Observations of Lightning Induced Whistler Triggered Upper Band Chorus

Poorya Hosseini and Mark Golkowski

Department of Electrical Engineering, University of Colorado Denver, Colorado, USA.

VLF radiation from atmospheric lightning discharges is known to be a key source of wave energy injected into the inner magnetosphere from the Earth's surface. A small fraction of the energy radiated from lightning discharges propagates through the ionosphere and enters the magnetosphere. Lightning discharges initially produce a broadband impulse or 'sferic' but after propagation in the dispersive magnetosphere this waveform soon becomes quasi narrow band with the characteristic spectrographic form of the whistler.

Most of this injected VLF wave energy into the magnetosphere will propagate in the unducted mode with a k-vector, which becomes increasingly oblique. Although unducted radiation is ubiquitous throughout the inner magnetosphere, it is generally of a low amplitude due to Landau damping and is not expected to produce strong nonlinear phenomena such as triggered emissions and chorus waves. However, VLF wave energy ducted or trapped in field-aligned plasma density enhancements can have relatively large amplitudes due to focusing and also linear cyclotron resonance growth. Therefore high amplitude ducted whistler waves can trigger a number of complex nonlinear phenomena. These include the triggering of VLF emissions and triggering of broadband VLF hiss or chorus. Such phenomena result from nonlinear electron cyclotron phase trapping by the whistler wave.

Observation of chorus and hiss being triggered by lightning induced whistlers are rare but have been reported since the 1970s in Antarctica. We present more recent observations of whistlers triggering upper band chorus emission from Alaska. Dispersion analysis of whistlers determine the L-shell range to be $4.5 < L < 5.9$ and equatorial plasma density range to be 50 – 200 el/cc. Moreover, there is a clear frequency band gap between upper and lower band of the observed chorus emissions. The observations point to ducted chorus generation in the vicinity of the plasmapause boundary.