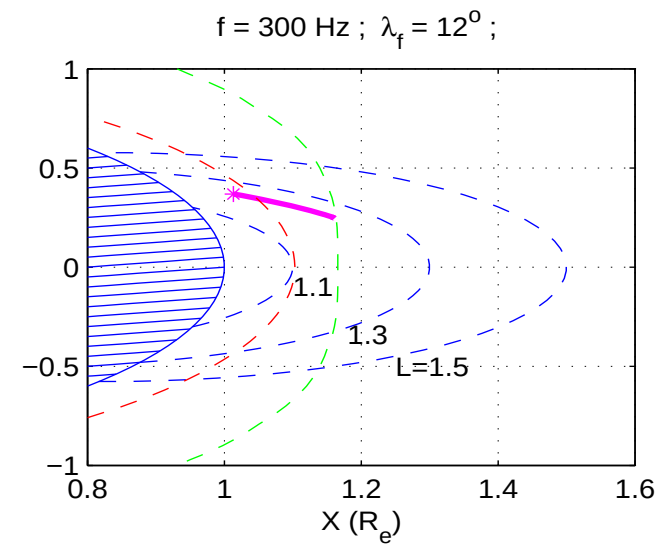
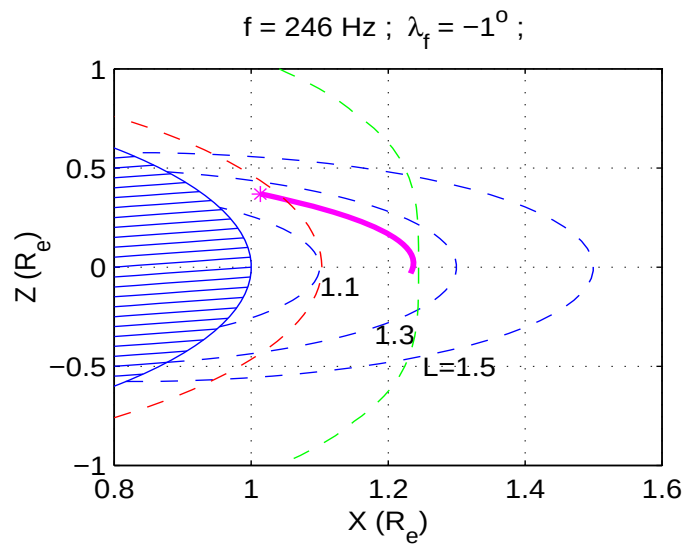
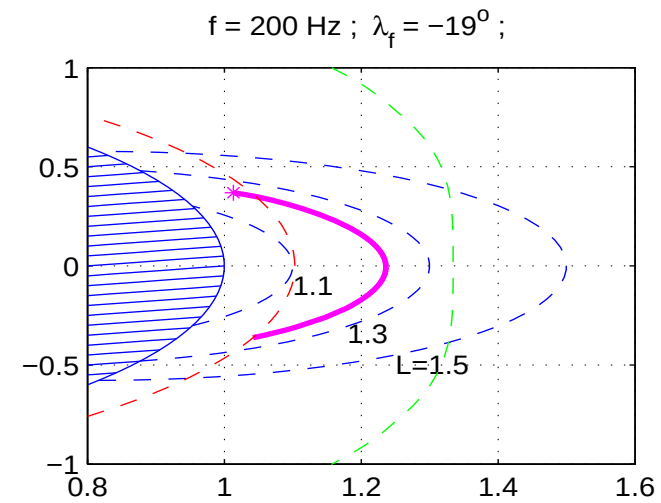
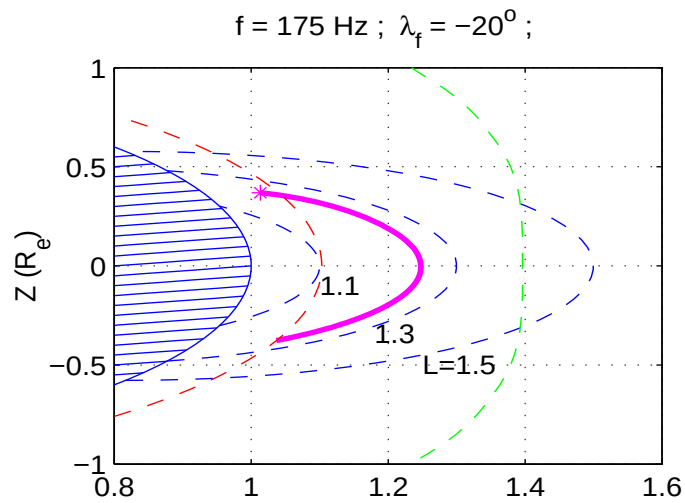
Wave normal angle and refractive index for waves observed
in the opposite hemisphere to the source.



