Structured Low-Frequency Whistler Mode Emissions Observed in Recent Auroral Rocket Experiments

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Recent advances in telemetry rates, data acquisition, and data storage technologies have made it possible to record waveforms of LF-MF waves (30-3000 kHz) in both rocket-borne and ground-based experiments. As a result new features of radio emissions of auroral origin have been documented. This paper focusses on emissions below the electron gyrofrequency, which is near 1 MHz in the auroral ionosphere. This frequency range is dominated by auroral hiss, a whistler mode emission which earns its name because at VLF it is often dominated by a structureless spectrum causing it to sound like hiss when played through a loudspeaker. However, it has long been known that even at VLF not all auroral hiss is structureless, and three recent auroral rocket experiments reveal structured waves dominating the LF-MF portion of the spectrum. The most distinctive of these are narrow-band ``stripes" which decrease in frequency approximately linearly from 500 kHz to 250 kHz over a few tenths of a second [Samara and LaBelle, 2006]. Less common are narrow-band "hooks" that increase in frequency, with long delays recorded for frequencies which approach a local cutoff frequency. Other features have broader bandwidths and frequencies that increase or decrease with time. In some cases, the polarization of these features and their lack of correlation with local plasma densities or particles suggest that they are electromagnetic and of remote origin, implying they are whistler mode. Under some conditions, whistler modes can penetrate the Earth-ionosphere boundary to be observed at ground-level, and in fact, recent observations at South Pole Station reveal a variety of structured features of LF auroral hiss, although the frequency range and detailed characteristics of the structured ground-level LF hiss does not generally match those of the LF-MF waves detected with the rocket-borne receivers. Propagation conditions may explain these differences between the ground-level phenomena and those observed with the rockets. These observations pose a challenge to plasma theoretical models of auroral whistler mode radiation. (Samara, M., and J. LaBelle, J. Geophys. Res., vol. 111, A09305, doi:10.1029/2005JA011535, 2006)