

Analysis of Sidebands from Magnetospheric Emissions Triggered by the Siple Station Transmitter

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The Earth's magnetosphere plays host to many unique physical processes resulting from interactions between plasmas and electromagnetic waves. One such process is the coherent wave instability (CWI), also known as the phenomena of VLF triggered emissions, which includes the amplification of injected whistler mode waves as well as production of sidebands in the frequency domain. A multitude of experiments on the CWI were conducted at Siple Station, Antarctica from 1973-1989. These experiments involved a 1500 kW transmitter radiating 1-5 kHz waves and effectively injecting coherent whistler mode waves into the magnetosphere at $L = 4-5$ shells. The injected signals were received at Lake Mistissini, Quebec after amplification and triggering in magnetospheric ducts. We focus on recently digitized data from 1986 and on observations of frequency sidebands. The observations are interpreted using a theoretical modulation model, which combines Amplitude Modulation (AM) and Frequency Modulation (FM) to mimic the modulation from in the magnetosphere seen in the digitized data. The model is parameterized by ξ , which quantifies relative AM and FM contributions to the signal from the magnetosphere. We analyze the observations using standard Fourier techniques as well as techniques based on minimum variance distortionless response (MVDR). Specifically, we implement MVDR using the ReFOCUS tool for covariance matrix estimation, developed by Arion Systems, Inc. It is found that generally $\xi \sim 150$ indicating the signals have larger AM contributions though FM effects can also be significant. It remains to be seen what the consequences are on the CWI process from the identified modulation contributions. Other unique sideband properties present in the observations include: 1) the relationship between the sideband frequency offset and the amplitude of the transmitted signal, 2) the absence of lower-frequency sidebands when higher frequency sidebands exist and 3) evidence of sidebands development leading to further sub-sideband development.