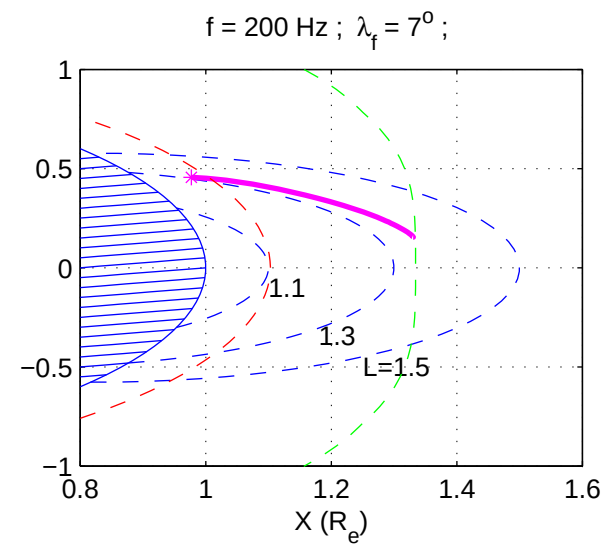
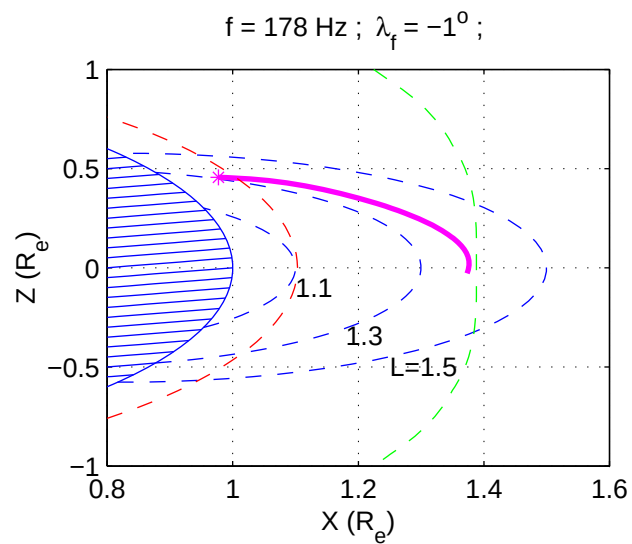
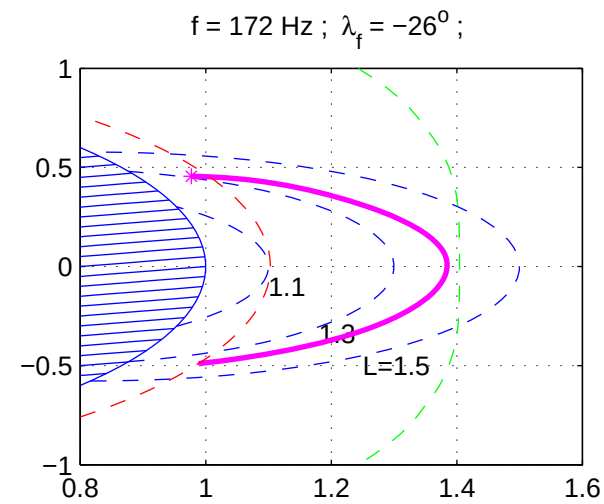
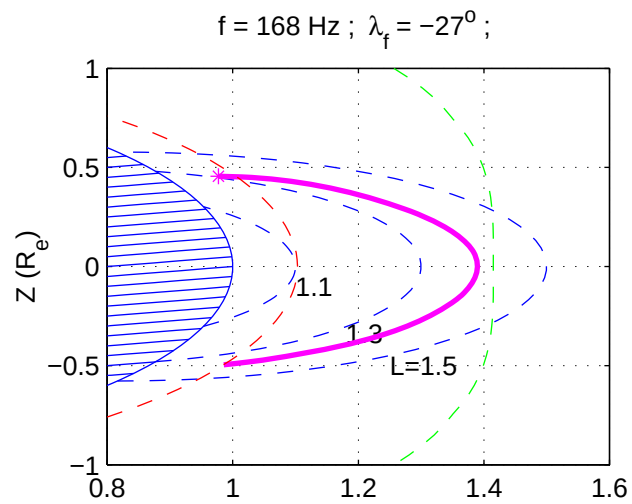
Ray trajectories for proton cyclotron waves of 200 Hz and various initial latitudes.



