PROPAGATION OF WHISTLER-MODE WAVES THROUGH THE IONOSPHERE TO THE RADIATION BELT

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Very-low frequency (VLF) waves in the whistler mode are important for the dynamics of energetic electrons in the Earth's magnetosphere. In particular, whistlers are capable of scattering high-energy radiation belt electrons into the loss cone via cyclotron resonance, and therefore, the controlled injection of kHz VLF wave power can significantly reduce the lifetime of MeV-energy electrons. In this presentation we reports results from two of our recent research projects.

One of them uses EMHD simulations to investigate whistler propagation through the ionosphere detected on the DEMETER satellite above HAARP transmitter at Alaska. Our simulations show that detected by the DEMETER satellite wave power enhancements localized above an active heating region are consistent with whistler propagation inside multiple density ducts. The initial concentration of wave power inside the ducts suggests that a density-dependent generation mechanism, such as linear mode conversion from lower hybrid waves, is responsible for generating these whistlers. Magnetic field-aligned density variation eventually causes power to leak from the ducts. This combination of ducting and leakage appears sufficient to explain the characteristics of the DEMETER signal. This event demonstrates that artificially generated density enhancements can act as whistler ducts, trapping the wave and guiding them across considerable distances with a minimal reduction in amplitude.

Another project investigates propagation of whistler-mode waves in the magnetized plasma with the transverse gradient in density and in the background magnetic field. This project reveals that the density gradient can support whistler ducting if the background magnetic field has a gradient in the same direction as the density, but with a different rate. We provided a quantitative criterion for parameters of the background media and whistler waves providing ducting and demonstrate relevance of these results to the whistler ducting in the radiation belt.