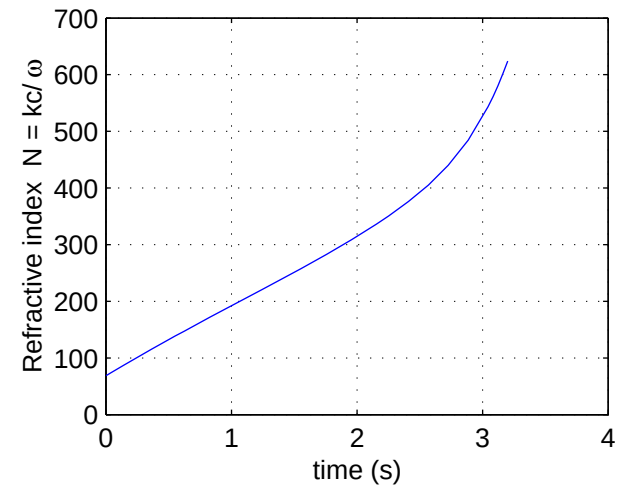
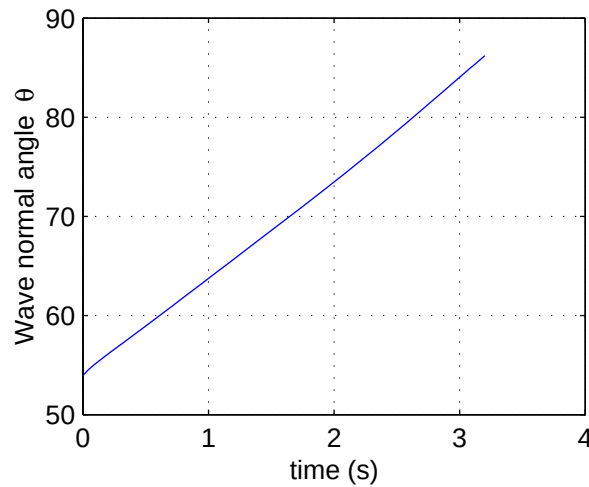
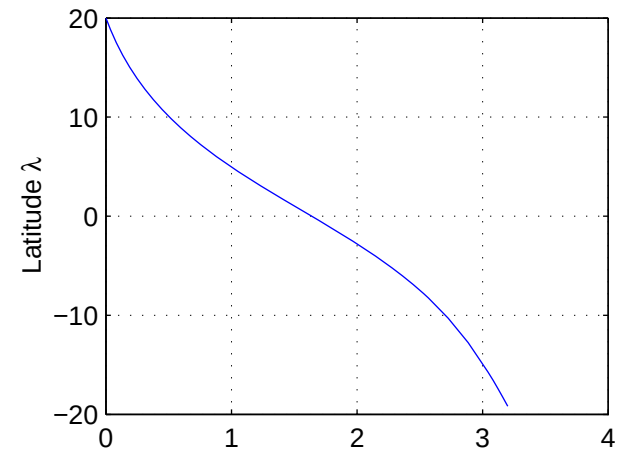
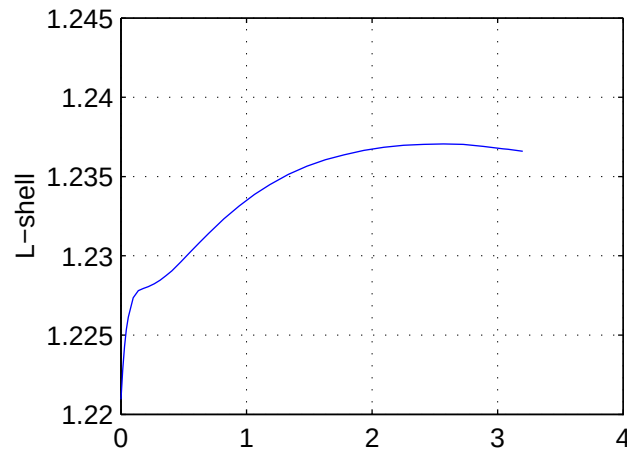
Ray trajectories for proton cyclotron waves of 250 Hz
and various initial latitudes



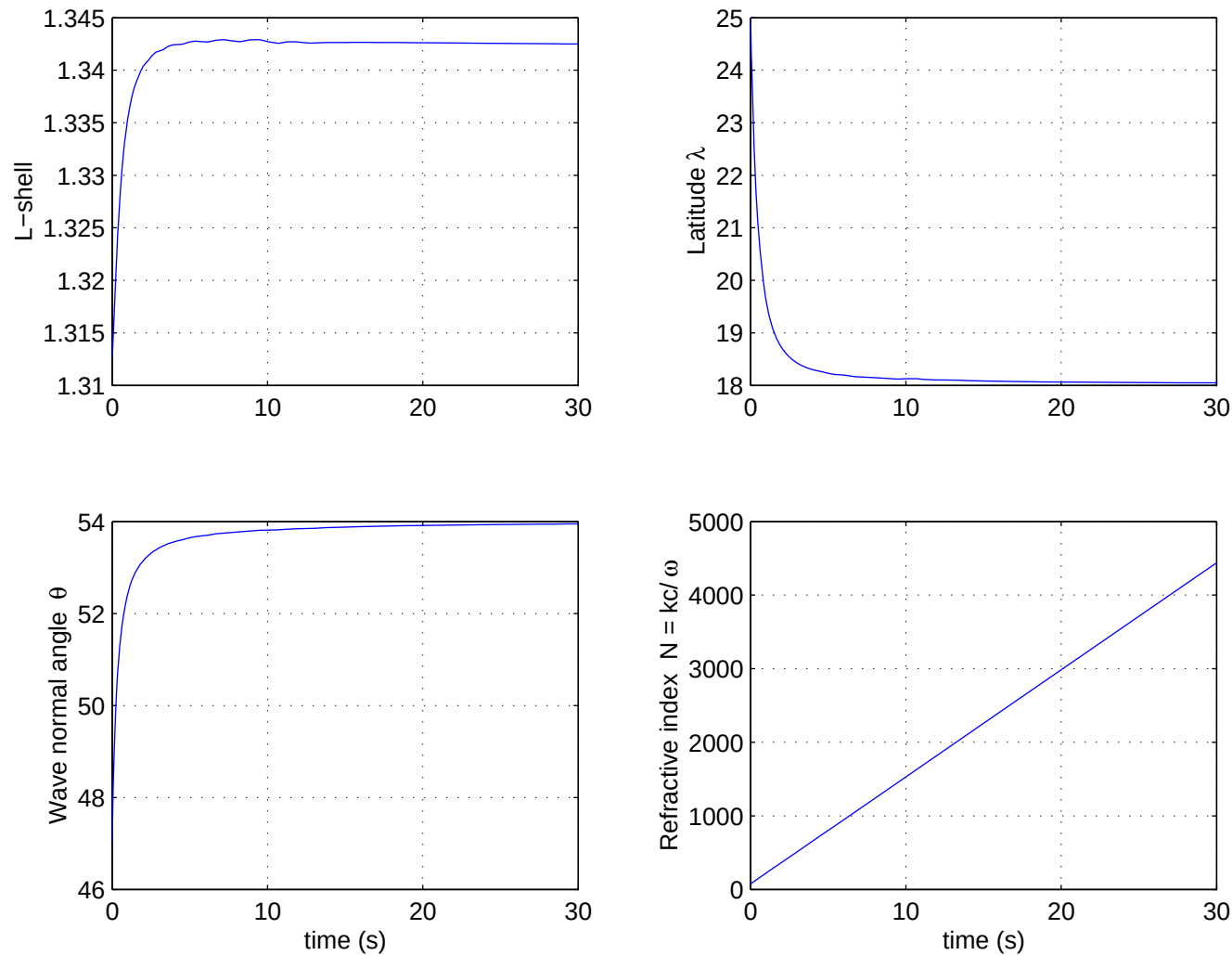
Ray trajectories for various frequency proton cyclotron waves
starting from $\lambda_0 = 20^\circ$



Ray trajectories for various frequency proton cyclotron waves
starting from $\lambda_0 = 25^\circ$



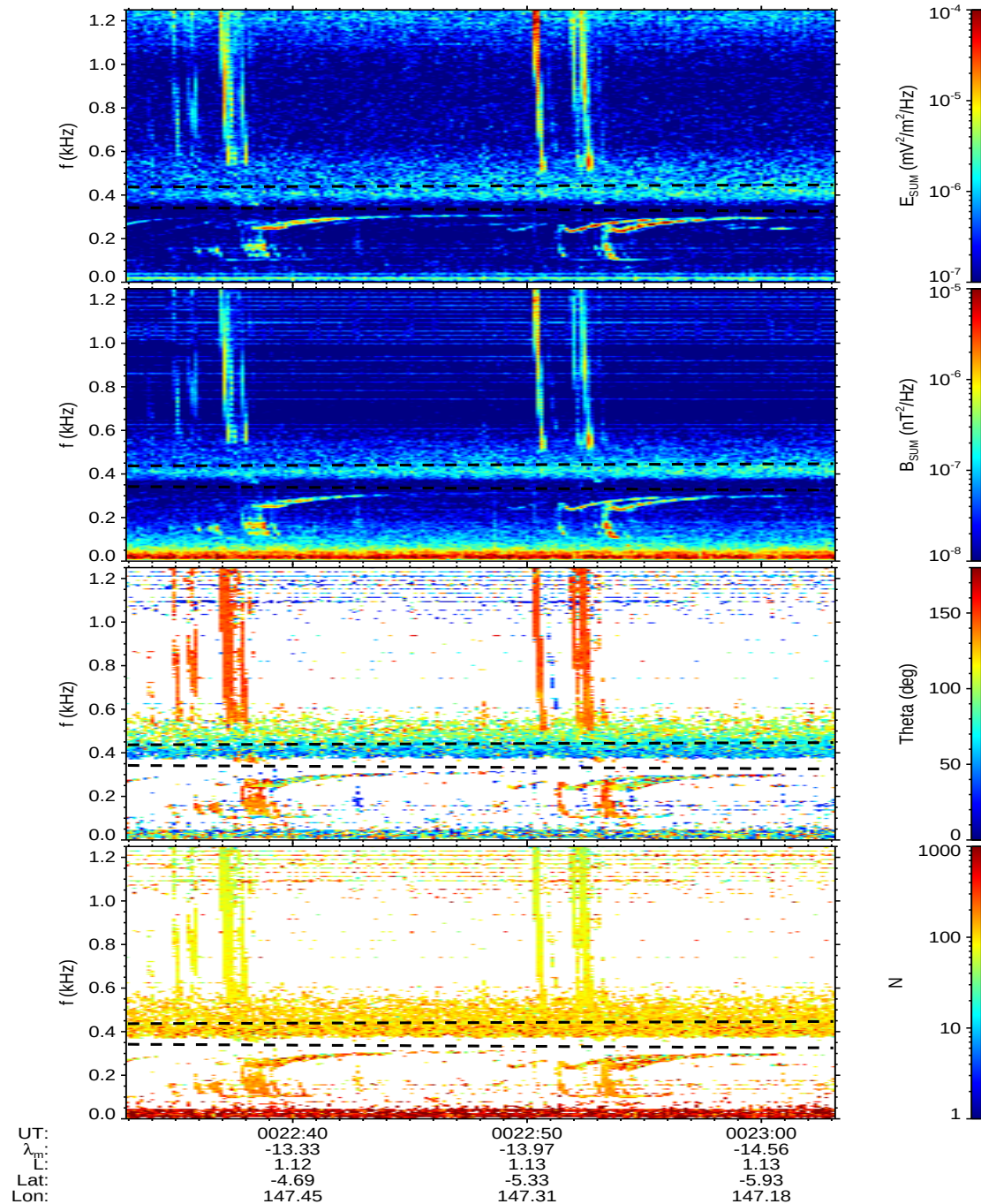
Wave parameters: L-shell, latitude , wave normal angle , and refractive index $N = kc/\omega$ for 200 Hz wave that starts at $\lambda_0 = 20^\circ$ and reaches the satellite height in the opposite hemisphere



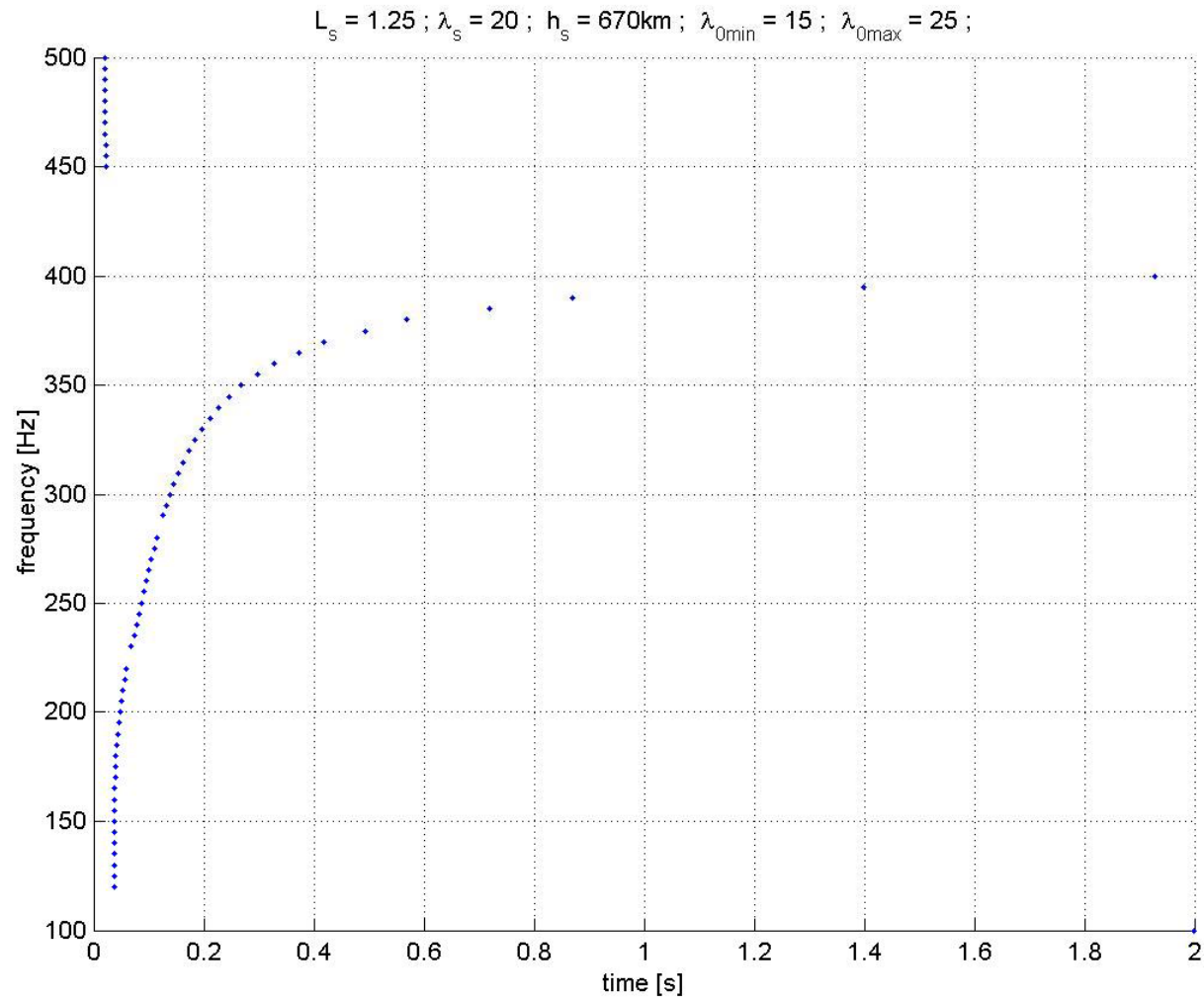
Wave parameters: L-shell, latitude , wave normal angle , and refractive index $N = kc/\omega$ for 300 Hz wave that starts at $\lambda_0 = 25^\circ$ and gets stuck in the same hemisphere as the source.

Proton whistlers observed in the hemi- sphere opposite to that of the lightning stroke.

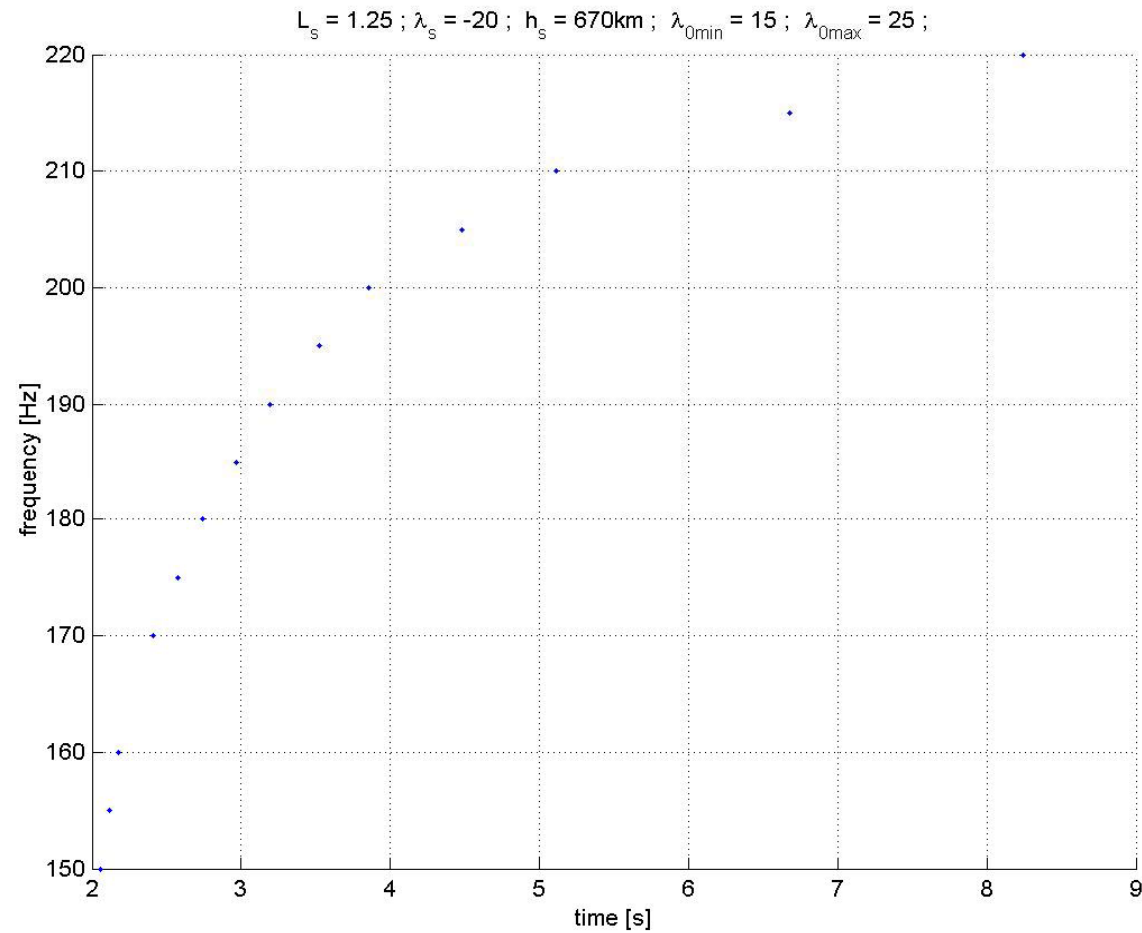
In contrast to classical
proton whistlers (Gurnett
et al., 1965), the upper-
frequency cutoff is now
not equal to local proton
gyrofrequency, but to the
corresponding equatorial
gyrofrequency.



Computer-simulated spectrogram of proton whistler



Computer-simulated spectrogram of proton whistler observed in the hemisphere opposite to that of the source



Computer-simulated overview spectrogram along the satellite orbit

